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(54) **Electronic ballast for fluorescent lamp**

(57) The invention relates to an electronic ballast for a fluorescent lamp, the lamp load circuit being connected between the inverter power switch devices (Q_1 , Q_2). The lamp load circuit comprises an inductor (L_{1pri}) and a capacitor (C_1) in a series connection with the lamp. The inductor (L_{1pri}) is cofunctionally complemented with a secondary inductor (L_{1sec}) that is connected to the same

circuit with the transformer primary winding (T_{1pri}) for supplying the heating current energy from the secondary inductor (L_{1sec}) to the transformer primary winding (T_{1pri}). The secondary windings (T_{1secA} , T_{1secB}) are connected to the lamp cathodes. The transformer primary circuit incorporates a control device (Q_3) for varying the heating current under an active control dependent on the desired lamp intensity level.

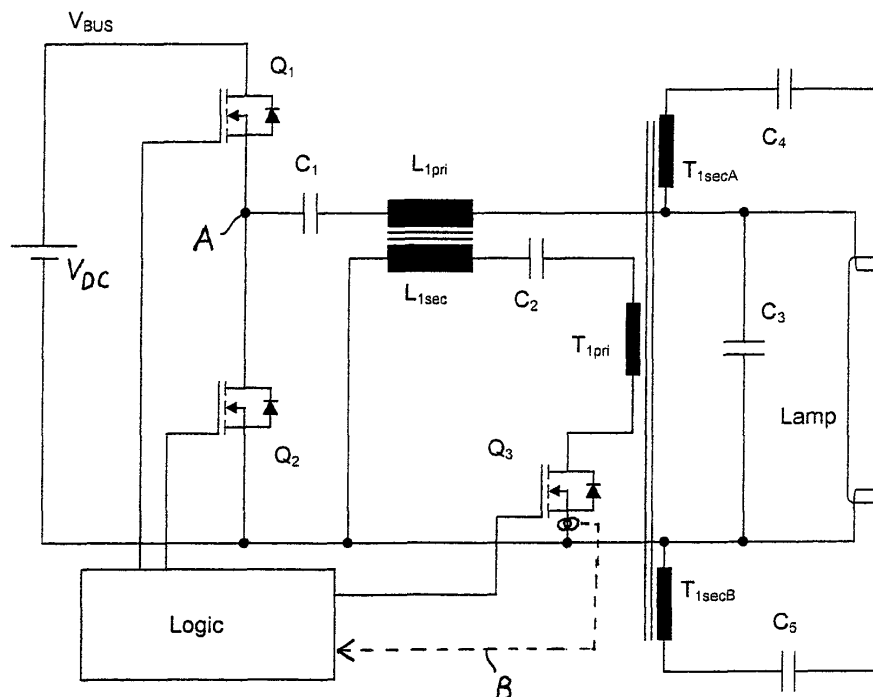


FIG. 1 Schematic diagram of heating current circuit

Description

[0001] The present invention relates to an electronic ballast for a fluorescent lamp, the ballast comprising

- an inverter which is supplied from a DC voltage source and includes two power switch devices operating in a push-pull mode for generating a high-frequency voltage,
- a lamp load circuit which is connected to the inverter and comprises a primary inductor and a capacitor and to which load circuit the fluorescent lamp can be connected,
- a heating circuit of the fluorescent lamp cathodes, the heating circuit including a transformer having a primary winding and secondary windings connected to the cathodes of the fluorescent lamp for feeding a heating current thereto,
- a secondary inductor cofunctioning with the primary inductor and connected to the same circuit with the transformer primary winding for supplying the heating current energy from the secondary inductor to the transformer primary winding, and
- a control device in the same circuit for controlling the level of the heating current.

[0002] This kind of ballast is known from patent publication US 2004/0100211 A1. Therein a thermistor with a positive temperature coefficient (PTC) is employed as the control device. This prior-art control circuit of cathode heating current is ill suited for use in controllable ballasts that also need active control of cathode heating current level.

[0003] While from the applicant's patent publication FI 108105 is known a ballast featuring active heating current control, this embodiment extracts the required energy from a high-voltage circuit via a high-voltage power switch device.

[0004] It is an object of the invention to provide an improved ballast with an active cathode heating current control extracting the heating current energy from a circuit operating at a voltage smaller than the voltage over the lamp load circuit inductor.

[0005] The goal of the invention is achieved by way of the features specified in appended claim 1. Details of preferred embodiments of the invention are disclosed in the dependent claims.

[0006] In the following, the invention will be examined in greater detail with the help of an exemplary embodiment by making reference to the appended drawings in which

FIG. 1 shows a circuit diagram of a ballast according to the invention as to its basic components; and

FIG. 2 shows the synchronization of waveforms in the ballast according to the invention.

[0007] In the configuration shown in FIG. 1, switches Q_1 and Q_2 form the normal half-bridge of a lamp circuit. In FIG. 2 is elucidated the push-pull mode operation of the power switch devices Q_1 and Q_2 . The lamp is stabilized to a desired intensity level by way of controlling the operating frequency of the switch devices Q_1 and Q_2 . A logic control circuit alters the operating frequency as determined by lamp dimmer control signal. Accordingly, switch devices Q_1 and Q_2 form an inverter circuitry supplied from a DC supply V_{DC} for generating a high-frequency AC voltage. Capacitor C_1 blocks the DC component of the lamp drive voltage and oscillator inductor L_{1pri} limits the lamp current depending on the operating frequency.

[0008] The voltage induced over the oscillator inductor secondary winding L_{1sec} is taken via capacitor C_2 to transformer T_1 . The current passing via T_1 is controlled by driving switch device Q_3 in synchronism with the operation of the half-bridge power switch devices Q_1 and Q_2 . The heating current of the lamp cathodes can be varied by controlling the pulse width of the drive signal taken to Q_3 . The secondary windings T_{1secA} and T_{1secB} of transformer T_1 are connected via capacitors C_4 and C_5 , respectively, to drive the heater circuits of the lamp cathodes. The lamp is paralleled with a starting capacitor C_3 .

[0009] Accordingly, the heating current energy is extracted from secondary L_{1sec} of lamp heating circuit inductor L_1 . Defined by the turns ratio, this secondary voltage is smaller than the voltage over the primary winding of inductor L_1 . This arrangement gives the benefit that a low-voltage switch device Q_3 can be employed for implementing the heating current control. Switch device Q_3 is in cut-off state when the cathodes are not being heated. During heating, the logic circuit controls switch device Q_3 as required by the operating level of the lamp. In FIG. 2 is illustrated the method of controlling Q_3 with the help of a pulse-width-controlled drive signal. Switch Q_3 is driven synchronized with the operating frequency of the inverter switches Q_1 , Q_2 , whereby the width of its drive signal pulses are made narrower than the drive pulses of the inverter switch devices. The synchronization can be timed to the front or back edges of the inverter drive pulses, whereby the timing of switch Q_3 operation occurs at either the front or back edge of its drive pulse, respectively.

[0010] In FIG. 1 is illustrated by dashed line B an arrangement for sensing the level of heating current supplied to the fluorescent lamp cathodes from the circuit passing via the transformer primary winding T_{1pri} , whereby the measurement signal is adapted by means of the logic circuit to control the operation of switch device Q_3 . Resultingly, the heating current control can accurately follow the lamp current control, even so that the varying operation of the lamp at different temperatures is taken into account.

Claims

1. An electronic ballast for a fluorescent lamp, the ballast comprising
 - an inverter which is supplied from a DC voltage source (V_{DC}) and includes two power switch devices (Q_1 , Q_2) operating in a push-pull mode for generating a high-frequency voltage, 5
 - a lamp load circuit which is connected to the inverter and comprises a primary inductor (L_{1pri}) and a capacitor (C_1) and to which load circuit the fluorescent lamp can be connected, 10
 - a heating circuit of the fluorescent lamp cathodes, the heating circuit including a transformer (T_1) having a primary winding (T_{1pri}) and secondary windings (T_{1secA} , T_{1secB}) connected to the cathodes of the fluorescent lamp for feeding a heating current thereto, 15
 - a secondary inductor (L_{1sec}) cofunctioning with the primary inductor (L_{1pri}) and connected to the same circuit with the transformer primary winding (T_{1pri}) for supplying the heating current energy from the secondary inductor (L_{1sec}) to the transformer primary winding (T_{1pri}), and 20
 - a control device (Q_3) in the same circuit for controlling the level of the heating current, 25

characterized in that the control device is a controllable switch for varying the heating current under an active control dependent on the desired lamp intensity level and that, defined by the turns ratio, the voltage over the secondary inductor (L_{1sec}) is smaller than the voltage over the primary inductor (L_{1pri}). 30
2. The ballast of claim 1, **characterized in that** the heating current is adapted controllable to a desired level by driving the switch (Q_3) ON and OFF with a pulse-width-controlled drive signal. 35
3. The ballast of claim 1 or 2, **characterized in that** the switch device (Q_3) is a switch transistor driven synchronized with the operating frequency of the inverter switches (Q_1 , Q_2), whereby the width of its drive signal pulses are made narrower than the drive pulses of the inverter switch devices. 40
4. The ballast of any one of claims 1 - 3, **characterized in that** the sensing of the level of heating current supplied to the fluorescent lamp cathodes is arranged to take place at the circuit passing via the transformer primary winding (T_{1pri}), whereby the measurement signal is adapted by means of the logic circuit to control the operation of the switch device (Q_3). 45

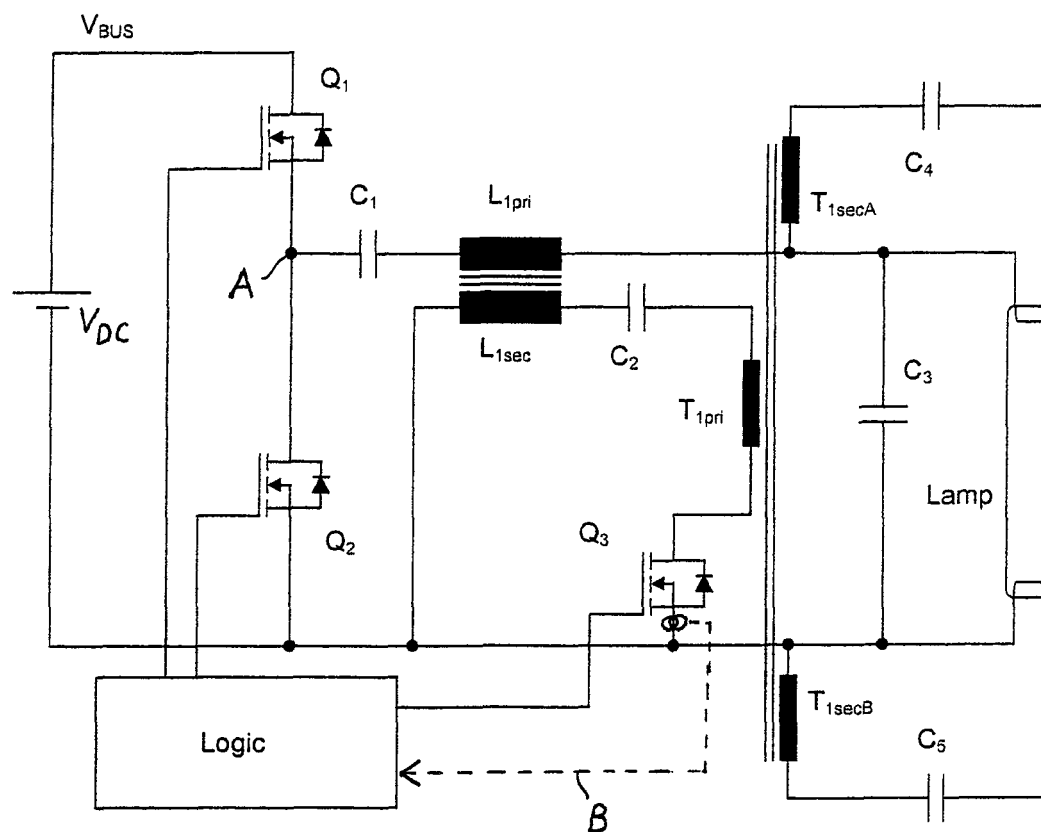


FIG. 1 Schematic diagram of heating current circuit

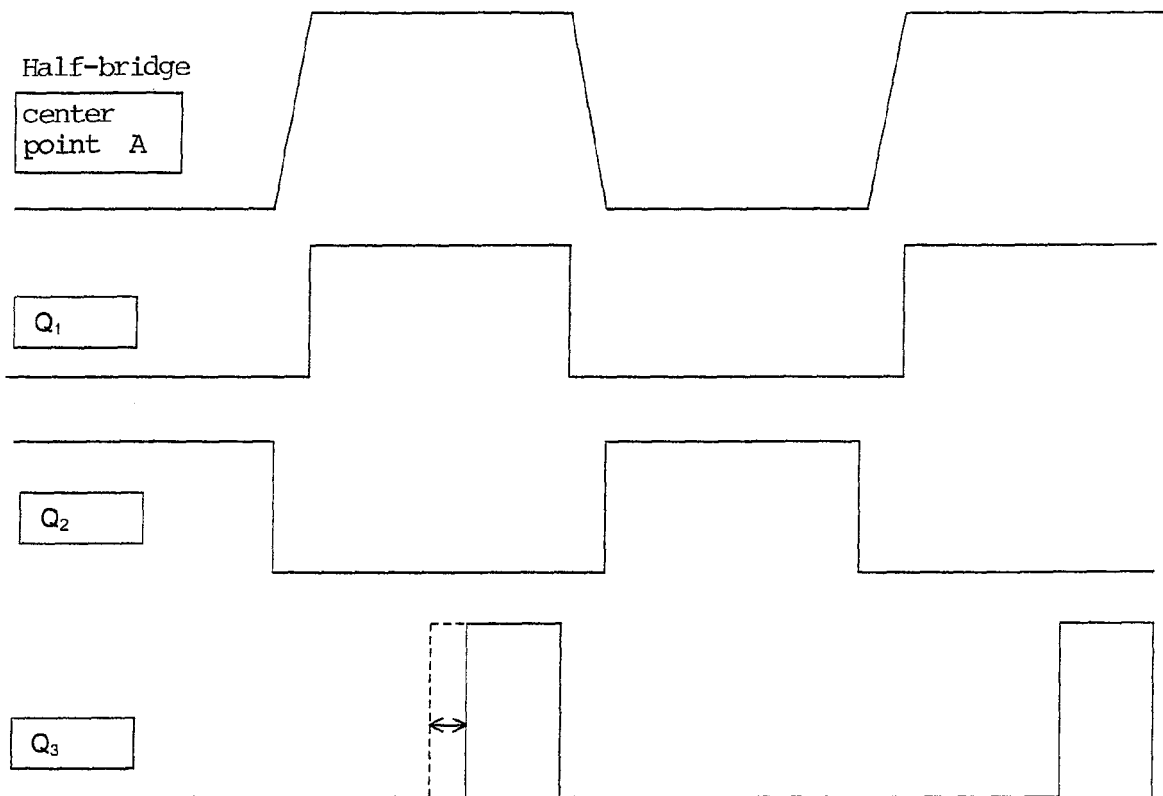


FIG. 2 Timing of operation waveforms



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 39 7003

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 10 2004 009995 A1 (TRIDONICATCO GMBH & CO KG DORN [AT]) 22 September 2005 (2005-09-22)	1	INV. H05B41/295
Y	* paragraphs [0010], [0025] - [0030]; figure 2 *	2-4	
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			TECHNICAL FIELDS SEARCHED (IPC)
			H05B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 6 March 2007	Examiner Speiser, Pierre
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 07 39 7003

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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06-03-2007

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- US 20040100211 A1 [0002]
- FI 108105 [0003]