Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

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This invention relates to a rectifying arrangement for ultra-short waves comprising a discharge tube with at least two grids placed between the anode and the cathode.

With ultra-short wave reception the usual detector arrangements do not operate in a satisfactory manner, since they involve considerable damping of the preceding oscillatory circuit. This applies to any detector arrangements in which the oscillations to be rectified are supplied to the control grid of a discharge tube. Due to the fact that with ultra-short wave reception the transient time of the electrons between the control grid and the cathode is of the same order of magnitude as the cycle of the oscillations to be rectified, a phase displacement occurs in these detector arrangements between the control grid voltage and the current flowing through the apertures of the control grid, said phase displacement causing considerable damping of the input circuit. As is well known diode detectors also involve considerable damping of the input circuit.

The present invention has for its object to provide a rectifying arrangement for ultra-short waves, in which the oscillatory circuit preceding the rectifier is damped only to a very small degree.

According to the invention the oscillations to be rectified are supplied to the negatively or slightly positively biased anode of a discharge tube and the connection of one of the grids of this tube to the cathode includes a high impedance to the rectified oscillations, a positively biased grid being interposed between this grid and the anode.

The invention will be more clearly understood by reference to the accompanying drawing representing by way of example, several embodiments thereof.

In the arrangement shown in Fig. 1 the ultra-high frequency oscillations to be rectified which occur in the oscillatory circuit 1 are supplied to the negatively biased anode 3 of a discharge tube 2, which in addition to the anode comprises two grids 4 and 5 and a cathode 6. Through the resistance 1 a positive bias is supplied to the grid 4, whilst the grid is high-frequency earthed by a condenser 8 constituting a short-circuit to the oscillations to be rectified. The end of the oscillatory circuit 1 remote from the anode 3 is connected across a condenser 9 to the cathode and across a resistance 10 to a source of negative bias. The connection of the grid 5 to the cathode 6 includes a high impedance to the rectified oscillations which consists of the parallel-connection of a resistance 11 and of a condenser 12 constituting a short-circuit to high frequencies. The rectified oscillations are taken off from the resistance 11 through a coupling condenser 13.

The operation of the arrangement will be explained by means of the curve shown in Fig. 3.

It is first assumed that no alternating voltage is set up at the anode. In this case the electrons emitted by the cathode flash at a definite speed through the positively biased grid 4, reverse their direction closely in front of the anode 3 and pass for the second time at the same speed through the grid 4. In this case the kinetic energy of the returning electrons is too low to gain access to the grid 5.

Now the case will be considered in which the alternating voltage $E_0$ is represented in Fig. 3 as a function of time is applied to the anode. An electron traversing the grid 4 for the first time at the moment $t_1$ and for the second time at the moment $t_2$ will be more retarded during its travel to the anode and will be less accelerated during its return than in the absence of the alternating voltage. Consequently the electron during its second passage through the grid 4 has a lower speed than during its first passage and cannot reach the grid 5. An electron, however, traversing the grid for the first time at the moment $t_3$ and for the second time at the moment $t_4$ will be less retarded during its travel to the anode and more accelerated during its return and consequently traverses the grid 4 for the second time at a higher speed. Now this electron due to its higher kinetic energy may sometimes reach the grid 5. Thus, we may say by approximation that electrons traversing the grid 4 for the first time with increasing anode voltage cannot reach the grid 5, whereas electrons traversing the grid 4 for the first time with decreasing anode voltage may sometimes reach the grid 5. Thus, a current flows to the grid 5 only during one half wave of the oscillation to be rectified, i.e. the arrangement yields a rectifying effect.

Therefore a low frequency voltage corresponding to the modulation of the received high frequency oscillations will be set up across the resistance 11. To low frequencies the arrangement behaves exactly as a grid detector. With high frequencies, however, the matter is quite different, since with the arrangement according to the invention damping of the receiving circuit is caused only by the energy required for accelerating the electrons, so that this damping is extremely weak.

Additional amplification of the rectified oscilla-
tions is obtained in a simple manner in the arrangement represented in Fig. 2 by interposing in the outer circuit of the positively biased grid 4 a high impedance to the rectified oscillations which consists of the parallel connection of a resistance 14 and of a condenser 15. In this case the electrodes 4, 5 and 8 constitute an amplifying system. The rectifying effect is not affected by the occurrence of a low frequency voltage at the grid 4, since this effect is put down only to acceleration and retardation of the electrons, which is almost independent of the voltage of the grid 4.

The rectifying arrangement according to the invention may also be used with success as a mixing stage with superheterodyne receivers Figs. 4 and 5 representing two circuit arrangements in which this is carried into effect.

In the arrangement shown in Fig. 4 the received high frequency oscillations occurring in the circuit 16 together with the locally generated oscillations occurring in the circuit 17 are supplied to the anode 3. The current flowing to the grid 5 comprises an intermediate frequency component which is sieved out by means of the oscillatory circuit 18 tuned to the intermediate frequency. The outer circuit of the grid 4 comprises another oscillatory circuit 19 for obtaining additional amplification. The desired negative bias of the anode 3 is obtained by the direct voltage drop in the resistance 22. To avoid undesirable capacitative couplings it is advisable to provide a positively biased screen grid 23 and 24 respectively on either side of the grid 4. These two screen grids are preferably directly connected together and are earthed to high frequencies through a condenser 21, whereas the required positive bias is supplied through the resistance 23.

In the arrangement shown in Fig. 5 only one of the two oscillations to be mixed is supplied to the anode 3. Consequently only one of the two oscillatory circuits 15 and 17, for instance the circuit 16, is connected to the anode, whereas the other oscillatory circuit, for instance the circuit 17, in series with the intermediate frequency circuit 18 lies in the connection of the grid 5 to the cathode. The current flowing to the grid 5 comprises a high frequency component giving a frequency occurring in the circuit 16 connected to the anode, which frequency together with the oscillations set up in the circuit 17 yields the intermediate frequency by grid rectification at the grid 5.

The arrangements according to the invention yield an extremely strong rectification if the time between the first and the second passage of the electrons through the grid 4 is on an average equal to one-half cycle of the oscillations to be rectified. However, it is essential only that the said time is of the same order of magnitude as the cycle of the oscillations to be rectified.

We claim:

1. A circuit for the rectification of ultra-short oscillations, comprising an electron discharge tube provided with an anode, a cathode and at least two grids interposed therebetween, means for impressing the oscillations to be rectified between only the anode and cathode, a high impedance across which the rectified oscillations are developed connected only between one of the grids and the cathode, and means for maintaining the second grid positively biased with respect to the cathode.

2. A circuit for the rectification of ultra-short oscillations, comprising an electron discharge tube provided with an anode, and at least two grids interposed therebetween, means for impressing the oscillations to be rectified between only the anode and cathode, a high impedance across which the rectified oscillations are developed connected only between one of the grids and the cathode, means coupled to said high impedance for taking off the rectified oscillations, and means for maintaining the second grid positively biased with respect to the cathode.

3. A circuit for the rectification of ultra-short oscillations, comprising an electron discharge tube provided with an anode, a cathode and at least two grids interposed therebetween, means for impressing the oscillations to be rectified between only the anode and cathode, a high impedance across which the rectified oscillations are developed connected only between one of the grids and the cathode, means for maintaining the second grid positively biased with respect to the cathode, a second high impedance connected to the positively biased grid, and means coupled to said last impedance for taking off the rectified oscillations in amplified form.

4. A circuit for the rectification of ultra-short oscillations, comprising an electron discharge tube provided with an anode, a cathode and at least two grids interposed therebetween, means for maintaining the anode at a negative potential with respect to the cathode, means for impressing the oscillations to be rectified between only the anode and cathode, a high impedance across which the rectified oscillations are developed connected only between the cathode and the grid next adjacent thereto, and means for maintaining the second grid positively biased with respect to the cathode.

5. A circuit as defined in claim 4, wherein there are provided means coupled to the high impedance for taking off the rectified oscillations.

6. A combined detector-amplifier circuit for the rectification and amplification of ultra-short oscillations, comprising an electron discharge tube provided with an anode, a cathode and at least two grids interposed therebetween, means for maintaining the anode at a negative potential with respect to the cathode, means for impressing the oscillations to be rectified between only the anode and cathode, a high impedance across which the rectified oscillations are developed connected only between the cathode and the grid next adjacent thereto, means for maintaining the second grid positively biased with respect to the cathode, a second high impedance connected to the second grid, the cathode, first and second grids constituting the electrode of an amplifier, the rectified oscillations developed across the first impedance appearing in amplified form across the second impedance by reason of said amplifying action.

7. In a superheterodyne receiver, a circuit for mixing received signal oscillations and locally produced oscillations for obtaining an intermediate frequency, comprising an electron discharge tube provided with an anode, a cathode and a plurality of grids interposed therebetween, means for impressing the received oscillations between only the cathode and anode, means for impressing the locally produced oscillations between cathode and one or other electrode of said tube, and an oscillatory circuit tuned to the intermediate frequency connected between cathode and the grid next adjacent the cathode.

8. In a superheterodyne receiver, a circuit for
mixing received high frequency signal oscillations and locally produced oscillations for obtaining an intermediate frequency, comprising an electron discharge tube provided with an anode, a cathode and a plurality of grids interposed therebetween, means for maintaining the anode at a negative potential with respect to the cathode, means for impressing the received oscillations between cathode and anode, means for impressing the locally produced oscillations between cathode and one other electrode of the tube, an oscillatory circuit tuned to the intermediate frequency connected between cathode and the grid next adjacent the cathode, and a positively biased grid interposed between the anode and the grid next adjacent the cathode.

9. In a superheterodyne receiver, a circuit for mixing received ultra-short signal oscillations and locally produced oscillations for obtaining an intermediate frequency, comprising an electron discharge tube provided with an anode, a cathode and a plurality of grids interposed therebetween, means for maintaining the anode at a negative potential with respect to the cathode, means for impressing both the received oscillations and the locally produced oscillations between cathode and anode, an oscillatory circuit tuned to the intermediate frequency connected between cathode and the grid next adjacent the cathode, a second similar oscillatory circuit connected to one of grids between the first grid and anode, and a positively biased shield grid having one part interposed between the last mentioned grid and the anode and another part interposed between said last mentioned grid and the grid next adjacent the cathode.

10. In a superheterodyne receiver, a circuit for mixing received ultra-short signal oscillations and locally produced oscillations for obtaining an intermediate frequency, comprising an electron discharge tube provided with an anode, a cathode and a plurality of grids interposed therebetween, means for maintaining the anode at a negative potential with respect to the cathode, means for impressing the received oscillations between cathode and anode, means for impressing the locally produced oscillations between cathode and the grid next adjacent the cathode, an oscillatory circuit tuned to the intermediate frequency connected between cathode and the grid next adjacent to the cathode, a second similar oscillatory circuit connected to one of grids between the first grid and anode, and a positively biased shield grid having one part interposed between the last mentioned grid and the anode and another part interposed between said last mentioned grid and the grid next adjacent the cathode.

11. In a superheterodyne receiver, a circuit for mixing received ultra-short signal oscillations and locally produced oscillations for obtaining an intermediate frequency, comprising an electron discharge tube provided with a cathode, a plurality of grids and an anode positioned in the order named, means for impressing the received oscillations between cathode and anode, means for impressing the locally produced oscillations between cathode and one other electrode of said tube, an oscillatory circuit tuned to the intermediate frequency connected between cathode and the first grid, a similar oscillatory circuit connected to the third grid, and means for maintaining the second and fourth grids at a positive potential with respect to the cathode.

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