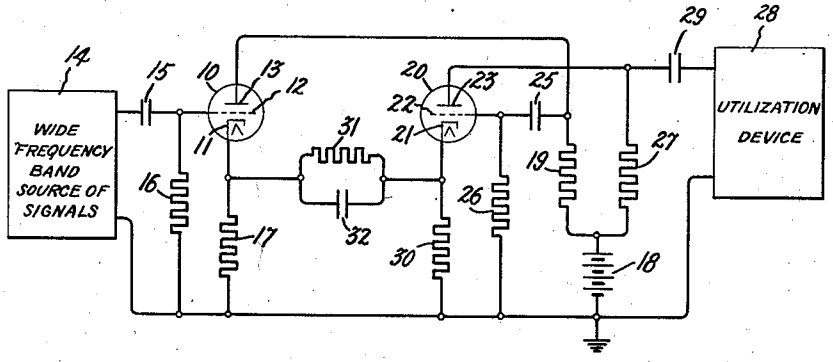
Jan. 30, 1945. R. B. DOME 2,368,454

THERMIONIC AMPLIFIER

Filed Jan. 23, 1943



Inventor:
Robert B. Dome,
by Harry E. Dunham
His Attorney.

Patented Jan. 30, 1945 2,368,454

UNITED STATES PATENT OFFICE

2,368,454

THERMIONIC AMPLIFIER

Robert B. Dome, Bridgeport, Conn., assignor to General Electric Company, a corporation of New York

Application January 23, 1943, Serial No. 473,361

2 Claims. (Cl. 179—171)

My invention relates to thermionic amplifiers and particularly to such amplifiers which include two or more electron discharge devices connected in cascade and provided with grid bias resistors in their cathode circuits which tend to produce degeneration.

The necessary negative grid bias voltage with respect to the voltage of the cathode in electron discharge devices employed in thermionic amplifiers is frequently obtained by providing a resistance in the cathode circuit between the cathode and ground. Any alternating current voltages appearing across the cathode resistor are in phase with the signal voltages impressed on the grid or control electrode and result in degeneration of the amplifier with respect to the signal voltage. For this reason, it is common practice to by-pass the cathode resistor with a condenser so that little if any voltage corresponding to the alternating current variations appears across the cathode resistor. When two or more amplifiers are connected in cascade, it has been found possible to avoid the necessity of providing by-pass condensers for the cathode resistors by utilizing available regenerative voltages in such a manner that the degenerative voltages in the cathode resistors are neutralized.

It is an object of my invention to provide a thermionic amplifier including two electron discharge devices connected in cascade and provided with an improved arrangement for overcoming the degenerative effects in the cathode resistors and for increasing the frequency range of the amplifier.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawing, the single figure of which represents a two-stage thermionic amplifier embodying my invention.

Briefly, the amplifier shown in the drawing comprises two electron discharge devices, resistance coupled in cascade; both devices are provided with resistors in their cathode circuits for obtaining the necessary bias voltage for their control electrodes. Instead of providing condensers by-passing the cathode resistors to prevent the impressing of degenerative voltages between the control electrode and cathode, a voltage which is regenerative with respect to the signal impressed on the first device is fed back by a resistance from the cathode of the second device to the cathode of the first device. The value of the resistance is selected so that the regenerative voltage fed back to the first device not only overcomes the degenerative voltage due to the cathode resistor of the first device but also provides sufficient regenerative voltage to increase the output of the first device to such an extent that the output signal of the second device is not less than it would be were a condenser provided to by-pass the cathode resistor of the second device to prevent degeneration. This circuit makes it possible to omit two by-pass condensers and the cost and weight of the circuit is reduced. Better over-all performance is obtainable because the circuit may be adjusted to give the same effect as would be obtained by complete by-passing of the cathode resistors by condensers having infinite capacity; it follows that the response of the amplifier at low frequency is increased. In order to increase the response of the amplifier at higher frequencies and to reduce the loss of gain in the higher frequency range, the resistance coupling the cathodes of the two electron discharge devices is shunted by a condenser which increases the feed-back of high frequency regenerative voltages.

Referring now to the drawing, the amplifier comprises a first electron discharge device 10 having a cathode 11, a grid or control electrode 12, and an anode 13. Signals within the wide frequency range are supplied from a suitable source 14 and impressed upon the grid 12 through a coupling including a condenser 15 and a resistor 16. Negative bias for the control electrode 12 is provided by a cathode resistance 17 between the cathode 11 and ground. Anode voltage for the device 10 is obtained from a suitable source such as a battery 18 connected to the anode through an output resistance 19. The output voltage of the device 10 is coupled to a second electron discharge device 20 having a cathode 21, a rigid or control electrode 22, and an anode 23. The anode 13 of the device 10 is coupled to the control electrode of the device 20 by a condenser 25 and a coupling resistor 26; the devices 10 and 20 are thus connected in cascade. The anode voltage for the device 20 is also obtained from the battery 18 which is connected to the anode 23 through a load resistance 27, and the output voltage of the device 20 is coupled to a suitable utilization device 28 by a condenser 29. The device 20 is provided with a resistance 30

in its cathode circuit for obtaining the required bias voltage for the grid 22.

In order to make it unnecessary to provide by-pass condensers for the resistances 17 and 30, the cathode 21 is connected to the cathode 11 by a resistance 31. The value of this resistance is selected so that a portion of the voltage appearing across the resistance 30 is fed back and impressed across the resistance 17. This voltage is 180° out of phase with the voltge generated in the resistance 17 and, therefore, tends to neutralize any degeneration due to voltages produced by the cathode current of the device 10. The value of the resistance 31 is selected so that the voltage impressed upon the cathode 11 from the cathode 21 is sufficiently great to provide regeneration in the device 10 and increase its output by an amount sufficient to compensate for degeneration produced in the device 20 due to the cathode resistance 30, it being understood that the regenerative feed-back will be made sufficient to provide an output for device 20 equal to or even greater than its output would be were a by-pass condenser provided for the resistor 30.

I have found that the range of the high frequency response of the amplifier may be extended substantially by providing a small condenser 32 across the resistance 31. When the amplifier shown in the drawing is provided with the condenser 32 its range of frequency response for a predetermined gain is increased beyond that obtainable in the same amplifier without the resistance 31 and condenser 32, but provided with by-pass condensers for the resistances 17 and 30.

The value of the resistance 31 may be obtained by connecting an alternating current voltmeter across the resistance 17 and adjusting resistance 31 until minimum voltage appears across the resistance 17. This adjustment provides neutralization of the loss due to degeneration in the resistance 17. In order to neutralize the loss due to degeneration in the resistance 30 at the second amplifying device 20, the value of resistance 31 is still further decreased to a point such that the over-all gain of the amplifier is the same as it was found to be with resistance 31 omitted and by-pass condensers provided for the resistances 17 and 30. After the correct value for the resistance 31 has been determined, a fixed resistor of this value is employed.

Obviously further electron discharge devices may be connected in cascade in the same manner, the neutralization being effected in stages, the values of the resistance (corresponding to resistance 31) of each stage being determined in the manner described above.

For purposes of illustration, but not by way of limitation, there are tabulated below the values of the resistances and capacitors employed in a circuit as illustrated in the drawing in which the device 10 was one-half of a 6SN7GT double-triode and the device 20 was the other half thereof.

Resistor:

16	megohm	1
17	ohms	1,000
19	do	5,600
26	megohm	1
27	ohms	5,600
30	do	1,000
31	do	1,800

Condenser:

15	μfd	0.06
25	μfd	0.06
29	μfd	0.06
32	μμfd	180

While I have shown and described my invention in connection with a two-stage amplifier employing two three-electrode electron discharge devices, other applications will readily be apparent to those skilled in the art. I do not therefore desire my invention to be limited to the particular circuit connections shown and described and I intend in the appended claims to cover all modifications within the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A thermionic amplifier comprising first and second electron discharge devices each having a cathode and an anode and a control electrode, means for impressing a signal on the control electrode of said first device, means for coupling said devices in cascade, first and second resistances connected respectively in the cathode circuits of said first and second devices, a third resistance connecting said cathodes for providing a regenerative voltage at the cathode of said first device to substantially neutralize the degenerative voltages produced by said cathode resistances, and a condenser connected in shunt with said third resistance for increasing the response of said amplifier at high frequencies.

2. A thermionic amplifier comprising first and second electron discharge devices each having a cathode and an anode and a control electrode, resistance means for coupling said devices in cascade, first and second resistances connected respectively in the cathode circuits of said first and second devices, a third resistance connecting said cathodes, and a condenser connected in shunt to said third resistance, said three resistances having values such that the degenerative effects of said first and second resistances are substantially neutralized and said condenser having a value such that the high frequency range of said amplifier for a predetermined gain, is substantially extended.

ROBERT B. DOME.

CERTIFICATE OF CORRECTION.

Patent No. 2,368,454. January 30, 1945.

ROBERT B. DOME.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, second column, line 45, for "rigid" read --grid--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 15th day of May, A. D. 1945.

Leslie Frazer

(Seal) Acting Commissioner of Patents.