

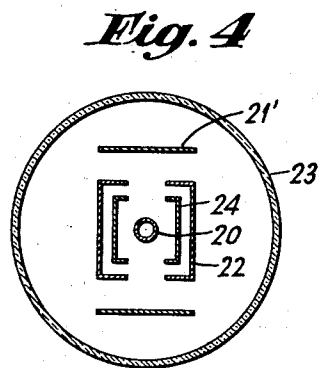
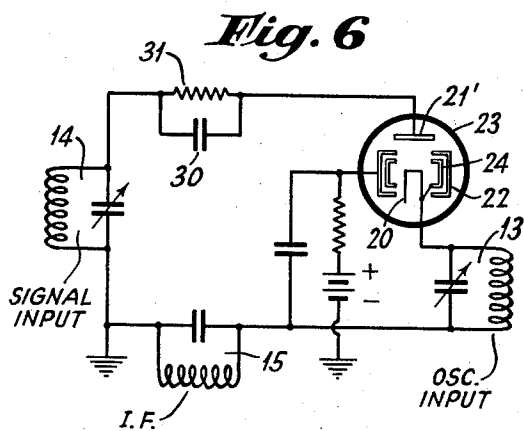
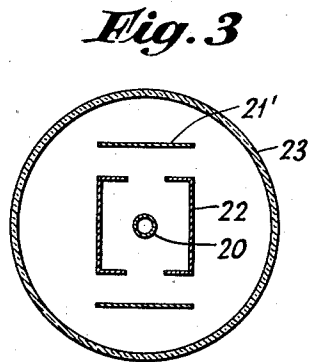
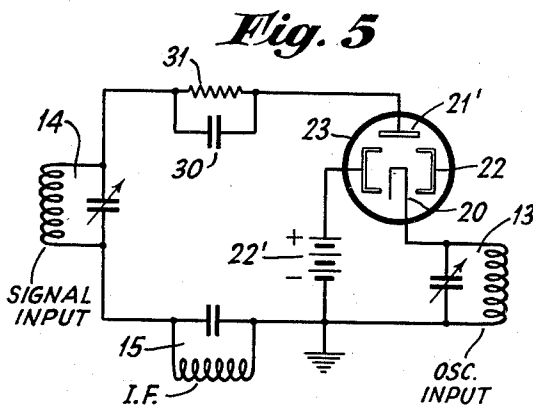
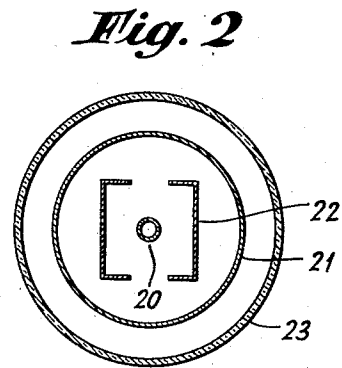
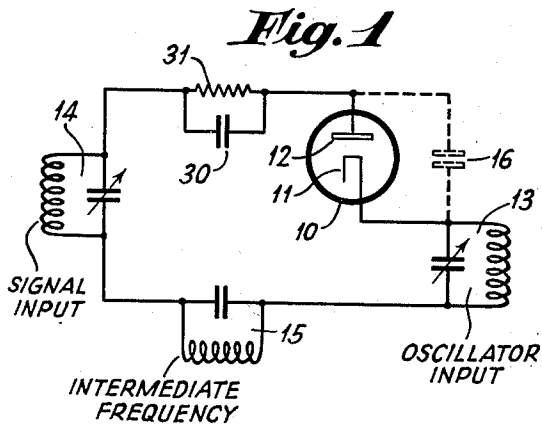
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ELECTRON DISCHARGE TUBE AND CIRCUITS

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ELECTRON DISCHARGE TUBE AND
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4 Claims. (Cl. 250—20)

My invention relates to electron discharge devices and associated circuits particularly suitable for use in superheterodyne operation at high frequencies.

In the conventional superheterodyne circuit making use of conventional tubes difficulty is experienced in obtaining satisfactory operation at the higher frequencies. This is due principally to the effect of the lead reactance and to the transit time of the electrons within the tube. It has been the practice to neutralize the lead reactance by means of tuned circuits connected to each of the leads. However, this practice increases the complexity of the circuit and increases cost, and is only a partial solution for the effective reactance at the higher frequencies. Transit time of electrons, that is the time necessary for electrons to pass from cathode to anode, can be reduced by decreasing electrode spacings in electron discharge devices. There is a practical limit to the extent to which this can be done. Close spacing introduces undesirable interelectrode capacities and also introduces manufacturing difficulties. Further, in the conventional tubes, the presence of controlling electrodes at low potentials between the cathode and the anode has the effect of increasing the transit time of the electrons between the cathode and anode.

It is, therefore, an object of my invention to provide an electron discharge device and a circuit particularly suitable for superheterodyne operation at high frequencies.

Another object of my invention is to provide an electron discharge device for superheterodyne reception in which coupling between oscillator and signal circuits is substantially reduced and lead reactances, interelectrode capacitances and transit time effects are minimized.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawing in which Figure 1 shows a tube and circuit arrangement to which my invention is directed, Figures 2, 3 and 4 are top end views of electron discharge devices made according to my invention and used in the circuits shown in Figures 5 and 6, which are schematic diagrams of tubes and circuits made according to my invention.

In accordance with my invention I use a diode connected in a mixing circuit for practicing my invention. Because of the simplicity of construction of the diode and the absence of a plurality of grids intermediate the anode and cathode, which grids are necessary in the conventional types of tubes for mixer operation, I am able to use a tube in which the spacing between the cathode and anode is reduced to a minimum and

a tube in which the leads may be made very short for reducing lead reactance and which permits the use of lumped circuits which may also be replaced by transmission lines acting as resonators.

In the conventional converter or mixer circuit, as used at low frequencies, the conventional mixer tube usually comprises at least a cathode, a signal grid, a screen, an oscillator grid to which the local oscillator voltage is applied and an anode. The signal and oscillator voltages of different frequencies act successively on the electron stream between the cathode and anode to produce an intermediate frequency in the anode or output circuit. At high frequencies, such tubes frequently fail to operate well and it has become customary to use a simple diode mixer.

In Figure 1 is shown a conventional diode tube and associated circuit to which my invention can be applied. As shown, a diode 10 having a cathode 11 and anode 12 is connected to a signal input circuit 14, and an oscillator input circuit 13. A grid-leak 31 and condenser 30 serve to automatically bias the anode negatively. The signal circuit 14 is connected to the anode 12 through 30 and 31, and the oscillator input circuit 13 is connected to the cathode. The output circuit 15, which is tuned to the intermediate frequency is connected between the other ends of circuits 13 and 14. Each of circuits 13, 14 and 15 are shown as parallel tuned circuits consisting of inductance and capacitance. It is understood, of course, that sections of transmission line or other types of high frequency circuits are frequently used in such circuits since their behavior is similar to that of the tuned circuits shown.

When oscillator and signal voltages are applied, the anode 12 of the diode draws pulses of current whenever its instantaneous voltage is positive with respect to the cathode. The current pulses contain a component whose frequency is the difference between oscillator and signal frequencies. This component builds up an intermediate frequency (I—F) voltage across the output circuit 15 which may be utilized for further amplification in the usual way.

In the above arrangement the internal capacitance between the electrodes indicated by the dotted capacity 16 results in a coupling between the oscillator input and signal input circuits of the tube. As a result a high in or out of phase oscillator voltage is built up on the signal input circuit which demodulates the tube in the one case and causes wide variations in performance over a band of frequencies in the other. In order to neutralize this effect I have provided diodes and circuit arrangements which are particularly suitable for use in the manner of the circuit disclosed in Figure 1.

As shown in Figure 2 the tube comprises a cathode 20 and an anode 21 and positioned between

the cathode 20 and anode 21 is a shielding and accelerating electrode 22 consisting preferably of sheet metal electrodes positioned on opposite sides of the cathode and providing oppositely disposed slots through which the electron current passes to the anode. These electrodes are all mounted within an envelope 23.

In Figure 3 the anode has been replaced by a pair of plates 21' to reduce the capacitance and to permit push-pull operation.

In order to raise the output impedance of the tube and to reduce the current to the shield 22, which during operation is normally maintained at a positive potential, I can, as shown in Figure 4, introduce a second shielding electrode 24 which may be directly connected to the cathode 20.

As shown in Figure 5 the cathode 20 is connected to the oscillator input circuit 13 and the anode to the signal input circuit 14. The combined shielding and accelerating electrode 22, however, is maintained at a positive potential with respect to both the cathode and the anode by a potential source 22'. This decreases the conductance of the cathode-to-anode path and serves to electrically screen the cathode from the anode, thus reducing coupling capacitance between the oscillator and signal circuits. Due to the fact the shield 22 is at a positive potential, electrons moving from cathode to anode are accelerated and thus the transit time of the electrons is reduced, which is particularly important when the tube is operated at very high frequencies. The intermediate frequency circuit 15 is connected to the free ends of the oscillator and signal circuits.

In Figure 6 I show a circuit employing the tube shown in Figure 4. In this arrangement the shielding electrode 24 adjacent the cathode is electrically connected to the cathode while the shielding electrode 22 is again maintained at a positive potential with respect to the oscillator and signal input circuits.

By means of my invention lead reactance, interelectrode capacity and capacity coupling and transit time effects, all of which are particularly undesirable at high frequencies and which reduce the efficiency of tubes operated at high frequencies, are minimized and tubes and circuits made in accordance with my invention will operate at much higher frequencies than the conventional tubes and circuits now employed.

While I have indicated the preferred embodiments of my invention of which I am now aware and have also indicated only one specific application for which my invention may be employed, it will be apparent that my invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of my invention as set forth in the appended claims.

What I claim as new is:

1. An electron discharge device including a cathode and an anode, and a shielding electrode comprising a pair of oppositely disposed shielding elements surrounding said cathode and between said cathode and anode, said shielding elements providing between them oppositely disposed apertures through which electrons may flow from the cathode to the anode, an input circuit con-

nected to said cathode for applying a voltage of one frequency to said cathode and a second input circuit connected to said anode for applying a voltage of a different frequency to said anode, and means for maintaining said shielding electrode at a positive potential with respect to the cathode and the anode, and an output circuit connected between the two input circuits.

2. An electron discharge device including a cathode and an anode, and a shielding electrode comprising a pair of oppositely disposed shielding elements surrounding said cathode and between said cathode and anode, said shielding elements providing between them oppositely disposed apertures through which electrons may flow from the cathode to the anode, an input circuit connected to said cathode for applying a voltage of one frequency to said cathode and a second input circuit connected to said anode for applying a voltage of a different frequency to said anode, and means for maintaining said shielding electrode at a positive potential with respect to the cathode and the anode, and an output circuit connected between the two input circuits, and a shielding electrode positioned between said first shielding electrode and the cathode and maintained at not greater than cathode potential.

3. An electron discharge device including a cathode and an anode, and a shielding electrode comprising a pair of oppositely disposed sheet metal elements surrounding said cathode and between said cathode and said anode, said sheet metal elements providing between them oppositely disposed apertures through which electrons may flow from the cathode to the anode, an input circuit connected to said cathode for applying a voltage of one frequency to said cathode and a second input circuit connected to said anode for applying a voltage of a different frequency to said anode, and means for maintaining said shielding electrodes at a positive potential with respect to the cathode and the anode, and an output circuit connected between the two input circuits, and a shielding electrode positioned between said first shielding electrode and the cathode, and an electrical connection between said last shielding electrode and said cathode.

4. An electron discharge device including a cathode and an anode, and a shielding and accelerating electrode between said cathode and anode and comprising oppositely disposed sheet metal elements positioned on opposite sides of the cathode, said sheet metal elements providing between them oppositely disposed apertures through which the electrons pass from the cathode to the anode, an input circuit having one side connected to the cathode for applying a local oscillator voltage to said cathode, and a second input circuit having one side connected to the anode for applying a signal voltage to said anode, and an intermediate frequency circuit connected to the sides of said input circuits opposite those connected to the cathode and the anode, and a voltage source connected to said shielding and accelerating electrode for biasing the same to a positive potential with respect to the cathode and the anode.

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