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HIGH FREQUENCY AMPLIFIER CIRCUIT

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Fig.1

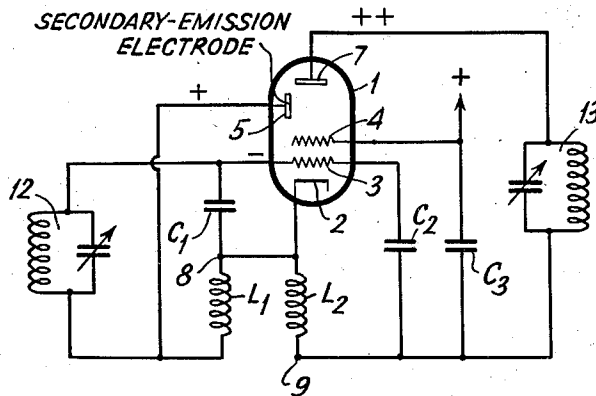
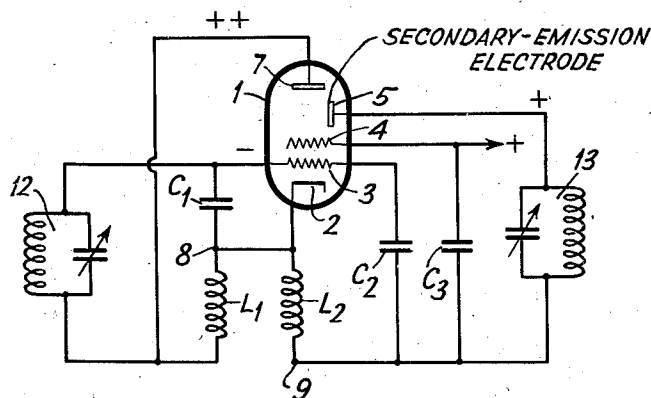


Fig. 2



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HIGH FREQUENCY AMPLIFIER CIRCUIT

Maximiliaan Julius Otto Strutt and Aldert van
der Ziel, Eindhoven, NetherlandsApplication January 17, 1941, Serial No. 374,805
In the Netherlands March 21, 1940

5 Claims. (Cl. 179-171)

In our copending application, Ser. No. 333,088, filed May 3, 1940, there is described a high-frequency amplifier circuit comprising at least one amplifier valve whose cathode is provided with at least two leads, one of which, for the oscillations to be amplified, is included in the input circuit and another in the output circuit and in which intermediate the control grid and the point of the cathode which is connected to the cathode lead included in the input circuit and intermediate the control grid and that end of the cathode lead included in the output circuit which is not connected to the cathode are capacities and one or both cathode leads comprises or comprise impedances of which at least one has an inductive character, said capacities and impedances being proportioned in such manner that the input damping is approximately zero or negative.

In one of the embodiments of the above application use is made of a secondary emission valve in which the output impedance is connected between the anode and cathode, whilst at the same time the secondary emission electrode is connected, for high-frequency currents, to that end of the cathode lead included in the input circuit which is remote from the cathode.

It has now been found that with this circuit the desired effect can no longer be obtained in some cases if the frequency of the oscillations to be amplified exceeds 50 megacycles/sec. The invention has for its object to improve the circuit concerned so as to permit of the input damping being also suppressed for ultra-high frequencies.

According to the invention, in a circuit according to the prior application which is arranged for the amplification of frequencies exceeding 50 megacycles/sec. and in which use is made of a secondary emission valve the output impedance is connected between the secondary emission electrode and the cathode, whilst at the same time the anode is connected in a high-frequency manner to that end of the cathode lead included in the input circuit which is remote from the cathode.

In order that the invention may be clearly understood and readily carried into effect it will now be described more fully with reference to the accompanying drawing, in which

Fig. 1 shows the circuit according to the prior specification above referred to, and

Fig. 2 shows an improved circuit according to the invention.

The circuit shown in Fig. 1 comprises an am-

plifier valve 1 having a cathode 2, a control grid 3, a screening grid 4, a secondary emission electrode 5 and an anode 7. The drawing only shows the high-frequency connections of the various electrodes, the direct-current connections being omitted. For the sake of completeness it must be remarked that the control grid 3 preferably has a negative bias relatively to the cathode 2, whereas the screening grid 4, the secondary emission electrode 5 and the anode 7 are placed at a positive potential which is higher for the anode 7 than for the secondary emission electrode 5.

The high-frequency oscillations to be amplified are fed to an input-oscillatory circuit 12 which is connected on the one hand to the control grid 3 and on the other hand, via one of the cathode leads, to the cathode 2. The anode 7 is connected to the cathode 2 via an output-oscillatory circuit 13, from which the amplified oscillations are taken off, and via the other cathode lead.

The cathode leads include inductances L_1 and L_2 and the point 3 of the inductance L_1 which is connected to the cathode is connected to the control grid 3 via a capacity C_1 and that end of the inductance L_2 which is remote from the cathode 2 is connected thereto via a capacity C_2 .

The screening grid 4 is connected to that end of the inductance L_2 which is remote from the cathode 2 via a capacity C_3 so that the natural capacity between the screening grid and the control grid assists in the action of capacity C_2 . The secondary emission electrode 5 is connected for high-frequency currents to that end of the inductance L_1 which is remote from the cathode.

If the elements L_1 , L_2 , C_1 and C_2 are proportioned correctly it can be ensured, at least for frequencies below 50 megacycles/sec., that the input damping which exists due to the finite transit time of the electrons is suppressed entirely so that the consequential input damping becomes zero or even negative. The elements L_1 , L_2 , C_1 and C_2 can be formed in part but not all of them by the natural inductances of the cathode lead and the natural tube capacities.

The operation of the circuit described is based on the fact that the current of the secondary emission electrode flows to the anode through the inductances L_1 and L_2 . If the transit time of the electrons is negligible relatively to the cycle of the oscillations to be amplified, the said current will be in phase with the control-grid alternating voltage, so that a voltage drop occurs across the inductances L_1 and L_2 which leads by an angle of 90° relatively to the control-grid

alternating voltage. Due to this potential drop currents will flow through the capacities C_1 and C_2 to the control grid which are in phase with the control-grid alternating voltage so that an undamping effect is obtained. The current of the cathode 2 which also causes a potential drop across the inductance L_2 which leads by an angle of 90° relatively to the control-grid alternating voltage will assist in this effect. The secondary emission current, however, is generally materially larger than the cathode current so that the effect of the first-mentioned current preponderates.

If the transit time of the electrons is no longer negligible relatively to the cycle of the oscillations to be amplified the current which flows from the secondary emission electrode through the inductances L_1 and L_2 to the anode will lag with respect to the control-grid alternating voltage. So long as this lag is less than 90° the said current contains a component which is in phase with the control-grid alternating voltage and the effect aimed at can therefore still be obtained with convenient proportioning of the circuit. As soon as, however, the lag becomes larger than 90° , as only occurs in practice at frequencies above 50 megacycles/sec., the desired suppression of the input damping is no longer possible. In principle, the effect aimed at may now be obtainable again by partially substituting for the elements L_1 , L_2 , C_1 and C_2 impedances of a different nature. This is, however, difficult in practice in view of the presence of the natural tube impedances. For obtaining the effect aimed at it is therefore preferable that the direction of the current which flows through the inductances L_1 and L_2 should be reversed.

According to the invention the latter result is obtained by interchanging the connections of the anode and of the secondary emission electrode in the circuit shown in Fig. 1. Thus the circuit shown in Fig. 2 is obtained in which the output oscillatory circuit 13 is connected to the secondary emission electrode 5 and the end of the inductance L_1 which is remote from the cathode is connected to the anode 7. The current of the secondary emission electrode 5 thus flows in the reverse direction through the inductances L_2 and L_1 .

This circuit permits of obtaining a complete suppression of the input damping if the lag of the current of the secondary emission electrode is comprised between 90° and 270° . If this lag becomes larger than 270° it is necessary to use the circuit shown in Fig. 1 again.

With increasing frequency of the oscillations to be amplified frequency-bands are therefore passed through in succession in which the circuit shown in Fig. 1 or that shown in Fig. 2 must be used.

We claim:

1. A high frequency circuit arranged for the amplification of frequencies about 50 megacycles/sec. comprising at least one amplifier valve having a control grid, an anode, a secondary emission electrode and a cathode, the latter being provided with at least two leads, one of which, for the oscillations to be amplified, is included in the input circuit and another in the output circuit, capacities connected between the control grid and the point of the cathode which is connected to the cathode lead included in the input circuit and between the control grid and that end of the cathode lead included in the output circuit which is not connected to the cathode, one or both of said cathode leads having an impedance con-

nected thereto at least one of which has an inductive character, said capacities and impedances being proportioned in such manner that the input damping is approximately zero or negative, an output impedance connected between the secondary emission electrode and the cathode, the anode being connected in a high-frequency manner to that end of the cathode lead included in the input circuit which is remote from the cathode.

2. A circuit for the amplification of high frequencies, comprising an electron discharge tube provided with at least a cathode, a secondary emission electrode, a signal input grid and an anode, the cathode having at least two leads connected thereto, input and output circuits connected respectively to the input grid and to the secondary emission electrode, the grid return of the input circuit being connected to one of the cathode leads, the electrode return of the output circuit being connected to the other cathode lead, a condenser connected from each of the cathode leads to the signal input grid, and a connection between the anode and the cathode lead included in the input circuit.

3. A circuit for the amplification of ultra-high frequencies, comprising an electron discharge tube provided with at least a cathode, a secondary emission electrode, a signal input grid and an anode, the cathode having at least two leads connected thereto, input and output circuits connected respectively to the input grid and to the secondary emission electrode, the grid return of the input circuit being connected to one of the cathode leads, the electrode return of the output circuit being connected to the other cathode lead, a condenser connected from each of the cathode leads to the signal input grid, and a connection between the anode and the cathode lead included in the input circuit, the input grid being maintained at a negative potential, and the anode and secondary emission electrode being maintained at a positive potential, that of the former being higher than that of the latter.

4. A circuit for the amplification of ultra-high frequencies, comprising an electron discharge tube provided with at least a cathode, a secondary emission electrode, a signal input grid and an anode, the cathode having a pair of leads connected thereto, an impedance connected to each of the cathode leads, input and output circuits connected respectively to the input grid and to the secondary emission electrode, the grid return of the input circuit being connected to the end remote from the cathode of the impedance connected to one of the cathode leads, the electrode return of the output circuit being connected to the end remote from the cathode of the impedance connected to the other cathode lead, a condenser connected between the signal input grid and the cathode end of the impedance included in the input circuit, a condenser connected between the signal input grid and the end remote from the cathode of the cathode impedance included in the output circuit, and a connection between the anode and the grid return of the signal input grid.

5. A circuit for the amplification of ultra-high frequencies, comprising an electron discharge tube provided with at least a cathode, a secondary emission electrode, a signal input grid, a screen grid and an anode, the cathode having a pair of leads connected thereto, an inductance connected to each of the cathode leads, input and output circuits connected respectively to the input grid and to the secondary emission elec-

trode, the grid return of the input circuit being connected to the end remote from the cathode of the inductance connected to one of the cathode leads, the electrode return of the output circuit being connected to the end remote from the cathode of the inductance connected to the other cathode lead, a condenser connected between the signal input grid and the cathode end of the inductance included in the input circuit, a condenser connected between the signal input grid 10

and the end remote from the cathode of the cathode inductance included in the output circuit, and a connection between the anode and the grid return of the signal input grid, the latter being maintained at a negative potential, and the anode and secondary emission electrode being maintained at a positive potential, that of the former being higher than that of the latter.

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