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ULTRA-SHORT-WAVE RECEIVER

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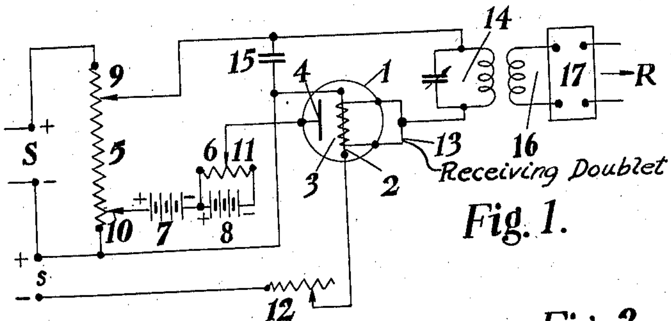


Fig. 1.

Fig. 2.

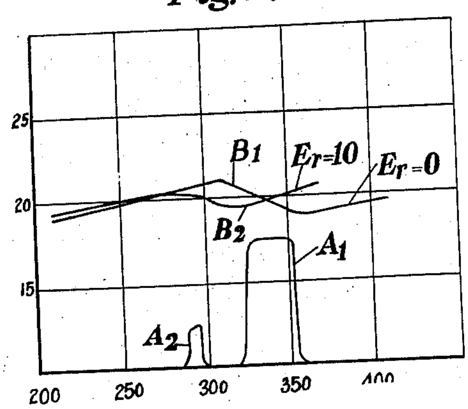
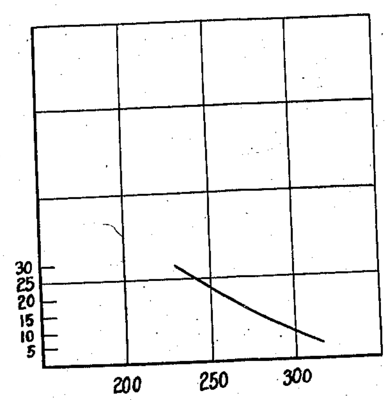


Fig. 3.



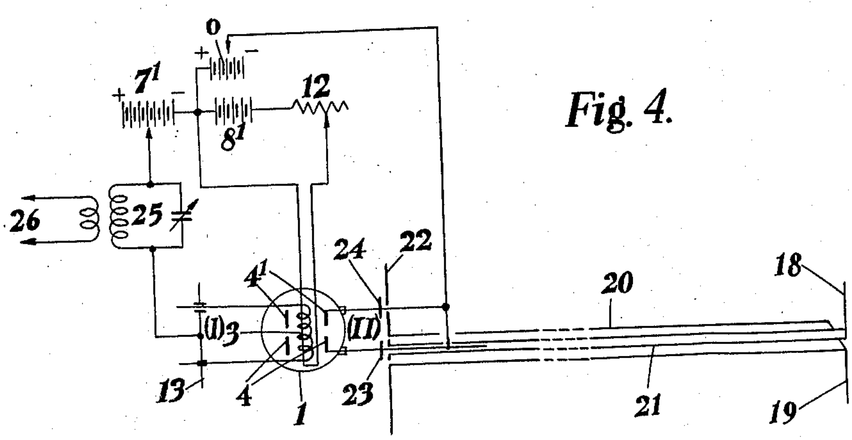


Fig. 4.

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ULTRA-SHORT-WAVE RECEIVER

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12 Claims. (Cl. 250—20)

The present invention relates to improvements in very short-wave tubes or ultra-short-wave tubes and in circuits employing same.

The invention is particularly applicable to wave lengths of the order of several decimeters or even of a fraction of a decimeter.

It has been found that when a tube with three or more electrodes is adjusted for the reception of ultra-short-waves, an effect of negative conductance is produced between any two of the electrodes of this tube, independent of the normal functioning of said tube.

This negative conductance can be employed to maintain oscillations at intermediate frequency in an oscillatory circuit tuned to this frequency and associated with said negative conductance, without disturbing the receiving properties of said tube. The intermediate frequency oscillation thus obtained is a function of the ultra-short-wave, for example, of its incident amplitude on the receiver tube. It may be arranged, moreover, that one only of the characteristics (for example the amplitude or the frequency) of the intermediate frequency oscillation varies with the amplitude of the incident ultra-short-wave. This property is capable of many applications, some of which will be set forth by way of example.

A first application of this property consists of a new method of reception of ultra-short waves.

Another application is the production of intermediate frequency currents and the use thereof for the amplification of the received signal by means of a single tube to which may be added, if necessary, further frequency changing stages. In addition it is possible to introduce reaction, or negative reaction or to make use of super-regeneration.

Another application of the effect mentioned above of negative conductance consists in providing an oscillatory circuit placed between the grid and the filament and another oscillatory circuit of the same frequency placed between plate and filament. These two circuits may be coupled to reinforce the local oscillation of intermediate frequency, without disturbing the functioning of the tube at the ultra-short frequency.

According to one of the features of the invention an ultra-short-wave tube is employed at the same time as an ultra-short wave receiving tube, and as a negative resistance adapted to maintain oscillations of longer wavelength in a tuned circuit placed, for example, between two of the electrodes of said tube. It may be arranged that the modulation in amplitude of the ultra-short-waves received produces a modulation in amplitude or in frequency of the waves of longer wave length obtained by the negative resistance effect of said tube.

According to another feature of the invention an arrangement is provided such that in an ultra-short-wave system employing intermediate frequency amplification the mean value of the intermediate frequency is independent of the ultra-short-waves received.

According to another feature of the invention an ultra-short-wave tube is employed for multiple functions, for example, the tube serves at the same time for the reception of ultra-short waves and for the generation of waves of lower frequency.

The invention will be better understood by reference to the following description based on the accompanying drawing, in which:

Figure 1 represents a receiving circuit for ultra-short-waves employing features of the invention;

Figures 2 and 3 represent experimental curves serving to explain the operation of the circuits shown in Figure 1;

Figure 4 shows another arrangement in which a tube of improved construction is employed.

Figure 1 represents an ultra-short-wave tube functioning simultaneously as ultra-short-wave receiver and as intermediate frequency oscillation generator.

In this drawing, 1 is the bulb of the vacuum tube, which comprises a cathode 2 heated by a source *s*; this cathode is surrounded by an oscillating electrode 3 to which are applied the ultra-short oscillations received on the doublet 13. A reflecting electrode 4 to which a negative potential is applied completes the tube. The electrodes 3 and 4 are fed by the source S through a potentiometric system 5 and 6 including counter-batteries 7 and 8. By means of a suitable adjustment of the contacts 9 and 10 on the potentiometer 5 and of the contact 11 on the potentiometer 6, considerable fluctuations in the voltage of the source S will not materially affect the tuning to an ultra-high frequency of the receiving tube 1. The supply of the cathode 2 may be adjusted to a suitable value by means of the rheostat 12.

According to one of the features of the invention, as is shown in Figure 1, an oscillatory circuit 14 is placed between the electrode 3 and the cathode 2. A condenser 15 is placed in this circuit in order that the intermediate frequency oscillations may be confined to the circuit comprising the electrode **3** and the oscillatory circuit **14**.

By adjusting the potentials applied to the electrodes, as will be shown hereinafter, it is possible to maintain sustained oscillations in the oscillatory circuit **14** at a lower frequency than that received on the doublet **13**.

The scale of frequency which it is thus possible to maintain in the oscillatory circuit **14** is very wide, and in experiments, it has been found possible in this way to produce oscillations from 40 centimeters wave length up to several thousand meters. It is to be noted that in the circuit **14**, in the case of oscillations of the order of 40 centimeters wave length, we are dealing with the type of oscillations known by the name of Barkhausen, and it is apparent that the tube **1** is capable of two simultaneous functions, one as receiver on waves of the order of a decimeter or a fraction of a decimeter by tuning the circuit of the oscillating electrode **3**, the other as an intermediate frequency generator of the order of 40 centimeters.

The condition of maintenance of the oscillations in the circuit connected between two of the electrodes of the tubes is that the negative resistance supplied with the tube **1** be sufficient to compensate the losses of the circuit.

Oscillations thus produced by the effect of negative conductance of the tube may be employed in various ways, in particular it is possible to couple to the circuit **14** another circuit **16** terminating in an intermediate frequency amplifier **17** which may employ the various known methods of reception.

The system thus constituted forms an extremely sensitive ultra-short-wave receiver, because the amplitude or the frequency, according to the adjustment of the intermediate frequency oscillation circuit is under the dependency of the amplitude of the ultra-short-wave received on the doublet or antenna **13**.

Modifications may be made in Figure 1, in particular, the oscillatory circuit may be inserted between the reflecting electrode **4** and the cathode **2**, or even two oscillatory circuits may be provided, one as shown on the drawing and the other between the electrode **4** and the electrode **2**. These circuits may or may not be coupled.

Figures 2 and 3 represent curves of the potentials concerned which serve to explain the operation of the circuit of Figure 1.

In Figure 2, the value of the direct current supplied to the oscillating electrode **3** in milliamperes is shown as ordinates; as abscissae, we have the value of the potential applied to the oscillating electrode **3** in volts.

The curve B_1 has been traced for a value of polarization Er of the electrode **4** equal to 0 volts and the curve B_2 for the value of the polarization Er equal to minus 10 volts. It will be seen on the drawing that for suitable values of potential applied to the oscillating electrode **3**, there are regions of oscillations shown by the curves A_1 and A_2 respectively corresponding to the curves B_1 and B_2; the ordinates of the curves A_1 and A_2 are in proportion to the amplitudes of the intermediate frequency oscillations obtained for these adjustments; at these same values of potential applied to the two electrodes the tube **1** functions as a receiver of ultra-high frequency waves received on the doublet **13**.

By means of the sets of curves given in Figure 2, we deduce the law which connects the potentials of the reflecting and oscillating electrodes for obtaining simultaneously ultra-high frequency reception and intermediate frequency oscillation.

This law may be represented by the curve of Figure 3, in which are entered in ordinates the negative polarizations applied to the reflecting electrode, and in abscissae the positive potentials applied to the oscillating electrode. These two potentials are expressed in volts.

As this law is practically linear, suitable adjustment of the contacts on the potentiometers **5** and **6**, and suitable value of the counter-batteries **7** and **8** permit the ultra-high frequency operation of the tube to be rendered substantially independent of the fluctuations of the source S.

Figure 4 represents another arrangement in which a particular tube construction is employed, which permits numerous embodiments to be obtained.

In order to improve the receptive properties of the tubes employed, and in particular to improve the methods of frequency changing and in particular the superheterodyne method, the tube concerned may have a cylindrical symmetry, and is, in this case, formed by an axial filament **1**, an oscillating electrode **3** in the form of a spiral and two half cylinders **4'** and **4** whose common axis is co-axial with the cathode. The two half cylinders **4'** and **4** of the reflecting electrode serve to form an ultra-high frequency circuit connected, for example, to a doublet or an antenna **18—19** by a transmission line with concentric conductors **20—21**. The oscillating electrode **3** is associated as shown, with a circuit (I) of ultra-high frequency. This arrangement thus supplies two ultra-high frequency circuits (I) and (II) reacting on each other, which permits the ultra-high frequency oscillations of either circuit to be controlled according to the conditions in the other circuit.

This circuit may be adjusted to permit the amplification at ultra-high frequency as well as the function of the tube on the superheterodyne principle.

In the case of superheterodyne operation brake-field oscillations are generated in circuit (I) and these oscillations are caused to beat, with those which are received in the circuit (II).

On the other hand this same arrangement may be operated in a different manner in which circuit (II) is replaced by circuit (I) as the collector of incoming waves. In this latter case, oscillations are received on doublet **13** and the circuit may be adjusted to operate as described with reference to Fig. 1.

In Fig. 4, the reference characters keep the same meaning as in Figure 1, except for the batteries **7** and **8**, which are replaced by **7'** and **8'**. It will be noted however, that the reflecting electrode is, as has just been stated, divided into two portions **4** and **4'** and that it is associated with a circuit (II), the condenser plates **23** and **24** serving for the coupling of this circuit (II) with an antenna **18—19** over a line with concentric conductors **20—21**. Finally, a device **22**, such as a movable screen, or reflector associated with the antenna **18—19** may be provided.

Among the various applications of the circuit shown in Fig. 4, the following may be mentioned.

First. Operation as superheterodyne receiver. The incident ultra-high frequency waves arrive at antenna **18—19** and are transmitted by the transmission line **20—21** to the circuit (II) connected by the condensers **23—24** to the two half cylinders **4** and **4'**, forming the reflecting electrode. Circuit (I) is set in oscillation by adjusting the potentials applied to the electrodes and the position of the movable reflector or screen. This local frequency differs from the incident frequency by a number of cycles which forms the intermediate frequency. The intermediate frequency may be collected for example, in the circuit **25** tuned to this frequency. Thence by a suitable coupling **26**, the oscillations are transmitted to an amplifier in which further frequency changes may be made and reaction effects may be utilized

Second. The arrangement of the circuits remaining the same, the circuit (I) may be adjusted so as to cause the tube to act as ultra-high frequency amplifier, while profiting by the negative resistance effects discussed in conjunction with Fig. 1. It will be noted that in this latter case the intermediate frequency maintained in circuit **25** of Fig. 4, becomes independent of the ultra-high frequency which it is desired to receive.

The invention may be employed in different ways from those described here by way of example.

In particular the invention may be applied to other tube structures than those shown, in particular to tubes comprising more than three electrodes.

It is also possible to provide in the receiving circuits, several associated tubes or several systems of electrodes corresponding to several tubes but enclosed in the same envelop.

What is claimed is:

1. Short wave radio receiver comprising a vacuum tube, electrodes therein including a thermionic cathodic electrode, an oscillating electrode and a two-part reflecting electrode, means for applying to the oscillating electrode a potential positive with respect to that of the cathodic electrode, means for applying to one part of said reflecting electrode a potential with respect to the cathodic electrode which is many times smaller than said first named potential, means for applying between the two parts of said reflecting electrode a modulated high frequency current and a resonant circuit tuned to an intermediate frequency and connected between two different ones of said electrodes for the generation of local oscillations.

2. Receiver according to claim 1, said resonant circuit being connected between said cathodic electrode and said oscillating electrode.

3. Receiver according to claim 1 including adjustment means for adjusting the frequency of the local oscillations.

4. Receiver according to claim 1 including an output circuit and coupling means between said output circuit and said resonant circuit.

5. Short wave radio receiver comprising a vacuum tube, electrodes therein including a thermionic cathode, an oscillating electrode and two similar reflecting electrodes, high frequency circuits connected respectively across two points of the oscillating electrode and between the two reflecting electrodes said circuits being tuned to frequencies which differ by a beat frequency, means for applying modulated high frequency currents to one of said high frequency circuits, an intermediate frequency circuit associated in energy transfer relation with said high frequency circuits for the production of currents of said beat frequency and means for biasing said electrodes.

6. Receiver according to claim 5 including adjustment means for determining the frequency of oscillations in that high frequency circuit which is connected to the reflecting electrode.

7. A receiving system for ultra-short electromagnetic waves comprising means for collecting energy from incoming ultra-short waves, an electron discharge device including a thermionic cathode, an oscillatory electrode and a reflecting electrode, means for supplying a biasing potential of the order of ten volts to said reflecting electrode and a positive biasing potential of the order of hundreds of volts to said oscillatory electrode with respect to said cathode, the said potentials being so related that a portion of the discharge device constitutes an impedance whose resistive component is negative, an oscillation circuit including frequency determining means, said portion of the discharge device being connected in said circuit so as to maintain in said circuit oscillations whose frequency is independent of the incoming ultra-short waves, means for applying across two points of said oscillatory electrode energy of said incoming ultra-short waves collected by said collecting means whereby the amplitude of oscillations in said circuit is varied in correspondence with variations in said energy, and apparatus for indicating such variations in the amplitude of said oscillations.

8. A receiving system in accordance with claim 7, wherein said means for supplying potential to said reflecting and said oscillatory electrodes comprise a common source of voltage and a voltage divider for deriving from said common source at least a portion of the bias potential for said oscillatory electrode and at least a portion of the bias potential for said reflecting electrode, the voltage division of said voltage divider being such that the varying biases on said oscillatory and reflecting electrodes resulting from voltage variations in said common source are continuously so related that said portion of the discharge device constitutes an impedance whose resistive component is negative.

9. A short wave radio receiver comprising a vacuum tube having therein an oscillating electrode and a reflecting electrode, a high frequency tuned input circuit connected across two points of said oscillating electrode and a resonant circuit connected between two of said electrodes and tuned to the frequency to be generated said frequency being lower than that of said input circuit.

10. A radio receiver according to claim 9 wherein one side of said resonant circuit last mentioned is connected symmetrically to said oscillating electrode and the other side of said resonant circuit is connected to another of said electrodes.

11. In combination, a thermionic vacuum tube having an oscillating electrode, a reflecting electrode and a cathode, means for applying high frequency oscillation across two points of said oscillating electrode and a resonant circuit connected between any two of said electrodes, biasing sources and connections thereto for applying a relatively high positive biasing potential between said oscillating electrode and said cathode and a lower biasing potential between said reflecting electrode and said cathode, the relation of said potentials being such that the current-voltage curve of said oscillating electrode has a negative slope.

12. An arrangement in accordance with claim 11 wherein a common source is provided for supplying said biasing potentials and means is also included whereby any variation in one potential will be accompanied by a corresponding but opposite variation in the other potential.

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