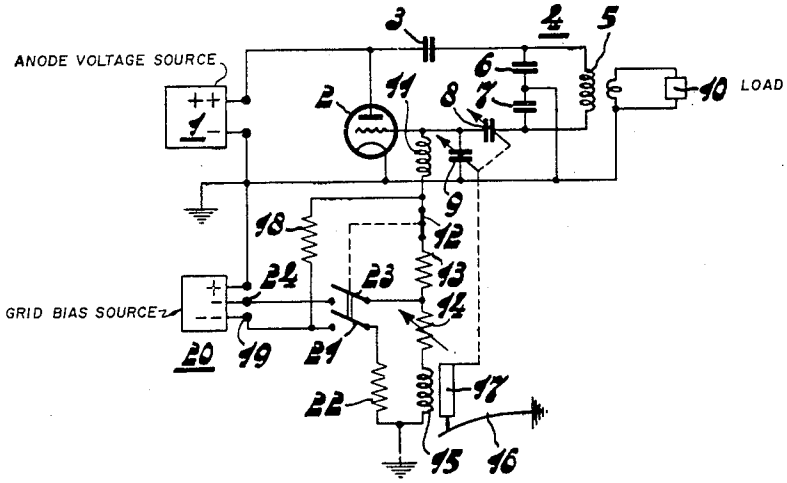
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HIGH-FREQUENCY HEATING SYSTEM

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INVENTOR

JACOB WILLEM DE RUITER

BY Fred M. Vogel

AGENT

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HIGH-FREQUENCY HEATING SYSTEM

Jacob Willem de Ruiter, Eindhoven, Netherlands, assignor to Hartford National Bank and Trust Company, Hartford, Conn., as trustee

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The present invention relates to high-frequency heating system. More particularly, the invention relates to a high-frequency oven comprising a grid-controlled electron tube oscillator in which the direct-current circuit of the control grid includes a coil for energizing a control member which is subject to the tension of a spring and which during operation controls the feedback coupling for automatic stabilization of the excitation of the control grid upon varying load.

In order to make the oscillator in such a high-frequency oven inoperative in case of intermittent use, it is desirable that the grid circuit include a grid-bias source which may be switched in and which cuts off the oscillator tube by means of negative grid-bias while maintaining the other operating voltages.

According to the invention, in high-frequency ovens of the type described, a longer life of the expensive oscillator tube especially when high powers are utilized (for example 1 kw. and higher) is achieved by the use of means by which the control member is moved, against the tension of the spring, into the position of minimum excitation when the oscillator tube is made inoperative by negative grid-bias.

In accordance with the present invention the control member initially occupies the position for minimum grid excitation (minimum feed-back) when the oscillator is made operative by suppression of the blocking grid-bias temporarily applied. A transient overload on the control grid as a result of the mechanical energy of the automatic control of grid excitation which otherwise might occur is thus avoided with certainty.

The control member may naturally be moved into the position for minimum excitation in different ways. The control member may be moved for example, by purely mechanical means with the use of an adjusting mechanism coupled to a switch for switching on the blocking voltage for the oscillator; or it may be moved by electromagnetic means with the use of a pull magnet counteracting the tension of its spring.

However, for the envisage purpose use is preferably made of the coil available for energizing the control member, i. e. by connecting it, on the one hand, by way of a switch which is to be opened for switching off the oscillator, to the control grid and, on the other hand, by way of a switch which is to be closed upon switching off the oscillator, to a source of negative auxiliary bias which provides the auxiliary current to substitute the maximum grid current which occurs in normal operation.

In order that the invention may be readily carried into effect, it will now be described with reference to the accompanying drawing, wherein the figure is a schematic diagram of an embodiment of the high-frequency heating system of the present invention.

The high-frequency oven of the figure comprises a triode 2, in Colpitts-oscillator connection, which is connected to an anode voltage source 1. The anode of the triode 2 is coupled by way of a coupling capacitor 3 to

one extremity of an oscillator-circuit 4 comprising a circuit coil 5 and circuit capacitors 6, 7 connected in series. The other extremity of the circuit 4 is coupled to the grid of the triode 2 by way of an adjustable capacitive voltage-divider having capacitors 8, 9, which serves to control the excitation of the control grid. The cathode of tube 2 is connected to ground and to the junction of the capacitors 6, 7 of the circuit 4.

A load 10 on the high-frequency oven is coupled by way of a transformer to the oscillator circuit 4.

The control grid of tube 2 is connected to ground by way of a D. C. grid circuit which includes in succession a high frequency choke 11, a switch 12 which is closed during operation of the oscillator, a fixed resistor 13, an adjustable resistor 14 and a coil 15 for energizing a control member 17 which can slide in the axial direction against the tension of a spring 16. The control member 17 is mechanically coupled to the adjustable voltage-divider 8, 9 for varying the excitation of the control grid, as shown by dotted line.

In the high-frequency oven so far described, a variation in the direct grid current by way of the energizing coil 15 and the control member 17 results in variation in the adjustment of the voltage divider 8, 9, which counteracts the first-mentioned variation.

In the absence of a direct grid-current the spring 16 forces the control member 17 and hence the voltage divider 8, 9 into the position of maximum grid-excitation and hence maximum feedback.

It is to be noted here that the spring 16 may exhibit a linear characteristic. However, in order to achieve a direct grid-current which is independent of the load, use is preferably made of a spring having a characteristic which is matched to the magnetic pulling force characteristic of the energizing coil with a given direct grid-current. More particularly the spring used may be of the type having a quadratic characteristic in the manner as described in detail in U. S. Patent application Serial No. 281,642, filed April 10, 1952.

To make the oscillator inoperative, the D. C. grid circuit described is interrupted by the switch 12. Thereafter the triode 2 is cut off by the negative grid-bias taken by way of a resistor 18 from a terminal 19 of a grid-bias source 20, at the same time as a resistor 22 loading the grid-bias source 20 is switched in by means of a switch 21 for fixing the biassing potential. Furthermore, the series-combination of the energizing coil 15 and the adjustable resistor 14 is connected, via a switch 23, to a terminal 24 of the grid-bias source 20, in order to move the control member 17, despite the tension of the spring 16, into the position for minimum grid-excitation. The holding current then flowing in the energizing coil 15 may be adjusted to the value desired by means of the adjustable resistor 14.

For switching the oscillator on again, the switches 12, 21, 23, which are preferably ganged and may be operated in common with the use of a switching relay, are moved again into the positions shown in the figure. A temporary overload on the control grid of the oscillator as a result of over-excitation thereof is avoided, since, upon switching-in, the control member 17 has to leave the position for minimum grid-excitation.

In order to avoid burning of the contacts of the switch 12 in the case of high-frequency ovens of high power, it is advantageous to bridge the said contacts in a known manner by use of a spark-extinguishing circuit constituted by the series-combination of a capacitor and a resistor.

When the oscillator is operative, the connection between the D. C. grid circuit 11—15 and the grid-bias source 20 may be wholly interrupted. However, in the circuit shown, the grid-bias source 20 is utilized for sup-

plementing the negative grid-bias required during the operation of the oscillator by way of the voltage-divider constituted by the elements 18, 13, 14, 15.

It is to be understood that the invention is not limited to the details disclosed but includes all such variations and modifications as fall within the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. A high-frequency heating system comprising an oscillator, said oscillator comprising an electron discharge tube having a control grid and a feedback circuit coupled to said control grid, said feedback circuit comprising a variable impedance coupled to said control grid, a direct current circuit coupled to said control grid, a control member coupled to said variable impedance whereby variation in position of said control member produces variation in the impedance value of said variable impedance thereby varying the excitation of said control grid, a spring disposed to exert a force in a given direction on said control member, said direct current circuit including a coil disposed to exert a force on said control member in a direction opposite to said given direction, said last-mentioned force having a magnitude as determined by the magnitude of the current in said direct current circuit, a grid bias source, means for selectively applying a negative grid bias from said source to said tube to cut off said tube, and means operative substantially simultaneously with said last-mentioned means for applying a current from said source through said coil thereby exerting a force on said control member in a direction opposite to said given direction whereby minimum excitation of said control grid is produced when said negative grid bias cuts off said tube.

2. A high-frequency heating system comprising an oscillator, said oscillator comprising an electron discharge tube having a control grid and a feedback circuit coupled to said control grid, said feedback circuit comprising a variable impedance coupled to said control grid, a direct current circuit coupled to said control grid, a control member coupled to said variable impedance whereby variation in position of said control member produces variation in the impedance value of said variable impedance thereby varying the excitation of said control grid, a spring disposed to exert a force in a given direction on said control member, said direct current circuit including a coil disposed to exert a force in said control member in a direction opposite to said given direction, said last-mentioned force having a magnitude as determined by the magnitude of the current in said direct current circuit, a grid bias source, means for selectively applying a negative grid bias from said source to said tube to cut off said tube comprising first switch means connected in said direct current circuit between said control grid and said coil to render said tube inoperative in its open position, and second switch means connected in said direct current circuit between said coil and said source and coupled to said first switch means to supply a current to said coil from said source in its closed position when said first switch is in its open position whereby a force is exerted on said control member in a direction opposite to said given direction thereby producing minimum excitation of said control grid when said negative grid bias cuts off said tube.

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