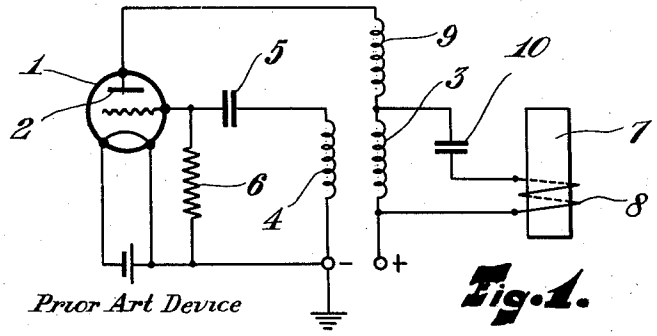
May 22, 1951 S. BREIMER 2,554,087

HIGH-FREQUENCY OSCILLATOR WITH A BACK-COUPLED ELECTRON TUBE

Filed Jan. 23, 1948



Prior Art Device

Fig. 1.

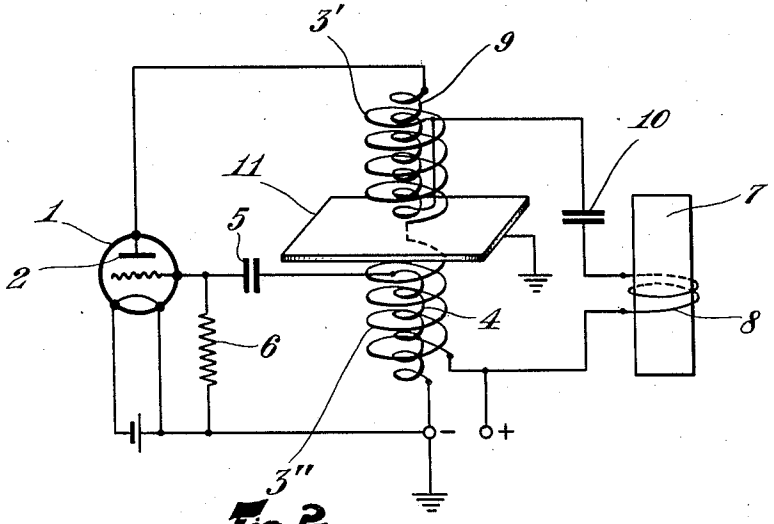


Fig. 2.

SYTSE BREIMER
INVENTOR.

BY Jean M Vogel

AGENT.

Patented May 22, 1951 2,554,087

UNITED STATES PATENT OFFICE

2,554,087

HIGH-FREQUENCY OSCILLATOR WITH A BACK-COUPLED ELECTRON TUBE

Sytse Breimer, Eindhoven, Netherlands, assignor to Hartford National Bank and Trust Company, Hartford, Conn., as trustee

Application January 23, 1948, Serial No. 3,916
In the Netherlands February 26, 1947

5 Claims. (Cl. 250—36)

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The invention relates to a high-frequency furnace with which the high-frequency energy is taken from a back-coupled electron tube. Such heating devices are utilized, for example, for inductively heating metal objects.

As an oscillator for generating high-frequency oscillations it is known to utilize a grid-controlled electron tube provided with a reaction coil included in the grid circuit and coupled to an oscillatory circuit which is included in the anode circuit of the tube and which determines the oscillator frequency, the current in this circuit acting as the heating current.

In order to increase the efficiency of such an oscillator system it is known to step the impedance of the oscillatory circuit towards the anode circuit (transformation ratio, for example, 1:2) by incorporating in the anode circuit an auxiliary coil which, together with the coil of the oscillatory circuit, forms either an ordinary transformer or an auto-transformer.

The invention has for its object to render possible a further increase of the efficiency of a high-frequency furnace of the type described.

According to the invention, this is achieved by magnetically decoupling the auxiliary coil located in the anode circuit of the oscillator tube and the reaction coil included in the grid circuit. This may be effected by dividing the coil of the oscillatory circuit into two spatially separated parts to which the auxiliary coil and the reaction coil respectively are coupled by means of mutually separated high-frequency iron cores.

A further possibility consists in arranging the two coils required to be de-coupled in a suitable manner with respect to one another, for example, at right angles to one another.

A form of construction which is advantageous both in mechanical and in electrical respect is obtained by dividing the coil of the oscillatory circuit, by means of a plate forming a magnetic screen and arranged at right angles with respect to the axis of this coil, into two parts inside which the auxiliary coil and the reaction coil respectively are concentrically arranged.

The invention will be explained more fully with reference to the figures of the accompanying drawing.

Fig. 1 represents the circuit-arrangement of a known form of construction of a high-frequency furnace and

Fig. 2 represents the circuit-arrangement of the above-mentioned advantageous embodiment of the invention.

In the circuit-arrangement according to Fig. 1 the high-frequency energy is taken from an oscillator comprising a directly heated triode 1 having an anode 2. The anode circuit of the triode 1 includes an oscillatory circuit which determines the oscillator frequency and which comprises a condenser 10 and a coil 3, the latter being coupled to a reaction coil 4 located in the control grid circuit. In the control grid circuit are provided in the usual manner a grid condenser 5 and a grid resistance 6.

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The current produced in the oscillatory circuit when the system oscillates is utilized for heating a work-piece 7 which, in connection therewith, is placed in the field of a heating coil 8 connected into the oscillatory circuit 10, 3.

The work-piece 7 causes appreciable damping of the oscillatory circuit, 10, 3, which implies that the resonance resistance of the oscillatory circuit, which forms the anode impedance of the oscillator tube, has an extremely low value and that particular steps have to be taken to ensure a reasonable efficiency of the system.

In connection therewith it is known to provide in the anode circuit of the oscillator tube an auxiliary coil 9 which, together with the coil 3 of the circuit, forms an auto-transformer for stepping-up the resonance resistance of the oscillatory circuit 10, 3.

The applicant has found that with the system described so far the transformation ratio cannot be raised to such an extent as is desirable in view of the mutual matching of the internal oscillator resistance and the anode impedance. This difficulty is experienced even if, like with the above-described oscillator system with auto-transformer and in contrast to the state in case of a so-called Hartley-oscillator, the whole of the circuit voltage is operative between the cathode of the oscillator tube.

The transformation ratio is primarily prevented from being raised by the fact that with an increasing number of turns of the auxiliary coil 9 during normal operation, uncontrollable oscillation of the system occurs, with which the frequency of the oscillations generated is considerably higher than the tuning frequency of the oscillatory circuit 10, 3.

As the applicant further stated, the parasitic oscillations result from the direct inductive coupling of the auxiliary coil 9 and the reaction coil 4, so that in the case of a great damping of the oscillatory circuit 10, 3 the system behaves as if the oscillatory circuit 10, 3 were absent.

According to the invention, the production of parasitic oscillations may be avoided, as will be

clear from the foregoing, by mutually de-coupling the auxiliary coil 9 and the reaction coil 4 magnetically, which is preferably effected in the manner illustrated in Fig. 2.

The circuit-arrangement shown in Fig. 2 differs from that described with reference to Fig. 1 in that the oscillatory circuit coil 3 is divided into two sections 3' and 3'' by means of a plate 11 which forms a magnetic screen and which is perpendicular to the coil axis. The auxiliary coil 9 is concentrically mounted within the section 3', the reaction coil 4 being mounted in a similar manner within the section 3''. Direct inductive coupling of the auxiliary coil 9 and the reaction coil 4 is avoided to a high extent by the screen 11, which may be constituted, for example, by a copper plate.

The above-mentioned arrangement affords the advantage of a small overall length of the coil system 3', 3'', 4, 9 and permits without the use of high-frequency iron cores, of obtaining comparatively high coupling factors, which is particularly desirable in order to avoid a large number of turns for the auxiliary coil 9.

It may be pointed out here that it would perhaps be possible to prevent the production of parasitic oscillations in a different manner, for example by means of a choke coil connected between the anode of the oscillator tube 1 and that end of the auxiliary coil 9 which is adjacent thereto. However, such a choke coil constitutes an undesired phase-rotating element in the anode circuit of the oscillator tube and, moreover, it causes losses, due to which the increase in efficiency which is fundamentally possible owing to the fact that the production of parasitic oscillations is prevented, would be lost again for the major part.

What I claim is:

1. A high-frequency oscillator comprising an electron discharge tube having a cathode, a grid and an anode, a resonant circuit having a tank coil, means to apply a positive potential to said anode through said tank coil, a reaction coil coupled between said grid and said cathode and inserted within a portion of said tank coil to sustain oscillations, an auxiliary coil interposed between said anode and said tank coil and inserted within another portion of said tank coil to increase the oscillatory voltage developed across said tank coil, and means to magnetically decouple said reaction coil from said auxiliary coil.

2. A high-frequency oscillator comprising an electron discharge tube having cathode, a grid and an anode, an oscillatory circuit including a tank coil constituted by two sections, means to apply a positive potential to said anode through said tank coil, a reaction coil coupled between said grid and said cathode and disposed within one section of said tank coil to effect inductive coupling therebetween and thereby sustain oscillations, an auxiliary coil electrically interposed between said anode and said tank coil and arranged within the other section of said tank coil to effect inductive coupling therebetween thereby to increase the oscillatory voltage developed across said tank coil, and magnetic screening means interposed between the two sections of said tank coil to magnetically decouple said auxiliary coil from said reaction coil.

3. A high-frequency oscillator comprising an electron discharge tube having a cathode, grid and an anode, a resonant circuit including a helical tank coil constituted by two sections, means to apply a positive potential to said anode through said tank coil, a reaction coil coupled between said grid and said cathode and disposed concentrically within one section of said tank coil to effect inductive coupling therebetween and thereby sustain oscillations, an auxiliary coil electrically interposed between said anode and said tank coil and concentrically arranged within the other section of said tank coil to effect inductive coupling therebetween thereby to increase the oscillatory voltage developed across said tank coil, and a magnetic shield interposed between the two sections of said tank coil to magnetically decouple said reaction coil from said auxiliary coil.

4. A high-frequency oscillator comprising an electron discharge tube having a cathode, grid and an anode, a resonant circuit including a helical tank coil constituted by two sections, means to apply a positive potential to said anode through said tank coil, a reaction coil coupled between said grid and said cathode and concentrically arranged within one section of said tank coil to effect inductive coupling therebetween and thereby sustain oscillations, an auxiliary coil electrically interposed between said anode and said tank coil and concentrically arranged within the other section of said tank coil to effect inductive coupling therebetween for increasing the oscillatory voltage developed across said tank coil, and a grounded magnetic shield interposed between the two sections of said tank coil and disposed perpendicularly with respect to the axis of the tank coil to magnetically decouple said reaction coil and said auxiliary coil.

5. A high-frequency oscillator comprising an electron discharge tube having a cathode, grid and an anode, a grid leak resistor connected between said grid and said cathode, a resonant circuit including a helical tank coil constituted by two sections, means to apply a positive potential to said anode through said tank coil, a helical reaction coil capacitatively coupled between said grid and said cathode and coaxially arranged within one section of said tank coil to effect inductive coupling therebetween and thereby sustain oscillations, an auxiliary coil electrically interposed between said anode and said tank coil and coaxially arranged within the other section of said tank coil to effect inductive coupling therebetween for increasing the oscillatory voltage developed across said tank coil, and a grounded magnetic shield interposed between the two sections of said tank coil and perpendicularly disposed with respect to the axis of said tank coil to magnetically decouple said reaction coil and said auxiliary coil.

SYTSE BREIMER.

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