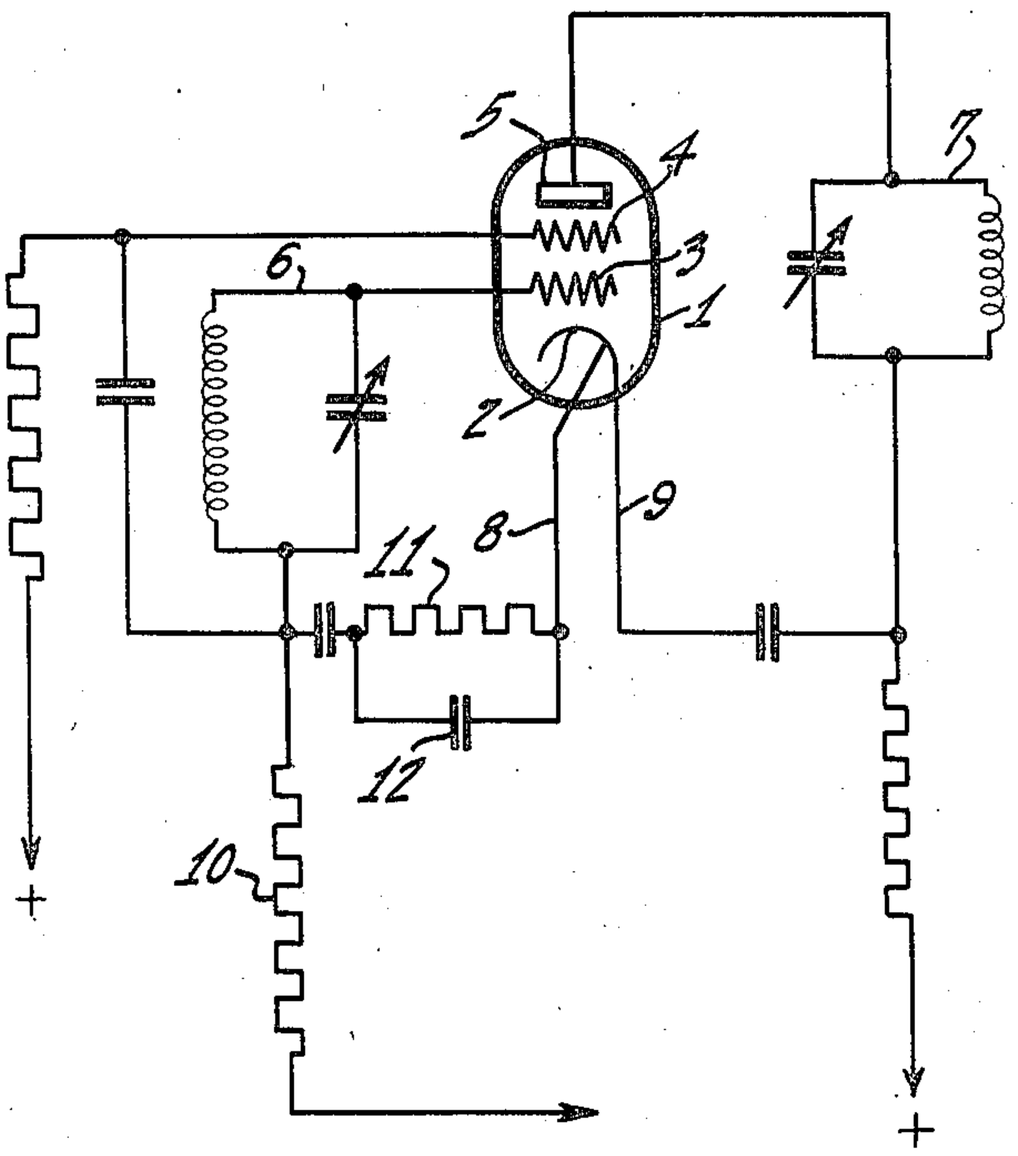
July 6, 1948. A. VAN DER ZIEL ET AL 2,444,864

HIGH-FREQUENCY TUNED AMPLIFYING CIRCUIT

Filed March 23, 1943



INVENTORS
MAXIMILIAAN JULIUS OTTO STRUTT
AND ALBERT VAN DER ZIEL

BY H. S. Grover

ATTORNEY

Patented July 6, 1948 2,444,864

UNITED STATES PATENT OFFICE

2,444,864

HIGH-FREQUENCY TUNED AMPLIFYING CIRCUIT

Aldert van der Ziel and Maximiliaan Julius Otto Strutt, Eindhoven, Netherlands, assignors to Hartford National Bank and Trust Company, Hartford, Conn., as trustee

Application March 23, 1943, Serial No. 480,199
In the Netherlands December 30, 1940

Section 1, Public Law 690, August 8, 1946
Patent expires December 30, 1960

3 Claims. (Cl. 179—171)

1

The invention relates to a circuit arrangement for transmitting high frequency electrical oscillations with the aid of a discharge tube which comprises an input electrode with a regulable bias voltage and whose input circuit comprises an oscillatory circuit tuned to the frequency of the oscillations to be transmitted, said oscillatory circuit being hereinafter referred to as "input circuit."

It is known that with such a system there arise difficulties when the frequency of the oscillations to be transmitted is so high that the transit time of the electrons in the tube is no longer so small as to be negligible with respect to the cycle of the oscillations, for in this case the input capacity of the discharge tube depends on the bias voltage of the input electrode so that upon variation of the bias voltage the tuning of the input circuit is also modified. Moreover, at these high frequencies there occurs between the input electrode and the cathode a virtual ohmic resistance whose reciprocal value is usually referred to as "electron damping" and which also depends on the bias voltage of the input electrode. In consequence thereof the damping of the input circuit is also altered upon variation of the bias voltage.

It is known to eliminate the undesired variations above referred to of the input capacity of the tube by providing an ohmic resistance which is not short circuited for high frequencies in that part of the cathode lead which is common to the input and output circuits. The cathode alternating current sets up across this resistance a voltage which is, at least approximately, in phase with the input alternating voltage set up at the input electrode and which depends on the value of the mutual conductance of the tube and therefore on the bias voltage of the input electrode. The voltage set up across the resistance causes in its turn a current flowing from the cathode to the input electrode through the natural capacity between these two electrodes, which current is also dependent on the bias voltage of the input electrode and leads by about 90° with respect to the input alternating voltage. This current may be considered to be a result of a negative capacity which is apparently present between the input electrode and the cathode and whose value depends on the bias voltage of the input electrode,

2

said capacity, when correctly dimensioned, compensating the undesired variations of the input capacity.

As is known, the undesired damping variations above referred to may also be suppressed by providing an ohmic resistance which is not short circuited for high frequencies in that part of the cathode lead which is common to the input and output circuits. In general, the ohmic resistance must have for this purpose a higher value than is required for the compensation of the capacity variations. The suppression of the damping variations is facilitated, however, by providing in parallel with the ohmic resistance a capacity whose impedance for the frequencies to be transmitted is at least of the order of magnitude of the ohmic resistance. By utilizing a properly chosen parallel capacity, it is even possible to eliminate at the same time the undesired capacity variations and damping variations.

It is furthermore known that in the transmission of high frequency oscillations with the aid of a discharge tube, undesired damping of an oscillatory circuit incorporated in the input circuit of the tube occurs due to the fact that the natural self inductance of that part of the cathode lead which is common to the input and output circuits brings about a coupling between the input and output circuits. As is known, this drawback may be obviated by utilizing a discharge tube whose cathode is provided with two separated supply conductors and is connected for high frequencies through the intermediary of one of these supply conductors, referred to hereinafter as the "input supply conductor," to the input electrode and through the intermediary of the other supply conductor, referred to hereinafter as the "output supply conductor," to the output electrode.

The use of such a discharge tube with two separated cathode supply conductors offers, however, the drawback that compensation of the variations of the input capacity and input damping, which occur upon variation of the bias voltage of the input electrode is not possible in the above described manner, since for these compensations it is essential that across an ohmic resistance connected into the cathode lead there should be set up a voltage which gives rise to a current through the natural capacity between

the cathode and the input electrode. If now, with a tube having two cathode supply conductors, an ohmic resistance is arranged in series with the input supply conductor, no voltage will be set up across this resistance since the cathode alternating current exclusively flows through the output supply conductor. If, on the contrary, an ohmic resistance is arranged in series with the output supply conductor, a voltage is set up across this resistance but this voltage does not bring about a current through the capacity between the cathode and the input electrode.

In view of the foregoing, it is the principal object of the present invention to provide, in a high-frequency system including a discharge tube having at least two separated cathode supply conductors, means to compensate for variations in the input capacity and input damping of the discharge tube which occur upon variation of the bias voltage on the input electrode.

According to the invention, in a system comprising a discharge tube provided with at least two separated cathode supply conductors, compensation of the variations of the input capacity and/or of the input damping of the discharge tube which occur upon variation of the bias voltage of the input electrode, is rendered possible by connecting the cathode for high frequencies to a positive auxiliary electrode present in the tube, via the input supply conductor and via an ohmic resistance which is arranged in series with the input supply conductor and which is not short circuited for high frequencies, that end of the said ohmic resistance which is remote from the cathode being connected to that end of the input circuit which is remote from the input electrode.

The invention will be explained more fully with reference to the accompanying drawing, which represents, by way of example, one embodiment thereof.

The drawing represents a discharge tube 1 comprising a cathode 2, an input electrode (control grid) 3, a positive auxiliary electrode (screen grid) 4 and an output electrode (anode) 5. The control grid 3 is connected to an input circuit 6 which is tuned to the oscillations to be transmitted whilst the anode circuit comprises an output circuit 7 which is also tuned to the oscillations to be transmitted.

The cathode 2 is provided with two separated supply conductors, viz, an input supply conductor 8 through the intermediary of which the cathode is connected for high frequencies to the control grid 3, and an output supply conductor 9 through the intermediary of which the cathode is connected, for high frequencies, to the anode 5.

To the control grid 3 there is supplied, through a resistance 10, a variable bias voltage which may be generated, for example, in the usual manner by a control rectifier for automatic volume control.

The variations of the capacity and/or of the damping which occurs between the control grid and the cathode, which variations are produced upon variation of the bias voltage, are compensated owing to the fact that, for high frequencies, the screen grid 4 is connected to the cathode through the input supply conductor 8 and through a resistance 11 which is connected in series with the supply conductor and which is not short circuited for high frequencies, that end of the said resistance which is remote from the cathode being connected to that end of the input circuit 6 which is remote from the control grid. The required value of the resistance 11 lies in general between 50 and 500 ohms. The compensation aimed at is brought about by the fact that the screen grid alternating current sets up across the resistance 11 a voltage which gives rise to a current flowing from the cathode to the control grid through the natural capacity between the control grid and the cathode.

For the compensation of the damping variations produced upon variation of the control grid bias voltage, it is to be preferred to connect in parallel with the resistance 11 a capacity 12 whose impedance for the oscillations to be transmitted is at least of the order of magnitude of the resistance 11. If only the variations of the input capacity have to be compensated, the capacity 12 may be suppressed.

By a proper choice of the values of the resistance 11 and of the parallel capacity 12, it is also possible to compensate the variations of the input capacity and the input damping simultaneously. In the case of a pentode having a mutual conductance of 10 mA/V, this result was obtained for wavelengths of from 3 to 6 metres by giving the resistance 11 a value of 180 ohms and the capacity 12 a value of 3 $\mu\mu$ F.

What is claimed is:

1. In a high frequency transmission system having a multi-electrode electron discharge device whose electrodes include a cathode, a first grid, a second grid and an anode in the order named, and which has associated therewith a circuit for varying the bias voltage on said first grid, means for supplying a positive direct current potential to said second grid, a parallel tuned input circuit and a parallel tuned output circuit, a pair of supply leads for said cathode, a connection from said first grid to one terminal of said input circuit, a connection from one of said cathode supply leads to the other terminal of said input circuit, said last connection including a resistor in series therewith which is unbypassed for high frequencies, a connection from said anode to one terminal of said output circuit, and a connection from the other cathode supply lead to the other terminal of said output circuit.

2. In a high frequency transmission system having a multi-electrode electron discharge device whose electrodes include a cathode, a first grid, a second grid and an anode in the order named, and which has associated therewith a circuit for varying the bias voltage on said first grid, means for supplying a positive direct current potential to said second grid, a parallel tuned input circuit and a parallel tuned output circuit, a pair of supply leads for said cathode, a connection from said first grid to one terminal of said input circuit, a connection from one of said cathode supply leads to the other terminal of said input circuit, said last connection including a resistor in series therewith which is unbypassed for high frequencies, said resistor having a value in the range between fifty and five hundred ohms, a condenser in shunt to said resistor whose impedance for energy of the operating frequency is at least of the order of magnitude of said resistor, a connection from said anode to one terminal of said output circuit, and a connection from the other cathode supply lead to the other terminal of said output circuit.

3. In a high frequency transmission system having a multi-electrode electron discharge device whose electrodes include a cathode, a first grid, a second grid and an anode in the order named, and which has associated therewith a

circuit for varying the bias voltage on said first grid, means for supplying a positive direct current potential to said second grid, a parallel tuned input circuit and a parallel tuned output circuit, a pair of supply leads for said cathode, a connection from said first grid to one terminal of said input circuit, a connection including a condenser in series therewith from one of said cathode supply leads to the other terminal of said input circuit, said last connection including a resistor in series therewith which is unbypassed for high frequencies, said resistor having a value in the range between fifty and five hundred ohms, a connection from said anode to one terminal of said output circuit, and a connection including a condenser in series therewith from the other cathode supply lead to the other terminal of said output circuit.

MAXIMILIAAN JULIUS OTTO STRUTT.
ALDERT VAN DER ZIEL.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,878,252	Taylor	Sept. 20, 1932
2,066,027	Braaten	Dec. 29, 1936
2,314,958	Van Der Ziel, et al.	Mar. 30, 1943

FOREIGN PATENTS

Number	Country	Date
57,644	Netherlands	June 15, 1946