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THERMIONIC VALVE OSCILLATOR WITH POSITIVE AND NEGATIVE FEEDBACK

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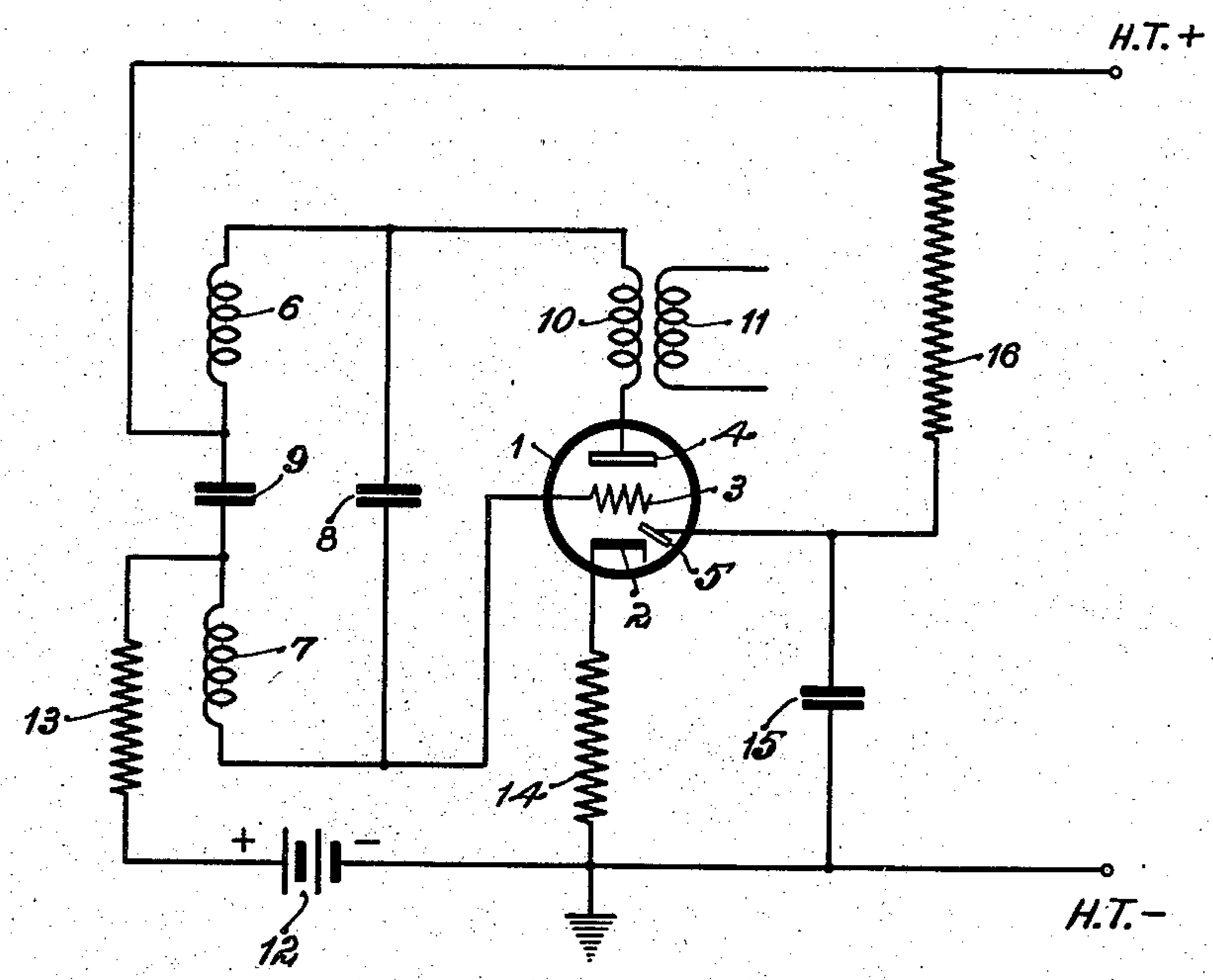

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THERMIONIC VALVE OSCILLATOR WITH POSITIVE AND NEGATIVE FEEDBACK

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This invention relates to thermionic valve oscillators.

Thermionic valve oscillatory circuits in which oscillations are maintained by means of positive feedback between the anode circuit and the grid circuit of a thermionic valve are well known. Such oscillators are usually provided with a grid leak and condenser and, in operation, grid current flows and a negative bias potential dependent upon the amplitude of the oscillations generated is thereby applied to the control grid of said thermionic valve, which consequently adjusts itself to a condition of equilibrium in which the average resistance of the circuit is equal to the average negative resistance provided by said valve.

It is found in practice that this method of operation is not always satisfactory, due to the fact that the amplitude of the oscillations is not accurately maintained by reason of the dependence of this amplitude upon grid current, and also due to the fact that it is difficult to design an oscillator to give a desired amplitude of oscillation because the effect of grid current cannot easily be calculated. Again, the operating characteristics of different valves employed may not be the same, or variation of the resistance of the oscillatory circuit may occur and, in either case, variation of amplitude of the generated oscillations may result.

It is an object of the present invention to provide a back-coupled thermionic valve oscillator in which the above-mentioned difficulties are reduced or eliminated.

According to the present invention a thermionic valve oscillation generating circuit arrangement in which oscillations are produced by positive feedback has, in addition to a positive feedback circuit, a negative feedback circuit for the oscillations generated and means for automatically rendering said negative feedback circuit operative when the amplitude of the generated oscillations exceeds a predetermined value, the negative feedback potentials so provided serving to limit the amplitude of the oscillations generated.

In a particular oscillation generating circuit, according to the invention, the negative feedback circuit includes a resistance of high value connected in the cathode circuit of the oscillator valve, said resistance normally being shunted by a path serving as a substantial short circuit for the generated oscillations, said path being arranged to be automatically disconnected when the generated oscillations exceed said predetermined amplitude.

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The short circuiting path is preferably constituted by a condenser and said path or condenser may be automatically disconnected by means of a unilaterally conducting device connected to the cathode of said valve and arranged to be biased so as to become non-conducting and thereby to effect disconnection of said path or condenser when the cathode of said valve rises above a predetermined potential.

In order that the invention may be more clearly understood and readily carried into effect, a Hartley type oscillator embodying the invention will now be described by way of example with reference to the accompanying drawing. The sole figure of this drawing represents a preferred circuit arrangement for carrying out the invention.

Referring to that drawing, the valve 1, which is preferably a high slope triode, a tetrode or a pentode, comprises a cathode 2, a control electrode 3 and an anode 4, together with an auxiliary anode 5 adapted to cooperate with the cathode 2 to form a unilaterally conducting device, which may, if desired, be constituted by a diode or other rectifying device separate from said valve. The oscillatory circuit comprises the close-coupled inductances 6, 7 and the parallel tuning condenser 8. A blocking condenser 9 is also provided in series with the inductances 6, 7. The upper end of the inductance 6 is connected through a winding 10 of the output transformer 10, 11 to the anode 4, and the high tension supply, which may be of 250 volts, is fed to said anode via the lower end of said inductance 6. The lower end of the inductance 7 is connected to the grid 3, and positive bias is applied to said grid by means of a source of bias 12 which may be of 50 volts through a resistance 13 connected to the upper end of said inductance 7. A high resistance 14, which may be of 50,000 ohms, is connected in the cathode circuit of the valve 1, and the lower end of said resistance is earthed and connected to the source of bias 12, the negative terminal of the high tension supply, and one side of a condenser 15, the other side of which is connected to the auxiliary anode 5 and also through a resistance 16 which may be 400,000 ohms to the positive terminal of the high tension supply.

The arrangement operates as follows: Due to the well-known Hartley connection of the oscillatory circuit with the valve 1, positive feedback arises and oscillations are set up in the oscillatory circuit comprising the elements 6, 9, 7, 8, and oscillatory current flows in the anode circuit of the valve 1. The auxiliary anode 5 is biased positively through the resistance 16, and a conducting path is thus provided between said anode 5 and the cathode 2, so that the condenser 15 is connected in parallel with the cathode resistance 14, said condenser being sufficiently large to insure that the cathode impedance is very small at the frequency of said oscillations. In these circumstances, the amplitude of the oscillations will steadily increase in the manner of the well-known Hartley circuit until a condition of equilibrium is reached in which the power delivered by the valve 1 to the oscillatory circuit is equal to the power loss in the circuit. This equilibrium normally involves the flow of grid current with its attendant disadvantages, and in applying the invention, the amplitude is prevented from growing to such excessive values by introducing negative feedback to cause limiting when the oscillations exceed a predetermined value. This limitation is, in the present example of the invention, caused by the operation of the auxiliary anode 5 in conjunction with the cathode 2. As the amplitude of the oscillatory current increases, the instantaneous maximum cathode current will tend to exceed the current passed by resistance 14 during the remainder of the cycle, so that during these maxima of cathode current values the potential of the cathode 2 will rise above the potential of the anode 5 with the result that for a period in each cycle of the oscillations the auxiliary anode 5 is effectively disconnected from the cathode 2 and the condenser 15, therefore, is disconnected from the cathode resistance 14. Thus, negative feedback is introduced due to the presence of the resistance 14 in the cathode circuit of the valve 1, and further increase in the amplitude of the oscillations substantially prevented. By arranging that the current passed by resistance 14 in the quiescent condition is much smaller than the current which can be passed by the valve without the flow of grid current for the high tension voltage available, it can be arranged that the oscillations are stabilized at such a value that grid current does not flow. It is found that, in these circumstances, the waveform of the oscillatory current in the anode circuit of the valve 1 is substantially rectangular and has a peak-to-peak amplitude substantially equal to the potential of said auxiliary anode 5 divided by the resistance of the cathode resistance 14.

In order to prevent drift of the potential of the auxiliary anode 5 due to charging the condenser 15, the resistance 16 is preferably chosen so that when the anode 5 is positive with respect to the cathode 2, that is to say, in the quiescent condition, the current flowing through the resistance 16 is substantially equal to one-half of the current flowing through the cathode resistance 14. In these circumstances the anode current waveform in the oscillating condition will be substantially a symmetrical square waveform and the output will be free of even harmonics.

It will be appreciated that the oscillator described above is free from the undesirable effects due to grid current and also lends itself to accurate design for a predetermined oscillatory current. When the desired current amplitude has been decided, the values of the cathode resistance 14 and the resistance 16 may be chosen to give the desired amplitude of oscillatory current in the anode circuit of the valve and the parallel resistance of the oscillatory circuit comprising the elements 6, 9, 7 and 8 then arranged to be sufficiently high to develop an oscillatory voltage to swing the control electrode 3 at least over the full grid bias of the valve 1 when said desired oscillatory current is fed into said circuit from the anode circuit of said valve 1.

A further advantage, which arises from the substantially rectangular waveform delivered by this type of oscillator, is that such a waveform contains a larger fundamental component than the very peak waveform delivered by back-coupled oscillators of known type in which grid current flows, so that freedom from harmonics, particularly even harmonics, is obtained.

If desired, the output may be derived from the potential across the oscillatory circuit and the output amplitude will then depend on the resistance of the oscillatory circuit. The output obtained from the anode current as described with reference to the drawing, though of square waveform, is largely independent of the exact resistance of the oscillatory circuit.

It is claimed:

1. A thermionic oscillation generator including a discharge tube having cathode, control and anode electrodes, a cathode resistor of high ohmic value connected between the cathode and a point of fixed potential, a source of direct current connected negatively to said point of fixed potential and positively to an anode circuit impedance in the circuit of said generator, a resonant input circuit having suitable connections to the tube electrodes for determining the frequency of the oscillations generated, means intercoupling the anode and the control electrode for producing positive feedback of oscillatory energy, means for connecting said grid to said point of fixed potential, an auxiliary anode in said tube, a capacitor for coupling said auxiliary anode to said point of fixed potential, said capacitor and said cathode resistor jointly constituting a negative feedback means, and means including a biasing circuit connected between said auxiliary anode and the positive terminal of said direct current source whereby the negative feedback means is rendered effective only when the cathode potential becomes more negative than that of the auxiliary anode.

2. A thermionic valve oscillation generating circuit including a valve containing cathode, control and anode electrodes, resonant circuit means coupling said electrodes to produce oscillations, and an auxiliary anode in said valve, a resistance of high value connected between the cathode and a negative terminal of a source of high tension supply and also between the cathode and grid of said valve, and a condenser connected between said auxiliary anode and the end of said resistance remote from said cathode, the arrangement being such that, in operation, said condenser normally provides a path across said auxiliary anode and resistance for the generated oscillations, said condenser being effectively disconnected to allow said oscillations to set up a potential drop in said resistance when the amplitudes of the generated oscillations reaches a predetermined value whereby the negative feedback so produced serves to limit the amplitude of said oscillations, a further resistance being connected between the positive terminal of the source of high tension supply and said auxiliary anode, said further resistance having a value such that the current flowing therethrough when the potential of said auxiliary anode is positive with respect to said cathode is equal substantially to half the current flowing through the resistance in the cathode circuit whereby drift of the potential of said auxiliary

anode due to charging of said condenser is substantially prevented.

3. An oscillation generator comprising an electron discharge tube having cathode, anode and control electrodes; a resonant input circuit interconnecting the cathode and control electrodes; an output circuit interconnecting the cathode and anode electrodes; a positive feedback circuit intercoupling the anode and control electrodes, an auxiliary anode in said tube; a cathode resistor of relatively high ohmic value connected between the cathode and a point of fixed potential, said resistor being common to said input and output circuits; a source of direct current and an impedance both included between said anode electrode and said point of fixed potential, and means for controlling the introduction of negative feedback through said cathode resistor for limiting the amplitude of the oscillations generated, said means comprising a resistor connected between the positive terminal of said source and said auxiliary anode, and a capacitor intercoupling said auxiliary anode and said point of fixed potential.

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Executrix of Alan Dower Blumlein, Deceased.

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