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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
H02M

A2

(11) International Publication Number: WO 99/67875

(43) International Publication Date: 29 December 1999 (29.12.99)

(21) International Application Number: PCT/KR99/00328

(22) International Filing Date: 22 June 1999 (22.06.99)

(30) Priority Data:
1998/23755 23 June 1998 (23.06.98) KR

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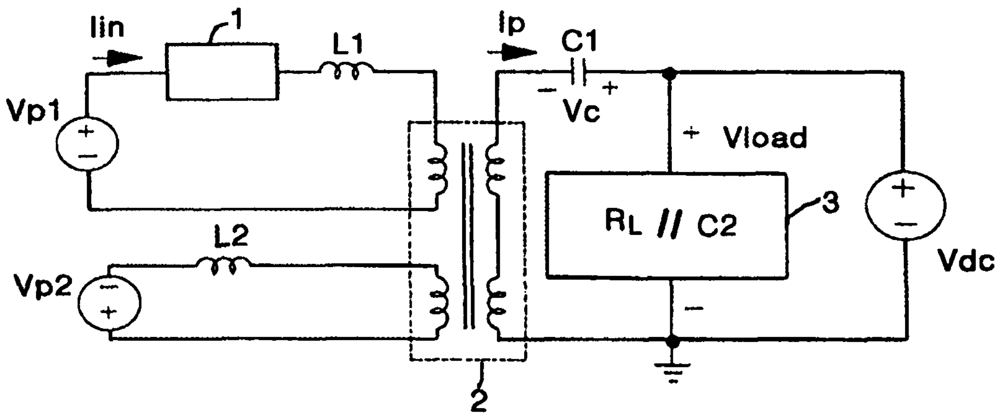
(81) Designated States: JP, US.

**Published**
*Without international search report and to be republished upon receipt of that report.*

(54) Title: HIGH VOLTAGE PULSE GENERATION DEVICE FOR MAGNETRON




(57) Abstract

The present invention relates to a high voltage pulse generation device for magnetron. The device is divided into a DC voltage generation part, which continuously applies a variable DC voltage at a constant value to the load, and a pulse voltage generation part, which generates a momentary high voltage pulse and supplies the same to the load. The voltage finally applied to the load is in the form in which the voltages outputted from the two devices are super-positioned. Further, a pulse transformer demagnetization power supply at the pulse voltage generation part is in place, separately, in order to make the magnetic component constant existing at the pulse transformer after pulse generation. Consequently, a high voltage pulse waveform can be obtained by means of momentary resonance and the pulse transformer using a low voltage at the time of pulse generation. Hence, as compared to the conventional circuits, the insulation space therein is reduced at the time of manufacturing, with the results of reducing the size and the weight thereof. In addition, when necessary, it is possible to adjust the size of peak value and the pulse cycle of the DC voltage applied to the load in addition to those of the pulse voltage.

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# High Voltage Pulse Generation Device for Magnetron

## Technical Field

The present invention relates to a high voltage pulse generation device for magnetron, which comprises a power supply in which a high voltage pulse is super-positioned onto the DC voltage, wherein the said magnetron is driven by generating a high voltage pulse using a pulse transformer and a resonance circuit.

## Background Art

A conventional high voltage pulse generation device is constituted in such a manner that a high pulse is generated by switching a DC power supply using a thyristor diode module (hereinafter TDM) and by having a resonance circuit at the TDM output.

However, a high voltage is applied to the TDM output because the TDM output is directly applied to the load via the resonance circuit. In other words, there is a disadvantage in that the cost is increased due to the high voltage rating of the high voltage switch for maintaining all the components in the circuit in high voltage ratings.

Therefore, the object of the present invention is to provide a relatively inexpensive high voltage pulse generation device by having a low voltage circuit to generate high voltage pulses.

Further, the object of the present invention is to provide a high voltage pulse generation device, in which the insulation space and the weight thereof are reduced.

Disclosure of Invention

To achieve this goal, the high voltage pulse generation device of the present invention is constituted in such a manner that a high voltage switch is placed at the primary side of a transformer, a resonance circuit over the primary side of the transformer and the secondary side of the transformer, and then a high voltage pulse is applied to the load at the secondary side of the transformer.

More specifically, the circuit presented in the invention herein is divided into two parts, which respectively generate different types of voltages. In other words, it is divided into a DC voltage generation part which continuously applies a variable DC voltage at a required value to the load, and a pulse voltage generation part generating a momentary high voltage pulse and supplying the same to the load. At that time, the voltage finally applied to the load is in the form in which the voltages outputted from the two devices are super-positioned therein. Further, a pulse transformer demagnetization power supply is constituted separately at the pulse voltage generation part in order to make a magnetic component constant existing at the pulse transformer after a pulse generation.

A high voltage pulse generation circuit is generally obtained by a resonance method or high voltage switch control. However, the method presented in the invention herein is to obtain a high voltage pulse waveform by a pulse transformer and momentary resonance using low voltage from the pulse voltage generation circuit which has a different resonance circuit constitution. Consequently, at the time of manufacturing, the insulation space therein is reduced in comparison with the conventional circuits so that the size and the weight thereof are reduced. Further, when necessary, it can adjust the of the peak value, the number of the pulse and the DC voltage applied to the load. The value of pulse width and the like is variable by adjusting the values in the design of the components used in the circuit. In addition, a thyristor diode module is used as a semiconductor switching element for resonance generation. As such, the control is simplified, and an advantage can be obtained in terms of manufacturing due to the simple system construction.

A circuit which generates a high voltage pulse uses a rectifier from the AC power supply, and a DC voltage is obtained, which in turn is used as a power supply. With respect to the resonance circuit, on the basis of a high frequency transformer, a resonance inductor is connected to the primary side, and a resonance capacitor is connected to the secondary side therein. With respect to the operation of the TDM, the resonance current begins to flow as the thyristor is turned on according to the discretionary frequency. A separate complex switching operation is not necessary due to the flow of a backward current path through the diode of the TDM from the moment that the flow of a resonance current is changed.

The power supply for the pulse transformer demagnetization added to the input current power supply controls the residual magnetism component existing at the pulse transformer after a pulse generation, resulting in avoiding saturation of a pulse transformer.

To switch high voltage, several elements must be connected in series due to the limited voltage and current rating of the switching elements, in order to raise the overall voltage share rate. In the present invention, the high voltage control was carried out by serially connecting several TDMs, each of which is one switch consisting of a thyristor, a semiconductor element switch for power supply, and a diode connected anti-parallelly thereto. Further, the DC base voltage applied to the load is supplied by a separate variable DC power supply circuit, and a pulse voltage is generated by a thyristor diode module, an inductor for the primary side resonance, and the secondary side capacitor.

Brief Description of the Drawing

Fig. 1 is a circuit diagram of a high voltage pulse generation device for magnetron according to the present invention.

Fig. 2 is a wave diagram of the voltage and current, which is applied to the load, and those of the input at the time of a pulse generation in the high voltage pulse generation device for magnetron according to the present invention.

Fig. 3 is a circuit diagram of a different constitution of a variable DC power supply device in the circuit of a high pulse generation device for magnetron of Fig.1.

Detailed Description of Preferred Embodiments

The circuit constitution and operation features of the present invention are described in detail with accompanying drawings as follows:

Fig. 1 is a circuit diagram of a pulse voltage generation circuit of the present invention, comprising a thyristor diode module (1) which interrupts an input DC power supply (Vp1) at an output with an on-off operation, a resonance inductor (L1) at the primary side of the pulse transformer which generates a pulse voltage by means of LC resonance in series with said thyristor diode module, a pulse transformer (2) which transforms the input voltage to high voltage, a resonance capacitor (C1) generating LC resonance, which is connected in series with said pulse transformer, a variable DC voltage generation part (Vdc) applying the predetermined DC voltage to the load, and a transformer demagnetization power supply (Vp2) which controls the residual magnetic component existing at the pulse transformer.

Fig.2 shows the circuit according to the present invention, which is a drawing of voltage waveforms and the current applied to the input power supply and to the both sides of the load upon pulse generation. At the initial state, a resonance capacitor (C1) is charged with a voltage (Vdc) to the extent provided by the variable DC power supply device. If the thyristor diode module (1) is conductive at $T=t_0$, then resonance is generated at the resonance capacitor (C1) by the power supply provided from the input under the state of a charged voltage provided from the variable DC power supply (Vdc). Under the state of the conductive thyristor diode module (1), a serial resonance circuit is formed according to the inductor (L1) for resonance of the primary side of the pulse transformer (2), a capacitor (C1) for resonance of the secondary side of the pulse transformer, and the load. When the current flowing at the thyristor of the thyristor diode module (1) is zero (t=tl), the direction of the current is changed, and then the reverse current starts to flow via a diode of the thyristor diode module (1). At that time, a thyristor is turned off by the reverse current flow, and this condition continues until the current of the thyristor diode module (1) returns to zero, terminating resonance when the current is zero. The above process is repeated with the desired pulse cycle.

Energy as below is charged at the capacitor (C1) for resonance. Voltage ($V_c$) is charged at the capacitor (C1) for resonance from the starting point of initial resonance to the extent of the variable DC voltage ($V_{dc}$). In this condition, if a thyristor diode module (1) is conductive, then resonance at the resonance circuit is generated. This continues until a circulation current returns to zero in sine waveform. The peak value of a pulse generated by resonance can be calculated based on the following equation:

$$R_L >> n \sqrt{\frac{L \bullet (C1 + C2)}{C1 \bullet C2}} \qquad (1)$$

wherein, n is a ratio between the number of turns of the primary side of the pulse transformer to the number of turns of the secondary side thereof; C1 is resistance capacitance; C2 is load capacitance; $R_L$ is load resistance; and $\rho$ is equivalent the impedance component of the main circuit.

At that point, the current following at the secondary side of the high voltage transformer is represented by the following equation:

$$I_p = \frac{nV_{pl}}{\rho} \sin \omega t \qquad (2)$$

wherein,

$$\omega = 1/n \sqrt{\frac{L \bullet (C1+C2)}{C1 \bullet C2}} \quad ;$$

the voltage applied to the load is as follows:

$$V_{load} = \frac{I_{max}}{C2 \bullet \omega} (1-\cos \omega t) \qquad (3)$$

wherein, the peak value of the pulse voltage is expressed by

$$V_{p \bullet peak} = 2n\, V_{pl} \frac{C1}{(C1+C2)} \qquad (4)$$

In the Fig.2, at the load voltage ($V_{laod}$), it can be seen that pulse voltage ($V_p$) is super-positioned at the moment of resonance after having had a constant DC value ($V_{dc}$).

As compared the conventional methods, the pulse generation device used in the present system can be miniaturized even further by reducing the insulating space using a pulse transformer (2).

Fig.3 is a circuit diagram, according to the present invention, having a different constitution of a variable DC power supply device at the main circuit for a high voltage pulse generation device for magnetron. The variable DC power supply ($V_{dc}$) device herein comprises a phase control voltage converter (6), a transformer (5), a rectifier (4), and a pulse inflow prevention diode (D1). As such, the voltage is supplied the load at a constant value. The phase control voltage converter (6) can easily control the voltage magnitude by phase control using a non-thyristor switch capable of turn-off.

As described above, according to the present invention, a high voltage pulse waveform could be obtained by momentary resonance and a pulse transformer using a low voltage from the pulse voltage generation circuit. As such, the insulation space at the time of manufacturing could be reduced with the effects of reducing the size and the weight thereof.

Claims

What is claimed is:

1. A high voltage pulse generation device comprising:

(a) a pulse transformer having a first primary side winding, a second primary side winding, and a secondary side winding;

(b) a first primary side circuit comprising:

(b-1) a first inductor connected in series to one terminal of said first primary side winding;

(b-2) a thyristor-diode module connected in series to said inductor;

(b-3) a first DC power supply connected between said thyristor-diode; module and the other terminal of said first primary side winding;

(c) a second primary side circuit comprising:

(c-1) a secondary inductor connected in series to one terminal of said second primary side winding;

(c-2) a secondary DC power supply connected between said secondary inductor and the other terminal of said second primary side winding; and

(d) a secondary side circuit comprising:

(d-1) a capacitor connected in series to one terminal of said secondary side winding;

(d-2) a load connected to said capacitor and the other terminal of said secondary side winding;

(d-3) a third DC power supply connected to the both terminals of said load.

2. A high voltage pulse generation device according to Claim 1, wherein said third DC power supply comprises:

(d-3-1) an alternating power supply;

(d-3-2) a phase control voltage converter in which the input thereof is connected to the both terminals of said alternating power supply;

(d-3-3) a high voltage transformer in which the primary side thereof is connected to the output of said phase control voltage converter;

(d-3-4) a rectifier in which the input thereof is connected to the secondary side of said high voltage transformer, and one of the output terminals therein is the output terminal of said third DC power supply; and

(d-3-5) a diode in which the anode thereof is connected to the other output terminal of said rectifier, and the cathode thereof is the other output terminal of said third DC power supply.

FIG.1

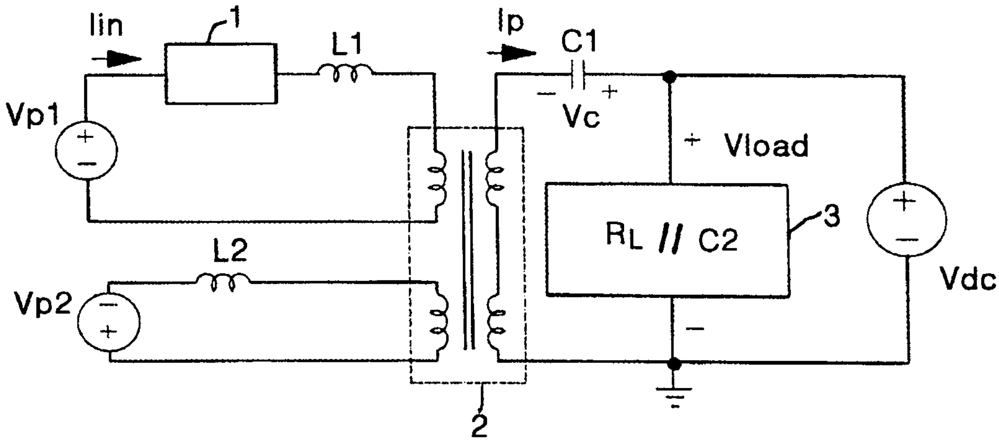
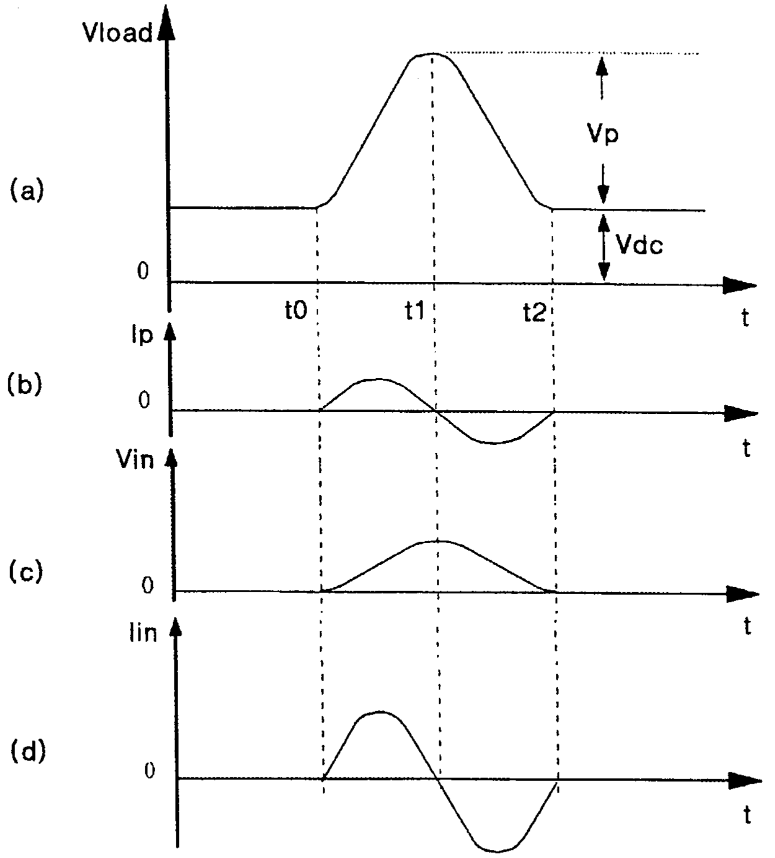


FIG.2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(a)
Vp
Vdc
0
t0
t1
t2
t
Ip
(b)
0
t
Vin
(c)
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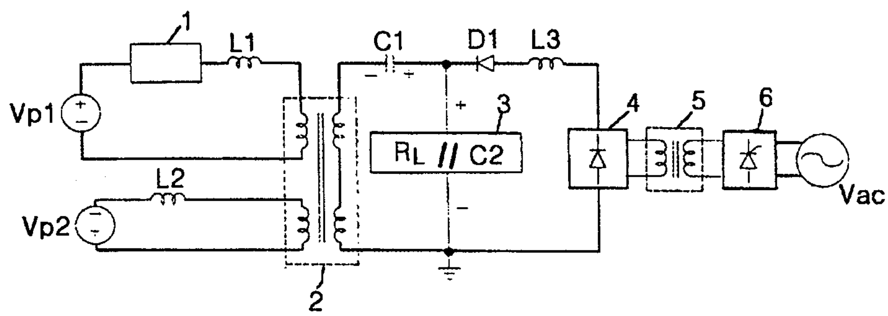
Iin
(d)
0
t

FIG.3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