

Sept. 19, 1944.

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2,358,428

THERMIONIC VALVE AMPLIFIER CIRCUIT ARRANGEMENTS

Filed May 15, 1943

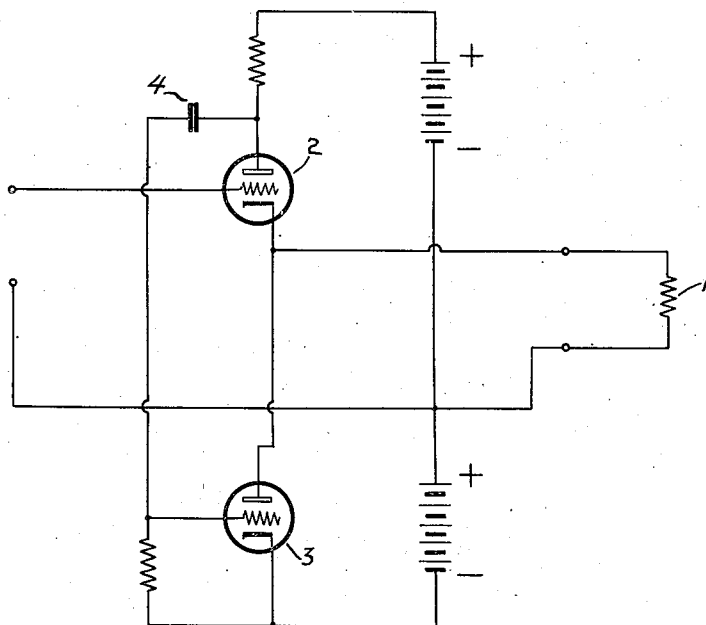


Fig. 1.

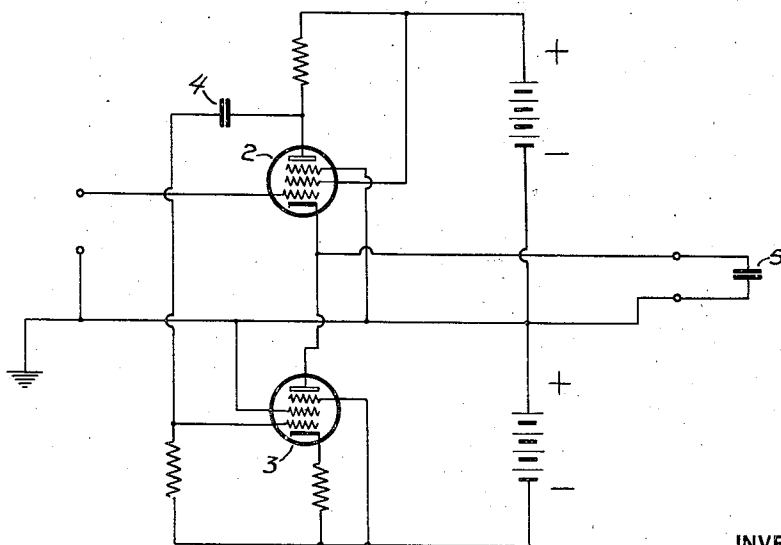


Fig. 2.

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2,358,428

THERMIONIC VALVE AMPLIFIER CIRCUIT
ARRANGEMENT

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Application May 15, 1943, Serial No. 487,160
In Great Britain September 7, 1940

6 Claims. (Cl. 179—171)

This invention relates to cathode follower circuit arrangements, that is to say, circuit arrangements including a valve having a load connected in its cathode circuit in such a manner as to provide negative feedback into its grid circuit so that the apparent output impedance of the cathode circuit of said valve as seen by said load is low and of the order of the inverse of the mutual conductance of said valve.

One of the objects of the present invention is to provide a circuit arrangement employing a pair of valves, one of which is arranged in a cathode follower circuit, for affording what is effectively a push-pull output without the necessity of employing a push-pull output transformer such as is usually required with push-pull circuits.

According to the invention, a circuit arrangement is provided comprising a thermionic valve and a load arranged in a cathode follower circuit, means for applying signals to the control electrode of said valve, a further valve having its output circuit arranged to feed current to said load in opposite sense to the current fed thereto by said first-mentioned valve, said further valve also being arranged to be controlled by said signals, the arrangement being such that if the current flowing through said load under the control of said first-mentioned valve is caused to increase on the application of said signals the current flowing through said load under the control of said further valve is caused to decrease and vice versa.

The output power which can be delivered to the load by a cathode follower circuit arrangement is limited by the available cathode current swing of the valve and it is usual to choose a valve capable of passing, without overheating, a mean current at least equal to one-half of the required output current swing and a peak current at least equal to the required current swing. One of the disadvantages of employing a valve in this manner is that the mean power output for a given size of valve is limited to a fraction of the maximum power output of the valve. A further disadvantage is that the mean current drawn by said valve is substantial and the arrangement is therefore uneconomical. By employing the arrangement according to the invention, the available power output of the valve can be more fully utilized. The mean current can also be reduced by so biasing said valves that in the absence of signals the anode current of each valve is small. The biases are, however, preferably arranged to be sufficient to ensure that the valves will oper-

ate on reasonably straight portions of their characteristic curves. By so biasing the valves it can be arranged that for large positive excursions of input signal voltages the load current is almost entirely supplied via one of said valves and for large negative excursions the load current is almost entirely supplied via the other valve. By employing two valves biased in the above manner, the mean current can be substantially reduced compared with the mean current which would be required for a single valve operating in a cathode follower circuit providing the same power output.

Preferably, the control electrode of said further valve is coupled to an impedance associated with the valve in the cathode follower circuit in such a manner that if signals are applied to said valve signals are also applied to said further valve but in opposite phase to the signals applied to said valve. The impedance is preferably provided in the anode circuit of said valve. An impedance may be connected in the cathode circuit of said further valve so as to provide negative feedback to linearize said further valve.

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

Figure 1 illustrates a circuit arrangement according to one embodiment of the invention, and Figure 2 illustrates a further embodiment of the invention.

Figure 1 of the drawing illustrates the invention as applied to an output stage of an amplifier feeding a load in the form of a low impedance concentric cable represented by the resistance 1. The triode valve 2 has the resistance 1 connected in its cathode circuit so as to provide negative feedback in its grid circuit, and the arrangement functions as a cathode follower circuit in which the impedance seen by the load is low and is substantially equal to the inverse mutual conductance of the valve 2. The cathode of the valve 2 is connected to the anode of a further valve 3, the control electrode of which latter valve is coupled to the resistance shown in the anode circuit of the valve 2 via the coupling capacity 4 and is also connected to the cathode of the valve 3 via the leak resistance shown. The cathode of the valve 3 is connected via the source of anode current, represented conventionally by a battery, to the negative terminal of the source of anode current for the valve 2, to which the lower end of resistance 1 is also connected.

Thus, when signals are applied to the input

terminals shown in the figure, the anode current of valve 2 is varied and the voltage changes across the resistance in the anode circuit of valve 2 are communicated via the coupling capacity 4 to the control electrode of valve 3. The signals so applied to valve 3 are, however, in opposite phase to those applied to valve 2. It will be appreciated from the circuit illustrated that the current fed by the valve 2 through the load 1 is in opposite sense to the current fed through the load by the valve 3. When the control electrode of the valve 2 is made positive on the application of the signals, the anode current of the valve 2 increases and the anode potential of the valve 2 decreases. This decrease of anode potential is applied via the resistance-capacity coupling to the control electrode of the valve 3 so that the anode current of the valve 3 is reduced. On the application of a signal causing the control electrode of the valve 2 to become less positive, the anode current of the valve 2 diminishes the increase in anode potential, which result is communicated to the control electrode of the valve 3 so that the anode current of this valve increases.

The bias potentials applied to the control electrodes of the valves 2 and 3 are so chosen that in the absence of input signal voltage the anode current of each valve is small, but sufficient to insure that the valves will operate on reasonably straight portions of their characteristic curves. It can therefore be arranged that for large positive excursions of the input signal voltage the current flowing through the load 1 is almost entirely supplied via the valve 2, and for large negative excursions of input signal voltage the load current is almost entirely supplied via the valve 3. The biases should be so chosen in relation to the signal voltages that if the anode current of the valve 2 were reduced to zero the anode potential of the valve 2 would be raised sufficiently to cause the valve 3 to pass maximum current. In operation, however, the bias potential applied to the valve 2 should be so chosen that the anode current of this valve is never entirely reduced to zero so that the output impedance always remains low. The output impedance of the two valves combined as seen by the load 1 can, if desired, be arranged to be less than the inverse of the mutual conductance of the valve 2.

If the signal voltages applied to the valve 2 comprise a television signal of the usual waveform consisting of picture signals and synchronising signals in different amplitude ranges, it can be arranged that the picture signal output is supplied mainly by current from the cathode follower valve 2 and the synchronising signal output is supplied mainly by current from the valve 3.

The circuit shown in Figure 1 thus provides what is effectively a push-pull output without the necessity of employing a push-pull output transformer and enables a substantial economy to be effected compared with a cathode follower circuit having a single valve producing the same power output.

The arrangement of Figure 2 shows an output stage feeding a capacity load 5, such as the modulating electrode of a cathode ray tube, which is of low impedance at high signal frequencies. As in the arrangement of Figure 1, it will be seen in Figure 2 that the cathode of the valve 2 in the cathode follower circuit is connected directly to the load and to the anode of the valve 3, the control grid of which is coupled through the con-

denser 4 and leak resistance to the anode resistance of the valve 2. A resistance is shown connected in the cathode lead of the valve 3, the value of the resistance being selected to provide negative feedback for the valve 3 such that it will operate substantially linearly. Since the output voltage swing is likely to be large, pentode type valves are employed instead of triodes which are shown in the arrangement of Figure 1, in which the voltage output swing is low. The operation of the arrangement is in substance similar to that already described with reference to Figure 1.

This application of the invention permits great economy in anode current, as high currents are only drawn when sudden changes of input signal voltages occur necessitating sudden bursts of current to charge or discharge the capacity 5.

Although the invention has been described with reference to output stages delivering television signals to low impedance loads, it will be understood that other kinds of signals may be used and the invention is particularly useful when the signals consist largely of sharp pulses.

I claim:

1. In an amplifier system of the cathode follower type comprising an electron discharge tube provided with signal input terminals and having a load impedance element in the cathode circuit thereof; the improvement which comprises an electron discharge device having at least a control electrode, cathode and anode, the anode to cathode path of said device and a current source being connected in series between the cathode and plate of said tube, means applying signal voltage existing at said latter plate to said control electrode, said load element being connected in shunt relation to said anode to cathode path, and the cathode of said tube and anode of said electron discharge device being at a common direct current potential.

2. In an amplifier system of the cathode follower type comprising an electron discharge tube provided with signal input terminals and having a load impedance element in the cathode circuit thereof; the improvement which comprises an electron discharge device having at least a control electrode, cathode and anode, the anode to cathode path of said device and a current source being connected in series between the cathode and plate of said tube, means applying signal voltage existing at said latter plate to said control electrode, said load element being connected in shunt relation to said anode to cathode path, and the cathode of said tube and anode of said electron discharge device being at a common direct current potential, an unbypassed resistive impedance in the space current path of said device for providing degenerative feedback to its said control electrode.

3. In an amplifier system, a pair of electron discharge devices each having at least a cathode, control electrode and output electrode, a closed circuit including the space current paths of said devices in series relation, means establishing the output electrode of one device at a positive potential relative to the cathode of the second device, an input circuit connected between the control electrode of said one device and a point of reference potential, an output circuit connected between the cathode of said one device and said point of reference potential, means for coupling the control electrode of the second device to the output electrode of the first device, and means directly connecting the output elec-

trode of the second device to the cathode of the first device.

4. In an amplifier system, a pair of electron discharge devices each having at least a cathode, control electrode and output electrode, a closed circuit including the space current paths of said devices in series relation, means establishing the output electrode of one device at a positive potential relative to the cathode of the second device, an input circuit connected between the control electrode of said one device and a point of reference potential, an output circuit connected between the cathode of said one device and said point of reference potential, means for coupling the control electrode of the second device to the output electrode of the first device, and means directly connecting the output electrode of the second device to the cathode of the first device, a resistive load element in said output circuit, said load element being unbypassed to provide degenerative feedback to said input circuit.

5. In combination with a signal amplifier tube having input and output electrodes, a resistive load element in the tube space current path common to the input electrodes and output electrodes of the tube whereby signal voltage developed across the load element is applied between the

5 tube input electrodes, means for applying signals to said input electrodes, a second tube provided with input signal connections to the output electrodes of said amplifier tube, and connections including said load element between the output electrodes of said second tube whereby said load element is arranged in push-pull relation to the space current paths of said two tubes.

10 6. In combination with a signal amplifier tube having input and output electrodes, a resistive load element in the tube space current path common to the input electrodes and output electrodes of the tube whereby signal voltage developed across the load element is applied between the tube input electrodes, means for applying signals to said input electrodes, a second tube provided with input signal connections to the output electrodes of said amplifier tube, and connections including said load element between the output electrodes of said second tube whereby said load element is arranged in push-pull relation to the space current paths of said two tubes, and a direct current connection from the anode of the first tube to the cathode of the second tube including a direct current source and a resistor in series relation.

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