Feb. 16, 1937. E. G. LINDER 2,071,311

MICRO-WAVE OSCILLATOR AND DETECTOR

Filed July 2, 1934

Fig. 1.

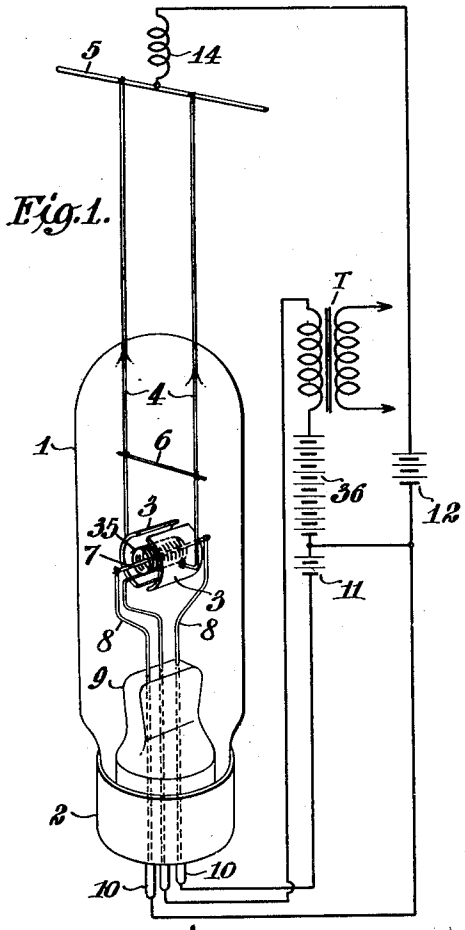


Fig. 2.

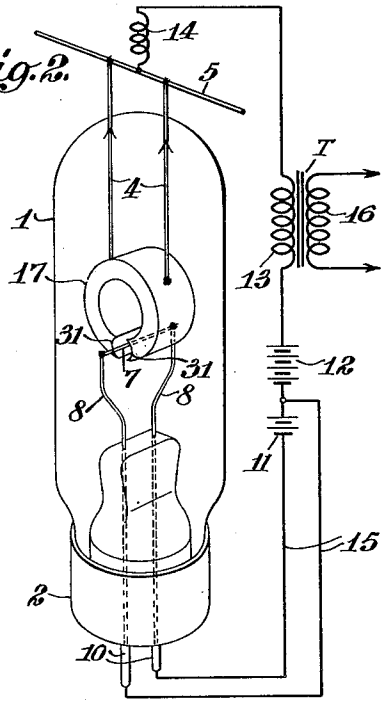


Fig. 3.

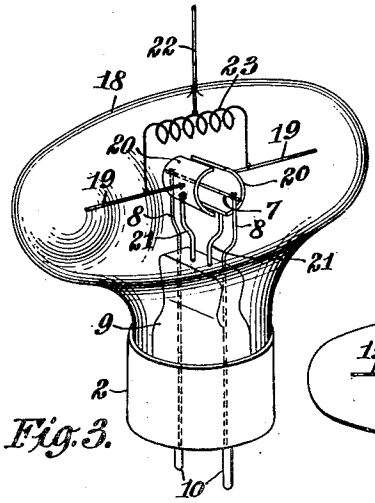


Fig. 4.

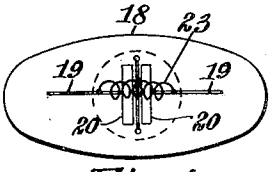
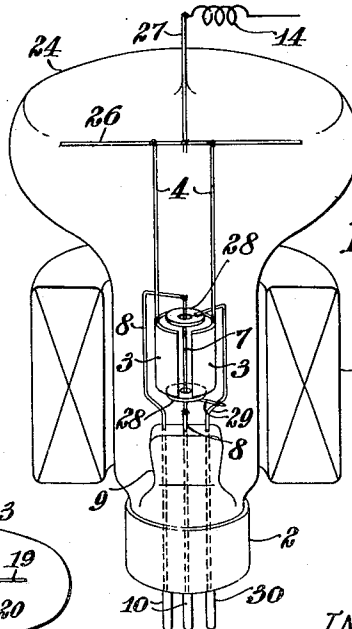


Fig. 5.



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MICRO-WAVE OSCILLATOR AND DETECTOR

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Application July 2, 1934, Serial No. 733,381

8 Claims. (Cl. 250—6)

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

The instant application is a continuation in part of my copending application Serial No. 703,346, filed December 21, 1933.

I have found that, when working with micro-wave lengths, that is with waves of less than a meter and down to a few millimeters in length, a very efficient and stable oscillator may be provided in which the tuned oscillator circuit is entirely comprised within the envelope of either a Barkhausen-Kurz tube or a magnetron type electron discharge tube. The envelope of such a tube may also contain both the transmission line and the antenna, if desired. It is, however, within the scope of my invention to provide oscillating means for ultra short wave radio transmitting and receiving apparatus having an antenna outside of the evacuated envelope.

It is an object of my invention to provide an oscillation generator or detector suitable for ultra high frequency transmitting and receiving apparatus.

Another object of my invention is to provide a magnetron type high frequency oscillator having split anode units suitably disposed within an evacuated envelope and suitably interconnected so that a resonant circuit is obtained entirely within the envelope itself.

The foregoing and other objects of my invention will be more fully understood from the following detailed description when read in connection with the accompanying drawing, in which

Figure 1 is a view showing in perspective one embodiment of my invention comprising a tuned oscillator circuit including split anodes of a Barkhausen-Kurz type tube,

Fig. 2 is a view in perspective of a magnetron type tube comprising an oscillating loop in which the included split anodes are integral with a heavy conducting ring,

Fig. 3 shows in perspective another embodiment of my invention in which the oscillator and antenna system are both entirely contained within an evacuated envelope,

Fig. 4 is a plan view of the tube shown in Fig. 3, and

Fig. 5 is a view in perspective of still another embodiment of my invention showing an oscillator circuit having split anodes and an antenna within the envelope, the tube elements comprising further a pair of end plates.

Referring to Fig. 1, I show an envelope 1 and base 2 of usual construction. A pair of split anodes 3 is mounted on stiff wires 4 which project through the top of the tube. These wires may be elongated to provide a transmission loop connecting with an antenna 5. A shorting bar 6 is welded across the wires within the envelope 1 and preferably so close to the anodes 3 that standing waves of the operating frequency and having one nodal point midway of the bar 6 may be produced thereon. A filament cathode 7 is shown at the axis of the semi-cylindrical anodes 3. Supporting posts 8 for the filament are mounted on the press 9 and are connected with the tube prongs 10. A control grid 35 is disposed between the cathode and anodes. It is supplied with a high potential from the source 36. Filament current may be derived from the source 11. By means of a source 12 a potential slightly greater than that of the filament but considerably below that of the grid is applied to the anodes, connection to which is made through the choke 14, the antenna 5 and the transmission wires 4.

If desired, end plates may be provided in the tube of Fig. 1 disposed as shown in Fig. 5 in connection with which they will be further discussed.

The shorting bar 6 together with the portions of the transmission wires 4 intervening between the shorting bar and the anodes 3 form a resonant loop which determines the natural frequency of the oscillator. The energy of the oscillations thus produced is more or less efficiently communicated to the antenna 5, from which it may be radiated as a carrier wave. The carrier may be modulated by means of audio frequency currents impressed upon the transformer T, thus varying the potential applied to the grid 35.

In Fig. 2 I have shown a construction of magnetron type oscillator tube comprised within an envelope 1 and having a unitary structure of split anodes 31 the faces of which are in effect the cylindrical walls of a hole drilled in a metallic ring 17. This bifurcated ring is supported by transmission wires 4 issuing at the top of the tube, the same as shown in Fig. 1. The filament cathode 7 is also of the same construction as in Fig. 1. This tube requires no grid because it operates in a magnetic field. Other details of the tube correspond with the details already described in connection with Fig. 1 and need not be specifically mentioned at this point.

The modification of my invention shown in Fig. 2 is particularly well adapted for operation at ultra high frequencies, even down to a few millimeters of wave length. It will be seen that

the bifurcated ring 17 affords a very short resonant path for such waves. On the ring and diametrically opposed to the axis of the electrodes a node will be formed. The transmission wires 4 are connected to one side and the other, respectively, of said node.

A suitable circuit diagram has been included in Fig. 2 so as to illustrate the utility of the tube either as an oscillator or as a detector. The transformer T, whose winding 13 is in the anode circuit, may have impressed upon its winding 16 a modulation current from any desired source. This serves to vary the potential applied to the anodes 31. If, however, the tube is to be used as a detector, the electrode potentials having been suitably adjusted to prevent oscillation, then the current in the plate circuit (Ip) will be varied by the received signal voltage impressed upon the anode (Ep) and demodulated energy will be derived from the transformer coil 16. When the three-element tube of Fig. 1 is operated as a detector variations in the plate voltage (Ep) effect a corresponding change in current flowing in the grid circuit (Eg).

The output coupling device T of Figs. 1 and 2 may be of any convenient type adapted to match the impedance of the tube with the impedance of the apparatus associated therewith.

In Fig. 3 I have shown a tube provided with a Zeppelin-shaped envelope 18 for another modification of my invention so as to comprise within the envelope itself the antenna wires 19. The antenna wires are preferably attached to the centers of the semicylindrical anodes 20. These anodes may be suitably supported by glass posts 21 erected on the press 9. The axis of the split anode system is disposed along the shortest diameter of the ellipsoidal envelope 18. This arrangement is preferred in order that the tube may be disposed between poles of a magnet having a relatively small gap therebetween. Thus the axis of the split anode structure may be oriented at a very slight angle to the lines of force of the magnet.

In order that a suitable anode potential may be applied in the tube of Fig. 3, a connecting lead 22 is provided at the top thereof and this lead may be attached within the tube to the midpoint of a choke coil 23, the terminals of which are connected to the antenna wires 19, preferably quite close to the plates 20. The filament cathode 7 and its supports are arranged in the same manner as shown in Figs. 1 and 2 and need not, therefore, be further discussed here.

Fig. 4 shows a plan view of the tube of Fig. 3 in order that the shape of the tube 18 may be more clearly understood.

Fig. 5 shows still another modification of my invention in which the envelope 24 is more or less pear-shaped. That is to say, it has a long narrow neck portion suitable for insertion within the hollow part of a magnetic solenoid 25. The enlarged portion of the bulb contains an antenna structure comprising the dipole element 26 at the ends of transmission wires 4. The semicylindrical anodes 3 are mounted on and supported by the wires 4. The entire anode and antenna structure may be suspended from a wire post 27 issuing out of the top of the tube. This post 27 also provides a connection with the anodes for applying suitable potential thereto.

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 been indicated at 28 in Fig. 5. They are supported from the press 9 by wires 29. Suitable potential may be applied to the end plates through the tube prong 30.

In this embodiment of my invention the resonant oscillatory circuit includes the split anodes 3, the transmission wires 4 and the middle portion of the dipole 26. The dipole 26 may be utilized either for transmission or reception of a modulated carrier wave. The details of the external connections may be the same as those shown in Fig. 2. The operation will therefore be well understood from the foregoing description.

It will be readily understood by those skilled in the art that any of the embodiments of my invention herein shown may be used as a short wave oscillator or as a detector. The antenna may be disposed either internally or externally of the evacuated envelope. End plates may be used in any case. If end plates are not used then the axis of the electrodes should be at a slight angle to the polar axis of the magnetic field in which the magnetron tube operates. If the tube is of the three-element type, for instance, as shown in Fig. 1 no magnetic field need be supplied. To obtain the specified results with tubes of the two-element type, with or without end-plates, or with the three-element type having end-plates, the tube is necessarily immersed in a magnetic field.

Although I have disclosed herein several modifications of my invention and have described a method of generating oscillations of ultra high frequency, it is to be understood that the foregoing description is merely illustrative of many ways in which 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 is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In a transceiver system, an electron discharge tube having split anodes, an evacuated envelope for said tube and means within said envelope, including a short-circuiting conductor interconnecting said anodes at suitable points, for establishing a resonant condition at a micro-wave frequency, means for generating oscillations of said micro-wave frequency for transmitting means for suppressing said generation of oscillations while receiving, and means for detecting received oscillations.

2. In an oscillator system, an electron discharge tube adapted for operation when immersed in and suitably oriented with respect to a magnetic field, an evacuated envelope for said tube, a bifurcated metallic ring mounted in said envelope, a filament-cathode disposed parallel to the terminal surfaces of said ring formed by said bifurcation, and means for establishing a resonant condition in said ring at a micro-wave frequency.

3. In an oscillator system, an electron discharge tube adapted for operation when immersed in and suitably oriented with respect to a magnetic field, an evacuated envelope for said tube, a press for mounting thereon the elements of said tube within said envelope, two non-metallic posts erected upon said press, two semicylindrical anodes each supported by one of said posts respectively, a dipole antenna system with-

in said envelope and mounted on said anodes, and means including an external connection and a choke coil interconnecting the arms of said antenna system at nodal points for impressing a suitable potential upon said anodes.

4. In a transceiver system, an electron discharge tube having split anodes adapted for operation when immersed in and suitably oriented with respect to a magnetic field, an evacuated envelope for said tube and means within said envelope, including a dipole antenna system and a pair of short-circuited transmission wires connecting said antenna system with said split anodes at suitable points for establishing a resonant condition on said anodes and in said antenna system at a micro-wave frequency, means for generating oscillatory currents for transmitting, means for preventing said generation of oscillatory currents while receiving, and means for detecting received oscillatory currents.

5. In a micro-wave transmitting and receiving system, an electron discharge tube having a cathode and a pair of substantially semi-cylindrical anodes disposed symmetrically about said cathode, an energy radiating and collecting system comprising two conductors connected one with one anode and one with the other anode, and a dipole antenna symmetrically connected with said conductors; an evacuated envelope containing said cathode, anodes and at least a portion of said conductors; means entirely within said envelope and including a short-circuiting conductor interconnecting the first said conductors for establishing standing waves within said tube at a micro-wave frequency, and means associated with said discharge tube for detecting received energy.

6. In a micro-wave transmitting and receiving system, an electron discharge tube having a cathode, a control electrode and a pair of substantially semi-cylindrical anodes, said electrodes being coaxially disposed, an energy radiating and collecting system comprising two conductors connected one with one anode and one with the other anode, and a dipole antenna symmetrically connected with said conductors; an evacuated envelope containing said electrodes and at least a portion of said conductors; means entirely within said envelope and including a short-circuiting conductor interconnecting the first said conductors for establishing standing waves within said tube at a micro-wave frequency, and means for preventing the generation of local oscillations while receiving.

7. A system in accordance with claim 6 in which an auxiliary assemblage including two annular end-electrodes is provided adjacent respective ends of said anodes for at least partially controlling the electron paths in a zone at least partially surrounded by said anodes and said end-electrodes.

8. In a micro-wave detector system an electron discharge tube having split anodes, a grid, and a cathode, said electrodes being coaxially disposed, an evacuated envelope for said tube and means within said envelope, including a dipole antenna system connected to said anodes at suitable points for collecting space energy of a frequency to which said detector system is resonant, and an output circuit for the energy detected connected between said grid and cathode.

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