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HIGH FREQUENCY OSCILLATOR HAVING GRID DIRECT CURRENT STABILIZING MEANS

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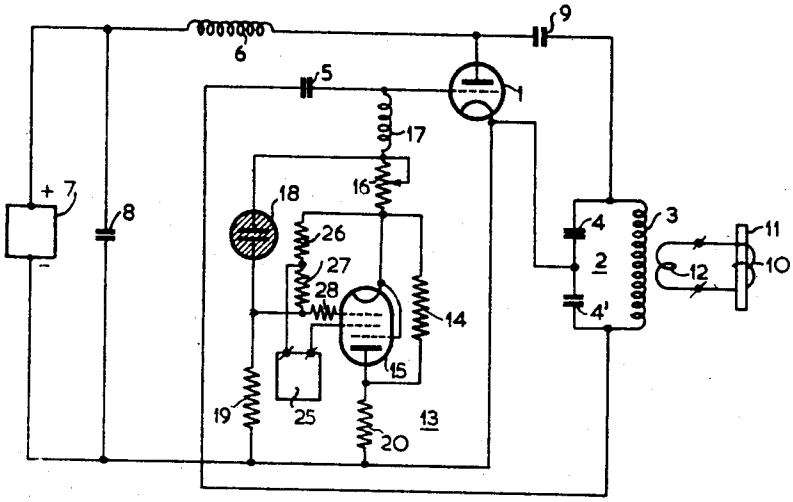

FIG.1

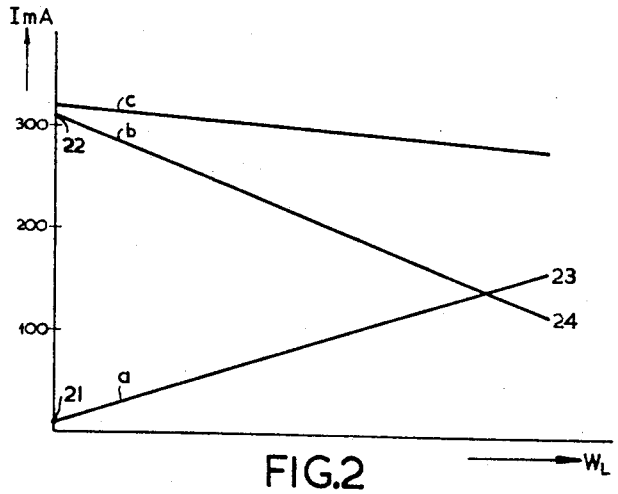

FIG.2

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HIGH FREQUENCY OSCILLATOR HAVING GRID DIRECT CURRENT STABILIZING MEANS

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6 Claims. (Cl. 331—183)

The present invention relates to a high-frequency oven circuit arrangement. More particularly, the invention relates to a high-frequency oven circuit arrangement comprising a feedback connected grid-controlled electron tube oscillator, in which the control grid D.C. circuit of the electron tube oscillator includes a pentode connected as a variable resistor between the control grid and the cathode of the back-coupled electron tube for the purpose of stabilizing the grid direct-current upon varying load.

In such high-frequency ovens, the direct-current stabilization of the control grid has the effect that an advantageous control of the feedback connected electron tube is obtained under any operating conditions, that is to say between no load and full load.

According to the invention, one resistor is arranged in parallel with the pentode which is connected as a variable resistor. Between the cathode of the pentode and the control grid of the feedback connected electron tube oscillator there is included a resistor, of which a point of junction remote from the cathode of the pentode is connected via a constant voltage source of positive polarity to the control grid of the pentode. The invention ensures that the pentode included in the control-grid D.C. circuit of the oscillator tube with effective stabilization of the grid direct-current, need be proportioned only for a fraction of the maximum grid direct-current of the high-frequency oven, which permits of using pentodes of considerably lower output for the stabilization of the grid direct-current.

In order that the invention may be readily carried into effect, it will now be described in detail, by way of example, with reference to the accompanying drawing, in which:

Fig. 1 shows a high-frequency oven according to the invention;

Fig. 2 shows several characteristic curves to explain the high-frequency oven of Fig. 1.

The circuit diagram shown in Fig. 1 relates to a high-frequency oven of high power, for example 12 kilowatts, in which the high-frequency energy is derived from a grid-controlled electron tube oscillator having a triode **1**. The anode circuit of the oscillator, which is a Colpitts circuit, includes an oscillatory circuit **2**, determining the frequency of the oscillator, and a circuit coil **3** which is bridged by two capacitors **4** and **4'** connected in series and the junction of which is connected to the cathode of triode **1**. One end of the anode circuit is connected via a capacitor **9** to the anode of tube **1**, the positive feedback voltage derived from the extremity of the oscillatory circuit remote from the anode is supplied through a grid capacitor **5** to the control grid of tube **1**.

The anode of tube **1** is fed through a high-frequency choke coil **6** by means of a direct current supply source **7**, which is shunted by a high-frequency decoupling capacitor **8**.

The circuit current which occurs in the oscillatory circuit **2** during oscillation of the circuit is used for heating a work-piece **11**, which is included in the load circuit constituted, for example, by a heating coil **10**. The circuit **2** is coupled by inductive means to a coupling coil **12**, to the output terminals of which the heating coil **10** is connected.

For stabilizing the grid direct-current of the high-frequency oven upon variable load, the control-grid D.C. circuit of the high-frequency oscillator includes a pentode **15** which is connected as a variable resistor. The pentode is bridged by a resistor **14**. The cathode of the pentode is connected via a variable resistor **16** and a high-frequency choke coil **17** to the control grid of the triode **1**. One point of junction of the variable resistor **16** is coupled via a constant biassing source of positive polarity and a series-resistor **28** to the control grid of pentode **15**. The constant biassing source of positive polarity is constituted by a gas-filled tube **18**, which is connected via a resistor **19** to the cathode of the oscillator triode. In order to prevent the anode dissipation of pentode **15** from exceeding a determined permissible limiting value, the anode circuit of the pentode includes a series-resistor **20**.

The grid voltage V_g of the pentode is given by the constant operating voltage V_o of the gas filled tube, for example 85 volts, less the voltage drop brought about by the grid direct-current I of triode **1** across resistor **16**, which has a value R. In the form of a formula, the grid voltage V_g is:

$$V_g = V_o - IR$$

If, as a result of variation in the load the high-frequency oven, the grid direct-current of the triode **1** varies, the grid voltage V_g of the pentode varies in the opposite sense with respect to the variation in the voltage drop across the resistor. The resistor constituted by the pentode **15** varies in the same sense as the variation in the grid direct-current, with the result that the variation in the resistor constituted by the pentode counteracts the variation in the grid direct-current of the triode **1**.

The variable grid resistor **13** thus has a maximum value with maximum grid direct-current of the triode **1**, that is to say in the unloaded condition of the high-frequency oven, thus value decreasing upon increasing load on the high-frequency oven. In the embodiment shown, the pentode **15** is adjusted by means of resistor **16** so that the pentode **15** is substantially cut off in the unloaded condition, that is to say with maximum grid direct-current, the total grid current then being substantially absorbed by the resistor **14** connected in parallel with the pentode.

Fig. 2 shows the variation of the currents I which occur in the variable grid resistor **13** as a function of the load W_L on the high-frequency oven. The curves *a* and *b* representing the direct currents absorbed by the pentode **15** and the resistor **14**, connected in parallel with the pentode, and the curce *c* representing the total grid current of the triode **1**. The current characteristics shown relate to the 12 kw. high-frequency oven of Fig. 1, which has been extensively tested in practice.

As previously mentioned, the pentode **15** is substantially cut off in the unloaded conditions, whilst the resistor **14** connected in parallel with the pentode **15** absorbs substantially the whole grid current of triode **1**. In this condition, the points **21** and **22** on the curves *a* and *b* represent the currents absorbed by the pentode **15** and the resistor **14**, which currents are 10 milliamps, and 310 milliamps, respectively.

When the load on the high-frequency oven increases, the current through the pentode **15** increases and the current through resistor **14** decreases. With full load

on the high-frequency oven, these currents which are represented by the points **23** and **24** on the curves *a* and *b*, are 160 milliamps. and 120 milliamps. respectively. The greatly varying anode voltage of the pentode **15** has substantially no influence upon the control of pentode **15**.

The variation of the total grid current of the high-frequency oven, which is equal to the sum of the currents traversing the pentode **15** and the resistor **14**, is represented by the curce *c* in Fig. 2. Between no load and full load on the high-frequency oven, the total grid current thus varies only from 320 to 280 milliamps.

The arrangement of the invention permits of obtaining effective stabilization of the grid direct-current of the high-frequency oven under any operating conditions; that is, between no load and full load. This object is attained with the use of the tube **15** which absorbs only a fraction of the total grid current, so that a considerably smaller type of tube is sufficient. In fact, in the embodiment shown, the pentode **15** need absorb only 160 milliamps. of the total grid current, which is at the most 320 milliamps. A considerable saving is thus obtained especially for high-frequency ovens of high output, for example upwards of 3 kilowatts.

In this connection, it is to be noted that, instead of utilizing a single pentode **15** in the grid D.C. circuit, it is also possible to utilize a plurality of parallel-connected pentodes of smaller type.

In the embodiment shown, the screen-grid voltage of pentode **15** is derived from a separate source of supply voltage, the positive terminal of which is connected to the screen grid of pentode **15** and the negative terminal of which is connected to the cathode. In order to avoid undue increase in screen-grid current when the anode voltage of pentode **15** drops out, for example upon switching off the high-frequency oven, a resistor **26** is included between the negative terminal of the supply voltage source **25** and the cathode of pentode **15** and the negative terminal is connected via a resistor **27** to the control grid. In fact the resistor **27**, together with the resistors **19**, **20**, **14**, constitutes a voltage divider connected in parallel with resistor **26** of the cathode circuit and of which the junction of resistors **19** and **27** is connected to the control grid of pentode **15**. In this condition the gas-tube **18** is extinguished. When in this circuit the screen-grid current increases, the control-grid voltage decreases, with the result that an undue increase in screen-grid current is counteracted.

In conclusion, several data of the equipment shown in Fig. 1 follow hereinafter:

Resistor **14**	ohms	2000
Resistor **16**	do	680
Resistor **20**	do	430
Resistor **19**	do	91K
Resistor **26**	do	1K
Resistor **27**	do	100K
Type of gas tube **18**		85A2
Operating voltage of gas tube		85 volts

What is claimed is:

1. A high frequency oven circuit arrangement, comprising a feedback connected grid-controlled electron tube oscillator including an electron tube having cathode, anode and control grid electrodes, a variable load coupled to the anode of said electron tube, means responsive to the flow of grid current for producing a biasing potential at said control grid electrode, said grid current responsive means comprising means for stabilizing the grid direct current of said oscillator upon variation of said load, said stabilizing means comprising a pentode having cathode, anode and control grid electrodes, means connecting said pentode between the control grid electrode and the cathode of said electron tube and means for varying the effective resistance of said pentode in a sense diminishing said resistance upon reduction of said biasing potential comprising a first resistor connected in parallel with said pentode between the cathode and anode of the said pentode, a second resistor connected between the cathode of said pentode and the control grid electrode of said electron tube, a source of constant voltage of positive polarity and means connecting a terminal of said second resistor between the said second resistor and said electron tube to the control grid electrode of said pentode through said source of constant voltage.

2. A high frequency oven circuit arrangement, comprising a feedback connected grid-controlled electron tube oscillator including an electron tube having cathode, anode and control grid electrodes, a variable load coupled to the anode of said electron tube, means responsive to the flow of grid current for producing a biasing potential at said control grid electrode, said grid current responsive means comprising means for stabilizing the grid direct current of said oscillator upon variation of said load, said stabilizing means comprising a pentode having cathode, anode and control grid electrodes, means connecting said pentode between the control grid electrode and the cathode of said electron tube and means for varying the effective resistance of said pentode in a sense diminishing said resistance upon reduction of said biasing potential comprising a first resistor connected in parallel with said pentode between the cathode and anode of the said pentode, a second resistor connected between the cathode of said pentode and the control grid electrode of said electron tube, said second resistor being proportioned to substantially cut off said pentode when said grid current has a maximum magnitude, a source of constant voltage of positive polarity and means connecting a terminal of said second resistor between the said second resistor and said electron tube to the control grid electrode of said pentode through said source of constant voltage.

3. A high frequency oven circuit arrangement, comprising a feedback connected grid-controlled electron tube oscillator including an electron tube having cathode, anode and control grid electrodes, a variable load coupled to the anode of said electron tube, means responsive to the flow of grid current for producing a biasing potential at said control grid electrode, said grid current responsive means comprising means for stabilizing the grid direct current of said oscillator upon variation of said load, said stabilizing means comprising a pentode having cathode, anode and control grid electrodes, means connecting said pentode between the control grid electrode and the cathode of said electron tube and means for varying the effective resistance of said pentode in a sense diminishing said resistance upon reduction of said biasing potential comprising a first resistor connected in parallel with said pentode between the cathode and anode of the said pentode, a second resistor connected between the cathode of said pentode and the control grid electrode of said electron tube, a source of constant voltage of positive polarity comprising a gas tube, means connecting a terminal of said second resistor between the said second resistor and said electron tube to the control grid electrode of said pentode through said source of constant voltage and means connecting said source of constant voltage to the anode of said pentode, said last-mentioned means including a resistor.

4. A high frequency oven circuit arrangement, comprising a feedback connected grid-controlled electron tube oscillator including an electron tube having cathode, anode and control grid electrodes, a variable load coupled to the anode of said electron tube, means responsive to the flow of grid current for producing a biasing potential at said control grid electrode, said grid current responsive means comprising means for stabilizing the grid direct current of said oscillator upon variation of said load, said stabilizing means comprising a pentode having cathode, anode and control grid electrodes, means connecting said pentode between the control grid electrode and the cathode of said electron tube and means for varying the effective resistance of said pentode in a sense diminishing

said resistance upon reduction of said biasing potential comprising a first resistor connected in parallel with said pentode between the cathode and anode of the said pentode, a second resistor connected between the cathode of said pentode and the control grid electrode of said electron tube, a source of constant voltage of positive polarity, means connecting a terminal of said second resistor between the said second resistor and said electron tube to the control grid electrode of said pentode through said source of constant voltage, and a third resistor connected in series between the anode of said pentode and the cathode of said electron tube.

5. A high frequency oven circuit arrangement, comprising a feedback connected grid-controlled electron tube oscillator including an electron tube having cathode, anode and control grid electrodes, a variable load coupled to the anode of said electron tube, means responsive to the flow of grid current for producing a biasing potential at said control grid electrode, said grid current responsive means comprising means for stabilizing the grid direct current of said oscillator upon variation of said load, said stabilizing means comprising a pentode having cathode, anode and control grid electrodes, means connecting said pentode between the control grid electrode and the cathode of said electron tube and means for varying the effective resistance of said pentode in a sense diminishing said resistance upon reduction of said biasing potential comprising a first resistor connected in parallel with said pentode between the cathode and anode of the said pentode, a second resistor connected between the cathode of said pentode and the control grid electrode of said electron tube, said second resistor being proportioned to substantially cut off said pentode when said grid current has a maximum magnitude, a source of constant voltage of positive polarity comprising a gas tube, means connecting a terminal of said second resistor between the said second resistor and said electron tube to the control grid electrode of said pentode through said source of constant voltage, means connecting said source of constant voltage to the anode of said pentode, said last-mentioned means including a resistor, and a third resistor connected in series between the anode of said pentode and the cathode of said electron tube.

6. A high frequency oven circuit arrangement, comprising a feedback connected grid-controlled electron tube oscillator including an electron tube having cathode, anode and control grid electrodes, a variable load coupled to the anode of said electron tube, means responsive to the flow of grid current for producing a biasing potential at said control grid electrode, said grid current responsive means comprising means for stabilizing the grid direct current of said oscillator upon variation of said load, said stabilizing means comprising a pentode having cathode, anode, control grid and screen grid electrodes, means connecting said pentode between the control grid electrode and the cathode of said electron tube and means for varying the effective resistance of said pentode in a sense diminishing said resistance upon reduction of said biasing potential comprising a first resistor connected in parallel with said pentode between the cathode and anode of the said pentode, a second resistor connected between the cathode of said pentode and the control grid electrode of said electron tube, a source of constant voltage of positive polarity, means connecting a terminal of said second resistor between the said second resistor and said electron tube to the control grid electrode of said pentode through said source of constant voltage, a source of screen grid supply voltage having a positive terminal connected to the screen grid electrode of said pentode and a negative terminal, a third resistor, means connecting said negative terminal to the cathode of said pentode through said third resistor and a voltage divider connected in parallel with said third resistor, said voltage divider including said first resistor and having a tapping point connected to the control grid electrode of said pentode.

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