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THERMIONIC VALVE CIRCUIT

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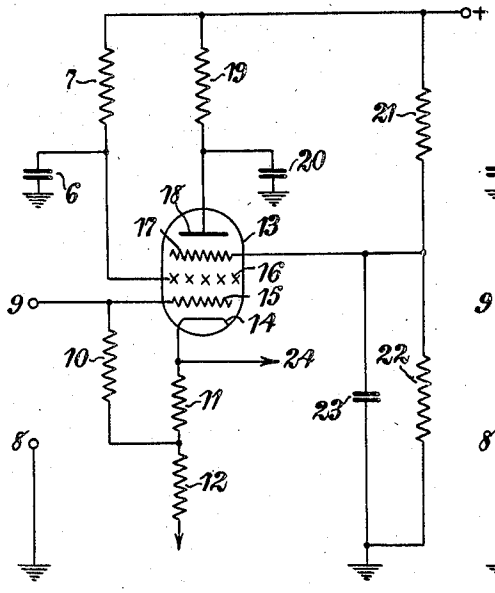


Fig. 1.

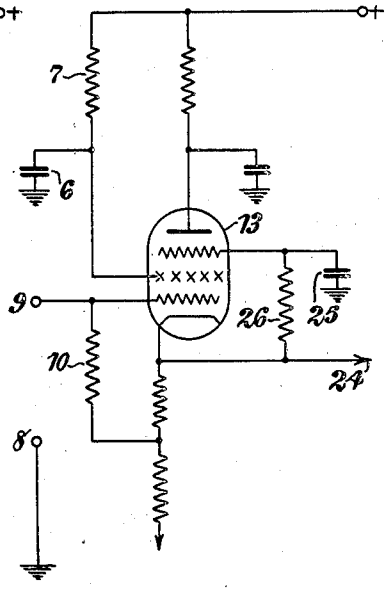


Fig. 2.

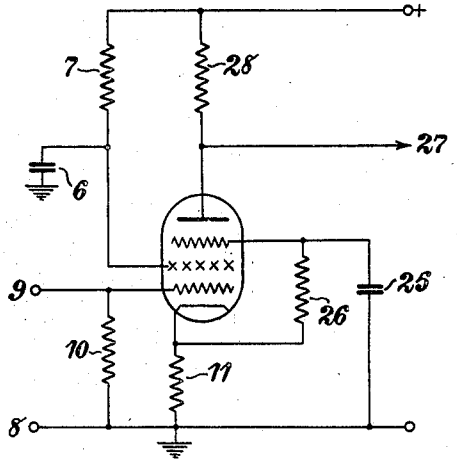


Fig. 3.

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THERMIONIC VALVE CIRCUIT

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3 Claims. (Cl. 179—171)

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The present invention relates to thermionic valve circuits of the type designed to handle signals of high frequency i. e., at such frequencies that the inter-electrode capacities of a thermionic valve employed in the circuit are effective to modify the functioning of the circuit.

In a number of such circuits it is necessary to connect an impedance between the cathode of a thermionic valve and the negative terminal of the source of anode current for the valve. For example, with the so-called "cathode follower valve" it is necessary to connect an impedance between the cathode and the negative terminal of the source and to apply between the control electrode of the valve and the negative terminal so that the potential of the cathode of the valve follows substantially the potential of the grid of the valve, the output in this case being usually taken from the cathode impedance. Furthermore, it is usual in order to reduce distortion in thermionic amplifiers and the like to insert an impedance in the cathode circuit in order to provide negative feedback for the purpose of straightening the valve characteristic and thus reducing distortion, the output in this case being usually taken from the anode circuit. In a particular case when a valve of the tetrode type, which may contain electrostatic shielding plates, or of the pentode type, which has a suppressor grid, is employed in such circuits it is usual to connect the shielding plates, or the suppressor grid, directly to the cathode in order that the bias on the said plates or suppressor grid is equal to the potential of the cathode. It has been found that when such circuits are operating at high frequencies the effect of the additional capacity of the shielding plates, or the suppressor grid, to ground is detrimental to the satisfactory operation of the circuits. For example, in the case of the cathode follower valve the extra capacity added between cathode and ground will tend to stop the potential of the cathode following that of the grid at high frequencies, whilst in the case of the negative feedback circuit already mentioned the feedback is reduced at high frequencies and thus the circuits are not satisfactory.

Similar difficulties arise in thermionic valve circuits in which impedances are connected in both anode and cathode circuits and outputs are derived from each impedance.

It is the object of the present invention to provide improved means whereby these and other disadvantages are substantially overcome or reduced.

According to the invention a thermionic valve circuit of the type referred to is provided, wherein an impedance is connected in the cathode circuit in such a manner that in operation the potential of the cathode varies, means being provided for biassing the suppressor grid, or shielding plates, at substantially the mean or low frequency potential of the cathode while maintaining it at a substantially fixed potential relative to ground for high frequency signals.

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

Figure 1 represents an embodiment of the invention as applied to a cathode follower circuit.

Figure 2 represents a further embodiment of the invention as applied to a cathode follower type of circuit, and

Figure 3 represents a further embodiment of the invention as applied to a negative feedback amplifier.

Referring to Figure 1, the reference numerals 8 and 9 represent the input terminals to a pentode thermionic valve 13 which is employed as a cathode follower valve. The cathode 14 of the valve 13 is connected to a source of negative potential by means of resistances 11 and 12 which are arranged in series. The junction of the two resistances is joined to the grid 15 of the valve by means of a leak resistance 10, the resistance 11 serving as a bias resistor in order to give the grid the correct bias potential. The screening grid 16 of the valve is taken to a suitable positive potential by means of a resistance 7 and is bypassed to ground by condenser 6 and the anode 18 is suitably decoupled from a source of positive potential by means of the anode decoupling resistance 19 and the decoupling condenser 20. The output of the valve is taken from line 24, which is connected to the cathode 14.

According to normal practice the suppressor grid 17 of the valve 13 would be connected directly to the cathode 14 of the valve. This may be desirable from the operating valve conditions, since even if the anode does not supply a load, it enables the amount of screen current to be more definite than is the case were the suppressor joined to the screen. In such a case it will be seen that the capacity of the suppressor grid to ground is added to the capacity of the cathode 14 to ground and thus the effective impedance between cathode and the negative source of supply, that is, the impedance due to the resistance 11 and 12 is reduced at high frequencies and thus the potential of the cathode 14 does not follow

the potential of the grid 15 so efficiently as at low frequencies. In order to avoid this additional capacity due to the suppressor grid, the suppressor grid 17 is, according to one embodiment of the invention, connected to a point on a potential divider 21 and 22 in such a way as to give the suppressor grid 17 a potential equivalent to that of the mean potential of the cathode 14. Should the resistance 22 be of a high value it may be necessary to bypass this resistance by means of a condenser 23. It will be seen that the suppressor grid capacity is now removed from the cathode circuit and does not affect the operation of the circuit whilst the suppressor grid is maintained at the potential necessary for it to perform its suppressor action.

A further method of avoiding the capacity effect will now be described with reference to Figure 2 of the accompanying drawing. In this figure like components to those in Figure 1 have been given like numerals and it is assumed that except for the suppressor grid circuit that the circuit behaves in a similar manner. In this case the suppressor grid 17 is connected to the cathode 14 by means of a high resistance 26, and in addition, the suppressor grid is bypassed to ground by means of a large condenser 25. Due to the direct current connection of the suppressor grid 17 to the cathode 14 by means of the resistance 26, the suppressor grid 17 is maintained at the mean potential of the cathode 14, the condenser 25, serving to prevent the potential of the suppressor grid fluctuating at high frequencies. Alternatively the resistance may be replaced by or in combination with an inductance of suitable value.

Figure 3 illustrates an embodiment of the invention as applied to an amplifier employing negative feedback in the cathode circuit. In this case the valve 13 has an anode resistance 28 across which output potentials are derived and passed out via lead 27. The resistance 11 serves a dual purpose of providing negative feedback for the purpose of reducing distortion in the amplifier and for providing a suitable negative grid bias for the grid of the valve 15. The normal connection of the suppressor grid directly to the cathode 14 has the effect at high frequencies of reducing the effective cathode impedance which determines the amount of negative feedback, and thus the feedback decreases at high frequencies and for these frequencies the output from the amplifier is increased with consequent distortion. For the purpose of eliminating this effect, the suppressor grid is connected to the cathode 14 by means of a resistance 26 and is also connected to ground by means of a large condenser 25. As in the case of Figure 2, suppressor grid is biassed at mean cathode potential and the effect of the suppressor grid to earth capacity is rendered ineffective on the feedback circuit.

Alternatively, the bias for the suppressor grid 17 of Figure 3 could be obtained, according to the invention, in a similar manner to that indicated with reference to Figure 1, namely, by connecting the suppressor grid to a tapping from a potential divider so as to provide the suppressor grid with a bias potential equivalent to the mean potential of the cathode of the valve.

In the negative feedback amplifier case not only is there the effect of the direct suppressor grid to ground capacity, but there is also the effect of the suppressor grid to anode capacity, thus when the grid of the valve is positive, the potential of the anode is made negative and thus the anode to suppressor grid capacity tends to stop the cathode feedback circuit operating correctly at high frequencies in a similar manner to the well known "Miller effect." By adopting the circuits according to the invention this effect is reduced.

A further circuit to which the present invention is applicable is that in which a thermionic valve circuit is provided giving outputs from both the cathode and anode circuits for example for obtaining a push-pull output. This case is similar to that described with reference to Figure 3, only differing in that the cathode impedance is normally larger than that necessary for the correction of distortion. Similar ill effects due to the suppressor grid to ground capacity occur, and this causes distortion in that added capacity lowers the high frequency output from the cathode circuit and decreases the high frequency output from the anode circuit. By adopting the methods already outlined it is possible to overcome or reduce these ill effects.

An example of a further case in which both cathode and anode impedance are employed is in television apparatus. In one particular application a television signal is applied to the grid of such a valve circuit, signals from the cathode impedance being fed to the anode of a further screen grid valve used for D. C. re-insertion whilst signals in an inverted sense are passed from the anode circuit to the control grid of the further screen grid valve in an inverted sense for the purpose of switching on the screen grid valve during black level portions of the television signal which succeed the synchronising pulses, the signals in the anode circuit having passed through a delay network.

Since, in the embodiment of the invention described, the suppressor grid is connected effectively for high frequencies to the end of the cathode impedance remote from the cathode of the valve a certain amount of negative feedback will be applied to the suppressor grid of the valve and the gain will be reduced slightly from that obtainable with the normal arrangement. In this connection, the arrangement of Figure 1 is preferred in that the feedback to the suppressor grid is constant for all frequencies handled, whereas with the circuit of Figure 2 the feedback decreases for low frequencies.

Although the invention has been described as applied to pentode valves it will be understood that the invention can also be applied to tetrode valves having shielding plates (see British patent specification No. 423,932), the shielding plates being connected as described above.

We claim:

1. A high frequency amplifier comprising an electronic tube including a cathode, a control electrode, a screen electrode, a suppressor electrode, and an anode, a source of potential having positive and negative terminals, a resistance for connecting the cathode to the negative terminal of the source of potential, a grid resistance for connecting the control electrode to a point along said first named resistance, a load impedance for connecting the anode to the positive terminal of said source of potential, means for maintaining said screen electrode positive with respect to said cathode, a potentiometer connected across said source of potential, means for connecting said suppressor electrode to a point along said potentiometer such that the potential of the suppressor electrode may be equal to the average potential of the cathode, means for impressing an input

signal upon the control electrode, and an output circuit whereby input signals of high frequency will be amplified by the tube in an amount substantially equal to the amplification of low frequency input signals.

2. An amplifier circuit comprising an electron tube which includes a cathode, a control electrode, a screen electrode, a suppressor electrode and an anode, a source of potential having positive and negative terminals, means including a resistance for connecting the cathode to the negative terminal of the source of potential, a grid resistance for connecting the control electrode to a point along said first named resistance, means for connecting the screen electrode and the anode to the positive terminal of said source of potential, a high impedance member for connecting the suppressor electrode to said cathode, electron storage means connected between the suppressor electrode and the negative terminal of the source of potential, means for impressing signal variations upon the control electrode and an output circuit, whereby high and low frequency signal variations may be amplified by the circuit in substantially like amounts.

3. A device for amplifying a wide band of frequencies ranging from substantially zero to frequencies of the order of one megacycle comprising an electronic tube including a cathode, a control electrode, a screen electrode, a suppressor electrode and an anode, a source of potential having positive and negative terminals, means including a load impedance for connecting the anode to the positive terminal of the source of potential, resistance means for connecting the cathode to the negative terminal, a resistance for connecting the control electrode to a point along said resistance means, a condenser connected between the suppressor electrode and a point of fixed potential, a potentiometer connected across the source of potential, means for connecting said suppressor electrode to a point along said potentiometer so that the average potential of the suppressor electrode is substantially equal to the average potential of the cathode, means to maintain the screen electrode positive with respect to the cathode, and an output circuit, whereby substantially linear amplification of the entire applied frequency range will result.

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