July 23, 1946. W. VAN B. ROBERTS 2,404,745

ULTRA HIGH FREQUENCY ELECTRON DISCHARGE DEVICE SYSTEM

Filed July 7, 1942

Fig. 1.

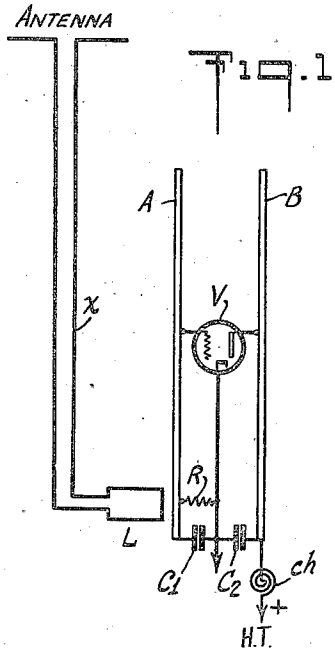


Fig. 2.

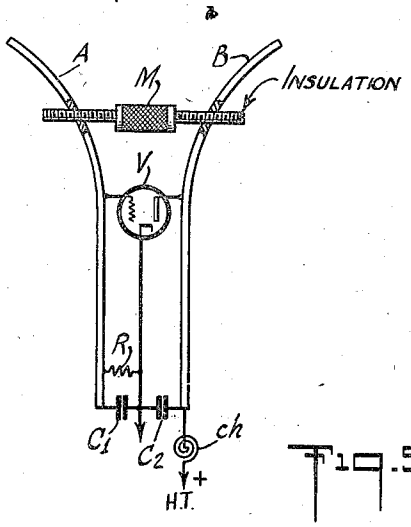


Fig. 5.

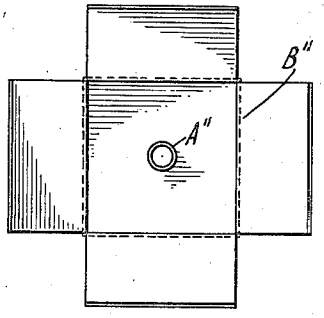


Fig. 4.

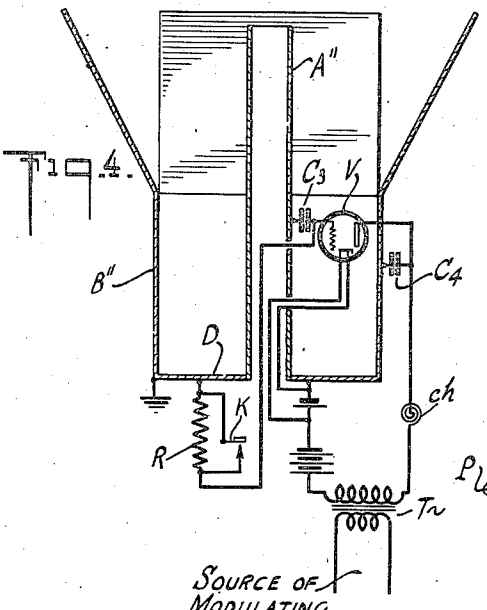
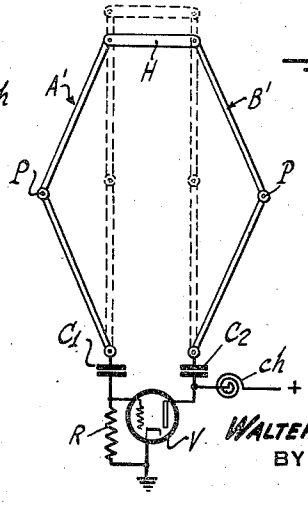


Fig. 3.



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ULTRA HIGH FREQUENCY ELECTRON DISCHARGE DEVICE SYSTEM

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6 Claims. (Cl. 250—17)

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This invention concerns an ultra high frequency system, and comprises an electron discharge device circuit having a single tuned circuit which serves both as an antenna and as a control element for the electron discharge device circuit.

In conventional transmitters, whether of the master oscillator power amplification type or a simple oscillator type, it is the practice to employ a final plate tank circuit having as little losses as possible, and to couple an antenna system to the plate tank circuit to obtain power therefrom. Usually, a resonant antenna system located at some distance from the transmitter is used and connected to the transmitter by a transmission line which is preferably non-resonant. In such a system there is at least one other resonant circuit, namely the antenna system, to be properly tuned, besides the tank circuit. When very short waves are employed, however, it is often undesirable to use a long transmission line and hence the oscillator system is located very close to the radiating element in order to reduce the length of line required. But when the oscillator is kept so close to the radiator, there is no longer any particular advantage in having the two structures, each designed solely for its particular function, and in accordance with the present invention a single structure is employed which acts both as an oscillator tank and as a radiator and which may be arranged to permit simple adjustment of the loading of the oscillator tank circuit without substantial effect upon the natural frequency thereof.

Accordingly, one of the objects of the present invention is to provide a simplified ultra short wave electron discharge device transmitter system wherein a single tank circuit can act both as an oscillatory tuned circuit for controlling the frequency of an electron discharge device generator and as a radiating element.

Although the foregoing object has particular reference to a combined oscillation generator and radiator, the principles of the invention are not limited in this respect and are applicable to receivers, for which reason a more specific object is to provide an ultra short wave electron discharge device receiver wherein a single resonant circuits acts both as an antenna pick-up device and as a resonant input circuit for an electron discharge device.

A more detailed description of the invention follows in conjunction with the drawing, wherein:

Fig. 1 shows a conventional type of transmitter circuit;

Figs. 2, 3 and 4 illustrate different electron discharge device embodiments of the present invention, for use particularly at ultra high frequencies; and

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Fig. 5 is a cross-section of Fig. 4 along line 5—5.

Fig. 1 shows a conventional type of high frequency oscillator employing a vacuum tube V which has associated therewith a tuned circuit in the form of a pair of parallel rods A and B each effectively one-quarter of a wavelength long. A separate dipole antenna ANT is connected by means of line X and coupling coil L to the oscillator tank A, B. The rods A, B are connected together at one end through radio frequency bypass and blocking condensers C_1, C_2. The cathode of tube V is connected to the junction point of condenser C_1, C_2 and to ground. The grid and plate electrodes of tube V are respectively connected to rods A and B. A grid-bias resistor R is provided to maintain the grid at a desired negative potential with respect to the cathode, and a choke coil CH is provided between one end of the conductor B (as shown) and a lead extending to the positive terminal of a source of unidirectional potential HT. This source HT may be placed at any suitable location, usually near the electron discharge device equipment, while the antenna may be more remotely connected, let us say on the roof of a building. The points of connection between the grid and plate electrodes of the vacuum tube V and the conductors A and B of the tank circuit, are so chosen as to match the impedance of the vacuum tube electrodes to the impedance of the tuned line tank circuit as much as possible. In the absence of coupling to the antenna, the tank A, B has very low losses as radiation from the two rods is, to a large extent, cancelled out, since the currents in these rods are in opposite directions.

According to the invention, there is eliminated the need for using a separate antenna system with its associated transmission line and coupling elements. This is done by so arranging the main oscillatory tank circuit that it functions both as a control element for the vacuum tube circuit and also as an antenna system. One such arrangement of the invention is shown in Fig. 2, wherein the rods A and B are separated, as by bending, to prevent the cancellation of radiation to the extent obtained in the conventional system of Fig. 1. By means of such a separation, there is obtained a much increased radiation resistance, and if the two rods A, B constituting the tank circuit are bent sufficiently far apart, the radiation loss may be made sufficiently large to load the oscillator

as much as required. For bending the rods A and B, there is shown a turn-buckle arrangement M having insulating rods linked to the elements A and B, as shown. It is thus possible, according to the invention, to provide an optimum loading on the tube.

One advantage of the invention resides in the fact that there are no high frequency currents in the connecting leads from the electron discharge device system to the apparatus supplying energy to the system. Thus, the combined vacuum tube oscillation generator and radiator can be located on the roof of a building while the source of polarizing potential, as well as the signal modulating apparatus, may be located at some distance removed from the generator and radiator, with the connecting leads between them devoid of high frequency currents.

Fig. 3 illustrates another embodiment of the invention, wherein the tank circuit is composed of rods A' and B' each of which has a length equal to a quarter of the length of the operating wave and connected at one end to the grid and plate electrodes of the vacuum tube V through suitable radio frequency by-pass and blocking condensers C_1, C_2. Rods A' and B' are shown pivoted at points P, P intermediate their ends, preferably near the center of the tank circuit, for enabling the rods A', B' of the tank to be separated to any desired degree. This is done by means of a handle H located at the end of the parallel rod tank removed from the vacuum tube. In one position the rods of the tank circuit can be parallel to each other, as shown in dotted lines, in which case there will be very little radiation from the tank circuit because of cancellation due to the currents in the rods flowing in opposite directions. The radiation resistance of the tank circuit is increased by pulling the rods A', B' apart by applying pressure to the handle H. The pivots P, P enable these rods to be pulled apart without bending, as shown. It should be noted that the grid and plate electrodes of the vacuum tube V are connected to points of high voltage on the tank circuit. This arrangement thus enables the radiation resistance to be increased to provide proper loading for the oscillator tube V without substantially affecting the frequency of oscillation which is determined mostly by the total length of the tank circuit between the grid and plate electrodes.

Fig. 4 shows another embodiment of the invention which gives a more symmetrical radiation pattern. In this figure, A'' is the inner conductor of a concentric line tank whose outer conductor is B''. The conductors A'', B'' are connected together at one end by a metallic end plate D. The outer conductor may be of square cross section, so that a portion, at least (the open-ended upper portion), of the outer conductor may be arranged to swing open. The degree of the opening determines the amount of radiation resistance and hence the loading of the oscillator. Although swinging the upper portion of the outer conductor open will change, to a small extent, the frequency of oscillation of the oscillator, this change is relatively minor and the circuit can be so designed that there is any desired frequency of oscillation for any particular loading of the oscillator. As for the operation of the oscillator itself (Fig. 4), it should be noted that the grid is connected to a desired point of radio frequency potential on the inner conductor through a radio frequency by-pass condenser C_3, while the plate is connected to ground from a radio frequency standpoint through a radio frequency by-pass condenser C_4, and the cathode is connected to a point of intermediate frequency potential. This is done by connecting the plate to the outer surface of the outer conductor (as shown), while the grid and cathode leads extend through apertures on different points of the inner conductor to suitable bias and heating sources. A transformer TR shows one way of applying modulating potentials to the generator. The modulation can also be effected, alternatively, if desired, by means of key K which is in shunt to a portion R of the grid bias resistance.

Fig. 5 is a plan view of the tank circuit of Fig. 4 along the line 5, 5 and is given to more clearly illustrate the configuration of the tank circuit when it is swung open.

Although Figs. 2, 3 and 4 have been described above in connection with transmitter arrangements, it should be understood that, if desired, the same systems can be used for receiving purposes, in which case the vacuum tube will act as a detector by suitably choosing the proper bias and polarizing potentials for the grid and plate electrodes.

In all of Figs. 2, 3 and 4 of the invention, it should be observed that a unitary structure having only a single fundamental resonance frequency is provided so that there is no possibility of any tuning adjustments being required except for the purpose of deliberately changing the frequency of the tank circuit. For very short waves, therefore, such that the combined oscillator and radiator must be physically close together in any case, there is obtained the advantage that only the unavoidable losses of the single resonant system need be subtracted from the useful vacuum tube output power. Another advantage is that the adjustment of the radiating oscillator is greatly simplified in that the loading may be adjusted by a single adjustment which does not seriously affect the frequency, and no tuning adjustment need be made on the radiating system except for the purpose of fine adjustment of the frequency.

What is claimed is:

1. An ultra short wave system comprising a multi-electrode electron discharge device including grid and plate electrodes, a single multi-element electrical resonant structure whose dimensions around said structure along the path of oscillatory current flow therein are such as to produce a desired oscillation frequency, the spacing between said elements being adjusted to give a desired coupling to the ether to thereby cause said structure to act as an antenna, leads regeneratively coupling said electron discharge device to said resonant structure, and means for supplying suitable bias and operating potentials to the electrodes of said device to generate and radiate oscillations or regeneratively receive and detect oscillations, said resonant structure comprising two metallic rods connected together at one end and connected at the other end to the grid and plate electrodes of said electron discharge device, said metallic rods being spaced further apart at their centers than at their ends.

2. An ultra short wave system comprising an electron discharge device having a grid and a plate, a single multi-element electrical resonant structure whose dimensions around said structure along the path of oscillatory current flow therein are such as to produce a desired oscillation frequency, a lead coupling said grid to one element of said resonant structure, another lead coupling

said plate to another element of said resonant structure, the spacing between said elements of said resonant structure being adjusted to give a desired coupling to the ether to thereby cause said structure to act as an antenna, and means for supplying suitable bias and operating potentials to the electrodes of said device to cause said device to generate and radiate oscillations or regeneratively receive and detect oscillations, said resonant structure comprising a pair of conductors which are arranged parallel to each other over a portion of their lengths and which diverge from each other for the remaining portion of their lengths.

3. An ultra short wave system comprising a multi-electrode electron discharge device including grid and plate electrodes, a single multi-element electrical resonant structure whose dimensions around said structure along the path of oscillatory current flow therein are such as to produce a desired oscillation frequency, the spacing between said elements being adjusted to give a desired coupling to the ether to thereby cause said structure to act as an antenna, leads regeneratively coupling said electron discharge device to said resonant structure, and means for supplying suitable bias and operating potentials to the electrodes of said device to generate and radiate oscillations or regeneratively receive and detect oscillations, said resonant structure comprising two metallic rods connected together at one end and connected at the other end to the grid and plate electrodes of said electron discharge device, said metallic rods being pivoted intermediate their ends and provided with means for spacing them further apart at the location of the pivots than at their ends.

4. An ultra short wave system comprising a multi-electrode electron discharge device having grid and plate electrodes, a single tuned circuit which serves both as a frequency controlling element and as an antenna, said tuned circuit consisting of a pair of conductors so spaced apart as to give a desired degree of coupling to the ether,

a low impedance connection between the grid electrode of said electron discharge device and one of said pair of conductors, another low impedance connection between the plate electrode of said electron discharge device and the other conductor of said pair, and means for supplying suitable bias and operating potentials to the electrodes of said device to generate and radiate oscillations or regeneratively receive and detect oscillations.

5. A system in accordance with claim 2, including a turn-buckle arrangement for adjusting the degree of divergence of said rods.

6. An ultra short wave system comprising a multi-electrode electron discharge device having a grid and a plate, a coaxial line resonant structure whose dimensions around said structure along the path of oscillatory current flow therein are such as to produce a desired oscillation frequency, said coaxial line structure having inner and outer conductors which are connected together at one end from a radio frequency standpoint and open at the other end, a connection from ground to said outer conductor, said inner and outer conductors being parallel to each other for a portion near the closed end and diverging from each other an adjustable amount for a portion near the open end, the spacing between the inner and outer conductors being adjusted to give a desired coupling to the ether to thereby cause said structure to act as an antenna, leads regeneratively coupling said electron discharge device to said resonant structure including a connection between said grid and a point on said inner conductor intermediate its ends and a connection of low impedance to energy of the operating frequency coupling said plate to ground, and means for supplying suitable bias and operating potentials to the electrodes of said device to cause said device to generate and radiate oscillations or regeneratively receive and detect oscillations.

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