Feb. 27, 1940. W. H. ALDOUS 2,191,903

ELECTRON DISCHARGE DEVICE

Filed Aug. 10, 1938

Fig. 1

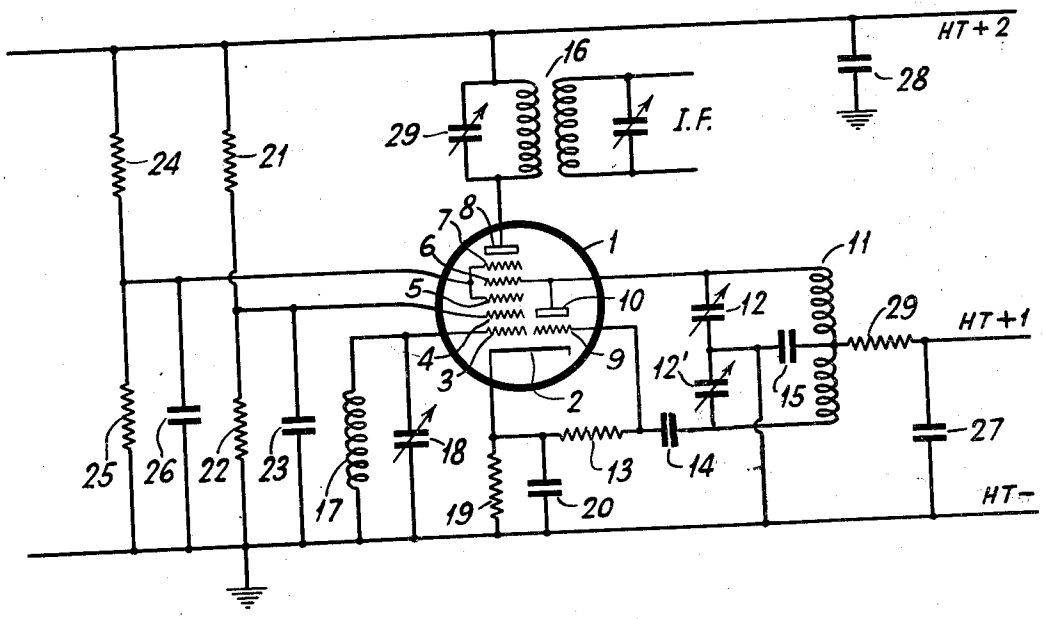
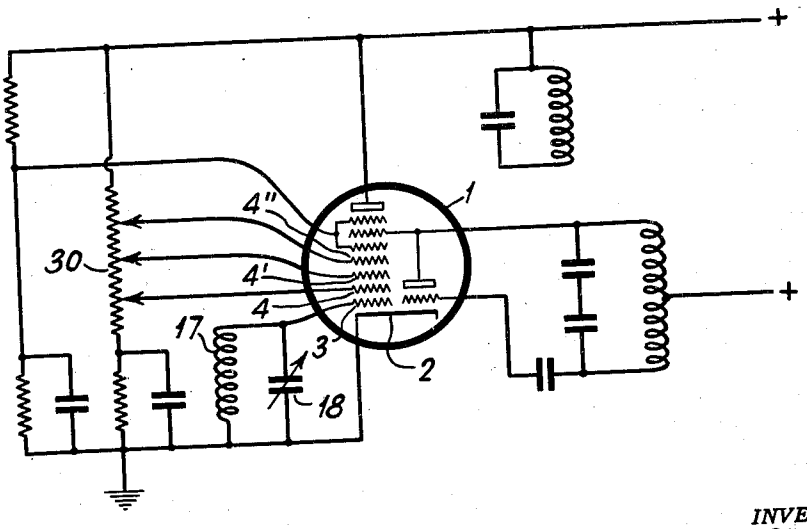


Fig. 2



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ELECTRON DISCHARGE DEVICE

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2 Claims. (Cl. 250—174)

The invention relates to electron discharge devices of the multi-grid type and particularly suitable for frequency changing in superheterodyne receivers, the two frequencies to be intermodulated being applied respectively to two different successive control grids.

A tube of this kind has the usual cathode and anode and a screen between the two control grids. A second screening grid is usually placed between the anode and the control grid next to it. The sequence of electrodes is then (1) cathode (2) first grid=first control grid, (3) second grid=first screening grid, (4) third grid=second control grid, (5) fourth grid=second screening grid, (6) anode. In using such a so-called "hexode" the first and third grids are usually made negative to the cathode, the second and fourth grids positive to the cathode.

In tubes with the electrodes arranged and connected in this manner, some of the electrons passing through the second grid are turned back by the third grid and may oscillate about the second grid. So long as the period of the electrical oscillations applied to any grid is long compared with the transit time of the electrons between any two electrodes, electrons which have passed the second grid can never be caught by the first grid, which is negative to the cathode. But if this condition is not fulfilled, electrons after passing the second grid may receive energy from the high frequency field and may reach the first grid. They then produce damping in the input circuit connected to the first grid, and the operation of the frequency changer is impaired in known manner.

The primary object of this invention is to prevent such impairment. The means adopted to prevent it do not introduce any serious disadvantages at low frequencies. The invention is not confined to tubes of the type specified adapted to be operated at very high frequencies, and may be applied to tubes suitable for receiving broadcasting.

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 be best understood by reference to the following description taken in connection with the accompanying drawing in which Figure 1 shows a schematic diagram of a tube made according to my invention and its associated circuit, and Figure 2 shows a modification of the tube shown in Figure 1, and its associated circuit.

The general idea underlying the invention is to cause the third grid to control, not the primary electrons from the cathode, but secondary electrons produced by these primaries at the second grid. These secondaries, when they leave the second grid, have a kinetic energy so low that any additional energy they may acquire from the high frequency field cannot make their kinetic energy sufficient to enable them to reach the first grid again. On the other hand, if the potential of the third grid is not too different from that of the second grid (being preferably just more negative) the secondary electrons, when they reach the third grid, will have kinetic energies so small that they are easily controlled by it. The primary electrons, having a high kinetic energy in the neighbourhood of the third grid are not turned back by it, but proceed almost unaffected towards the anode.

According to the invention an electron discharge device of the type specified includes at least one secondary emission grid, intervening between the first and second control grids, composed of or coated with material having a coefficient of secondary electron emission substantially greater than that of any clean metal such as nickel, tungsten or molybdenum. Preferably its surface is one of those known to have the highest coefficients of secondary emission and used for the secondary cathodes of electron multipliers, for example that produced by heating an oxidized metal in caesium vapor.

Instead of a single grid so coated between the control grids a series of grids each so coated may be introduced, and in operation maintained each at a more positive potential than the preceding, so that, in known manner, the number of secondary electrons is increased by the impact of electrons from an earlier grid on a later grid.

The single secondary emission grid or the combination of grids in series must be such as to act in a known manner as a screening grid between the first and second control grid.

If, as is preferable, there is a screening grid between the second control grid and anode, it should be capable of being maintained at a higher potential than the second grid, and therefore should not be connected within the tube to the second grid. For since the secondary electrons will not be accelerated materially, if at all, by the second control grid, they must receive their acceleration from the screening grid.

An accelerating grid may be interposed between the secondary emission grid(s) and the second control grid, and maintained in operation at a potential positive to both of them. The secondary electrons in the neighbourhood of the

second control grid are then in a retarding field, as are the electrons controlled by the second control grid in the aforesaid hexode.

In the ordinary use of the hexode aforesaid, the cathode and the second control grid are often connected directly to the cathode and control grid of an oscillator tube, which is within the same envelope as the hexode and shares its cathode. A tube according to the invention may share its cathode with another tube adapted to act as an oscillator, but it is not possible to connect the second control grid to the control grid of the oscillator, since the second control grid must be substantially positive to the cathode; but the second control grid may be connected to the anode of the oscillator. Alternatively a condenser and grid leak coupling may be used.

In the drawing the tube made according to the invention is used as a frequency changer, and is along with a triode, serving as an oscillator supplying it, enclosed in a common envelope 1, and share a common cathode 2. The tube has the following electrodes in order: The cathode 2, the first control grid 3, the screening grid 4 coated in known manner with material of high coefficient of secondary emission, the accelerating grid 5, the second control grid 6, the second screening grid 7 (which may be connected within the tube, as shown, to the accelerating grid 5), and the anode 8. The triode consists of cathode 2, control grid 9, and anode 10 joined directly to second control grid 6.

The input circuit comprising the coil 17 and condenser 18 is connected between the cathode 2 and first control grid 3. The various voltages for the various grids are obtained by a voltage divider arrangement comprising resistors 21—22, 24—25 and by-passing condensers 23 and 26. The oscillator circuit comprises the coil 11 and condensers 12' 12, and a blocking condenser 14 used to permit high voltage to be applied to the anode 10 of the oscillator section of the tube. The biasing resistors 13 and 19 and 29 serve to obtain proper biases for the various electrodes. Bypassing condensers 20 and 27 are used. The output circuit connected to the anode 8 comprises condenser 29 and primary of transformer 16 for supplying the intermediate frequency.

The modification of my invention in which the tube is provided with a plurality of grids between the control grid and accelerating grid and each coated with emitting material is shown in Fig. 2. These grids are grids 4, 4' and 4'' and obtain their proper voltages from the divider resistor 30. The arrangement is otherwise the same as in Fig. 1.

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 for frequency changing and having a cathode, a first control grid, a plurality of successive grids coated with emitting material, an accelerating grid, a second control grid and an anode, and a grid and a second anode directly adjacent and laterally of said cathode and independent of the other grids and other anode for providing an oscillator section in the tube and a connection between the second anode and the second control grid.

2. An electron discharge device for frequency changing and having a cathode for emitting primary electrons, a first control grid, a grid coated with emitting material for emitting secondary electrons when struck by primary electrons from said cathode, an accelerating grid, a second control grid and an anode for receiving secondary electrons from the coated grid, a grid and a second anode directly adjacent and laterally of said cathode and independent of the other grids and other anode for providing an oscillator section in the tube, said second control being adapted to modulate said secondary electrons from said coated grid during operation of said electron discharge device and a connection between the oscillator anode and the second control grid.

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