



(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
28.05.2003 Bulletin 2003/22

(51) Int Cl.⁷: **H05B 41/282**, H05B 41/36

(21) Application number: **02079806.2**

(22) Date of filing: 18.11.2002

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
 IE IT LI LU MC NL PT SE SK TR**
 Designated Extension States:
AL LT LV MK RO SI

(72) Inventor: **Dal Santo, Ivan**
20080 Calvignasco (Milan) (IT)

(74) Representative: **De Gregori, Antonella et al**
Ing. Barzano & Zanardo Milano S.p.A.
Via Borgonuovo 10
20121 Milano (IT)

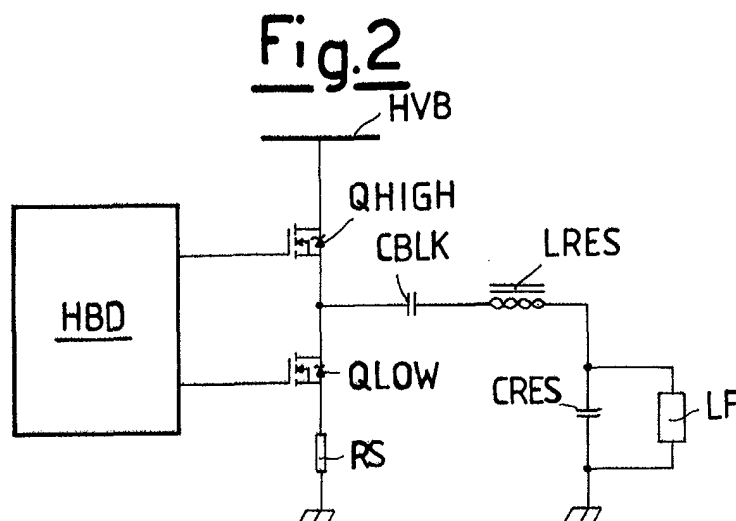
(30) Priority: **21.11.2001 IT MI20012453**

(71) Applicant: **VLM S.p.A.**
20090 Buccinasco (Milan) (IT)

(54) **Electronic circuit for supplying high-frequency power for fluorescent lamps**

(57) An electronic circuit for supplying high-frequency power for fluorescent lamps (LF) of different types and powers, according to which the lamp (LF) is recognised by measuring the active power absorbed and,

therefore, it is supplied with suitable current and voltage values; the power supply circuit thus adapts to each individual lamp, ensuring high performance, high efficiency and long useful life.



Description

[0001] The present invention refers to an electronic circuit for supplying high-frequency power to fluorescent lamps of different types and powers.

[0002] Electronic ballasts are apparatuses which allow high-frequency power supply (in the order of tens of kHz) to fluorescent lamps with undoubted advantages in terms of efficiency and performance, such as protection against working anomalies, no flickering, etc.

[0003] Nevertheless, all of the types of electronic "ballast" currently on the market can only supply a single type of lamp, of a certain power, or groups of lamps having electrical characteristics (lamp current and voltage) which are similar between the individual lamps, with the consequent drawbacks given by low performance which, in many cases, is not congruous with the type of lamp supplied, by low efficiency and by the relatively short useful life.

[0004] The purpose of the present invention is therefore that of avoiding the aforementioned drawbacks and, in particular, that of realising an electronic circuit for supplying high-frequency power for fluorescent lamps which is capable of supplying fluorescent lamps of different types and powers, overcoming the limitations of apparatuses available up to now.

[0005] Another purpose of the present invention is that of realising an electronic circuit for supplying high-frequency power for fluorescent lamps which is particularly reliable and which is capable of recognising the type of lamp connected to it, then supplying it in the correct manner.

[0006] A further purpose of the present invention is that of indicating an electronic circuit for supplying high-frequency power for fluorescent lamps which is also simple to realise, safe and relatively economic, also concerning the low management and maintenance costs, with respect to the electronic "ballasts" of the conventional type.

[0007] These and other purposes are achieved, in the invention, by realising an electronic circuit for supplying high-frequency power for fluorescent lamps according to claim 1, to which we refer for the sake of brevity.

[0008] Further characteristics and advantages of an electronic circuit for supplying high-frequency power for fluorescent lamps, according to the invention, shall become clearer from the following description, given as an example and not limiting purposes, referring to the attached drawings, in which:

- figure 1 shows a circuit diagram relative to the topology of the power stage of the power supply device, according to the present invention;
- figure 2 shows a circuit for measuring the power absorbed by each lamp, which is used in the power supply device, according to the present invention;
- figures 3 and 4 show a block diagram of a discriminator circuit of the power absorbed and a circuit for

changing the frequency of oscillation, which are present in a power supply device, according to the present invention;

- figure 5 represents a circuit for comparing and varying the frequency used in the power supply device, according to the present invention;
- figure 6 shows an example overall embodiment of the electronic circuit for supplying high-frequency power for fluorescent lamps, according to the present invention.

[0009] As can be seen clearly in the aforementioned figure 1, the topology of the power stage of the power supply circuit for fluorescent lamps object of the invention is a half-bridge with series resonant load, consisting of the capacitor CRES and of the inductor LRES, and has the fluorescent lamp LF connected in parallel to the resonance capacitor CRES.

[0010] Two power MOSFETs, indicated with QHIGH and QLOW in figure 1, are connected to the series resonant load and are supplied with power by a supply line or high voltage bus HVB (about 400 Volts). Moreover, the power MOSFETs QHIGH and QLOW are driven by a suitable integrated command circuit ("half-bridge driver") - indicated with HBD in figure 1.

[0011] Connecting to the mains, the power supply circuit or "ballast" starts to oscillate at a frequency value far from the value of the resonance frequency of the mains comprising the capacitor CRES and the inductor LRES, allowing the cathodes or filaments of the lamp to be preheated, without switching it on.

[0012] The voltage at the ends of the lamp LF is, indeed, kept below a predetermined value which is shown on the specific lamp. Such a value is the lowest from all of the lamps which can be supplied.

[0013] Moreover, during the preheating step, recognition of the lamp LF is stopped and the power supply circuit oscillates at the same frequency independently of the lamp LF connected.

[0014] With the preheating of the filaments of the lamp LF completed, the frequency of oscillation of the supply circuit gradually decreases moving closer to the resonance value of the mains L-C formed by the capacitor CRES and by the inductor LRES. The voltage at the ends of the lamp LF increases allowing it to be switched on.

[0015] With the lamp LF switched on, the supply circuit or "ballast" functions at the minimum frequency of oscillation corresponding to the maximum power.

[0016] The procedure with which the electronic power supply recognises the lamp LF consists of measuring the average power absorbed by it and of varying the frequency of oscillation of the half-bridge circuit to adapt the current and voltage values to that which is requested by the lamp LF.

[0017] If an average power value greater than a certain threshold is measured this means that the lamp LF with the highest power is connected and the "ballast"

continues to function at the lowest frequency corresponding to the maximum power.

[0018] If, on the other hand, an absorbed power value lower than the aforementioned threshold is detected, this means that a lamp LF with the lowest power is connected and, in this case, the "ballast" increases the frequency of oscillation reducing the power supplied to the lamp LF.

[0019] The measurement of the power absorbed by the lamp LF is carried out through a resistance, indicated with RS in figure 2 connected in series to the "SOURCE" of the MOSFET with power QLOW. The average value of the voltage signal at the ends of the resistance RS is directly proportional to the average power absorbed by the lamp LF.

[0020] To obtain the average value of the voltage drop at the ends of RS, according to the present invention, a low power filter R-C is used, generically indicated with LPF in figure 3. Following on from such a low power filter LPF, a discriminator circuit of the power absorbed is foreseen which, in preferred example embodiments of the present invention, consists of a comparator CMP with output DO, of the open-drain type (see, in particular, figure 3).

[0021] The signal coming from RS, mediated by the low power filter LPF, is compared with a low voltage reference LVR.

[0022] When the signal S coming from the sensing circuit and, therefore, coming from the resistance RS is greater than the reference LVR the output DO of the comparator circuit CMP is forced to ground. Vice-versa, when the signal S is lower than the reference LVR the output DO of the comparator CMP is an open circuit.

[0023] A second comparator circuit PI ("preheat inhibit") is used to inhibit the recognition of the fluorescent lamp LF during the preheating step of the filaments. In practice, until the voltage VCPH is less than a high voltage reference HVR, the output OUT of the comparator PI is low and forces to ground the low voltage reference LVR of the comparator CMP.

[0024] As can be seen in figure 4, the output DO ("open-drain output") of the comparator CMP relative to the power signal is connected to the pin 6 (capacitor CT) of an integrated circuit which functions as a half-bridge driver circuit. In particular, in preferred but not limiting embodiments of the present invention, the integrated circuit IR2156 is used as a half-bridge driver HBD.

[0025] The output DO of the comparator CMP is also connected to the pin 4 (resistance RT) of the integrated driver circuit HBD, respectively, through a signal diode DS (usually a 1N4148 diode is used) and a resistance RSH.

[0026] When the output DO of the comparator CMP is low (practically at ground level), i.e. in maximum power conditions, the resistance RSH is disconnected from the pin 6 (capacitor CT) of the driver circuit HBD, since the diode DS is inversely polarised, the voltage at the pin 6 (and therefore the voltage taken at the ends of the

capacitor CT) always being greater than 4.8 Volts.

[0027] If, on the other hand, the output DO of the comparator CMP is high (circuit open), i.e. in minimum power conditions, the resistance RSH is connected in parallel to the resistance RT, unless there is a drop in potential on the diode DS. In such conditions, the capacitor CT is charged faster and the frequency of oscillation of the half-bridge is higher.

[0028] The value of the resistance RT, together with the value of CT, set the minimum value of the frequency of oscillation (and a corresponding maximum power value), whereas the value of the resistance RSH sets the frequency of oscillation relative to the minimum operating power condition.

[0029] For the discriminator stage of the power absorbed schematised in figure 3, according to the invention, a double comparator CMOS with output DO ("open-drain") is used, indicated with CDO in figure 5.

[0030] In particular, in the case of the present invention, the comparator TS393 was used, in which the two voltage thresholds LVR (threshold of the power comparator CMP of figure 3) and HVR (threshold of "inhibit" of Figure 3) are obtained by a partition, formed by the resistances RDV1, RDV2, RDV3 of figure 5, of the supply voltage VCC of all of the integrated circuits, the typical value of which is 15.6 Volts.

[0031] These two references LVR and HVR are respectively connected to the non-inverting input of the power comparator CMP (pin 3 of the comparator CDO) and to the inverting input of the inhibit comparator PI (pin 6 of the comparator CDO).

[0032] The inverting input of the power comparator CMP (pin 2 of the comparator CDO) is connected to the signal S coming from the resistance RS, mediated by the low-power filter R-C, whereas the inverting input of the inhibit comparator PI (pin 5 of the comparator CDO) is connected to the capacitor CPH (pin 7 of the driver circuit HBD of figure 5), with which the preheating time of the fluorescent lamp LF is set.

[0033] Finally, figure 6 schematically illustrates the overall circuit of the power supply device or "ballast" object of the invention. For the sake of clarity, said circuit has been divided into five blocks and, in particular, it is possible to identify an interference filter F ("EMI filter"), a stage S1 for the active control of the power factor ("PFC section"), a half-bridge driver circuit HBD, a discriminator circuit CDO of the power absorbed ("power comparator") and a resonant load LR.

[0034] The interference filter F is not essential for the operation of the supply circuit, but is obviously necessary to contain the interference within the limits set by the current norms in the field.

[0035] The stage S1 allows the values of the power factor near to the unit to be obtained and allows the harmonic content of the current absorbed by the mains to be limited within the limits dictated by the norms.

[0036] The stage S1 also allows a virtually constant continuous regulated voltage (with a low residual "rip-

ple" at 100 Hz) to be obtained with which the half-bridge is to be supplied.

[0037] From the description which has been made, the characteristics of the electronic circuit for supplying high-frequency power for fluorescent lamps object of the present invention are clear, just as the advantages are also clear.

[0038] Finally, it is clear that numerous other variants can be brought to the supply circuit in question, without for this reason leaving the novelty principles inherent to the inventive idea, just as it is clear that, in the practical embodiment of the invention, the materials, the shapes and the sizes of the illustrated details can be whatever according to requirements and they can be replaced with others which are technically equivalent.

Claims

1. Electronic circuit for supplying high-frequency power for fluorescent lamps (LF), **characterised in that** it comprises a command circuit (HBD) of a power stage, a resonant load circuit (LR) and a discriminator circuit (CDO) of the active power absorbed by each lamp (LF), which measures the power absorbed by each type of fluorescent lamp (LF), so that said lamp (LF) is correctly supplied with consequent determined values of current and voltage.
2. Electronic power supply circuit according to claim 1, **characterised in that** it also comprises at least one interference filter (F) and at least one circuit stage (S1) for actively controlling the power factor, in order to obtain power factor values near to the unit and to limit the harmonic content of the current absorbed by the mains, said circuit control stage (S1) also allowing a substantially constant continuous regulated voltage to be obtained with which said power stage is to be supplied.
3. Electronic power supply circuit according to claim 1, **characterised in that** said power stage is of the half-bridge type and comprises a resonant load of the series type with resonance capacitor (CRES) and inductor (LRES), said fluorescent lamp (LF) being connected in parallel to said resonance capacitor (CRES).
4. Electronic power supply circuit according to claim 1, **characterised in that** power transistor devices (QHIG, QLOW), which are supplied with power by a high voltage ballast (HVB), are connected to said series resonant load, said transistor devices (QHIG, QLOW) being driven by said driver circuit (HBD) and said connection to the supply line being used to operate a preheating step of the filaments of said lamp (LF) during which said supply circuit oscillates at a predetermined frequency value, in-

dependently from the type of fluorescent lamp (LF) connected.

5. Electronic power supply circuit according to claim 4, **characterised in that** following said preheating step of the filaments of the lamp (LF) there is a step in which said frequency of oscillation gradually reduces moving closer to the resonant frequency value of said resonant circuit (CRES, LRES), so that the voltage at the ends of said lamp (LF), increasing, allows it to be switched on.
6. Electronic power supply circuit according to claim 5, **characterised in that** said frequency of oscillation of the half-bridge circuit is regulated so as to adapt the voltage and current values applied to said fluorescent lamp (LF), according to the average power values absorbed by the lamp (LF) with respect to a determined threshold value.
7. Electronic power supply circuit according to claim 6, **characterised in that** one of the terminals of at least one of said power transistor devices (QLOW) is connected to at least one resistive element (RS), suitable for measuring the power absorbed by said lamp (LF), said resistive element (RS) being connected to a low-power filter (LPF) which is, in turn, connected in cascade to said discriminator circuit (CDO) of the power absorbed.
8. Electronic power supply circuit according to claim 7, **characterised in that** said discriminator circuit (CDO) comprises at least one first comparator device (CMP) with output (DO) of the open-drain type, said first comparator (CMP) taking care of comparing a signal (S) coming from said resistive element (RS) and mediated by said low-power filter (LPF) with a low voltage reference (LVR), so as to force said output (DO) to ground or to make it an open circuit, according to the value of said signal (S) compared to said low voltage reference (LVR).
9. Electronic power supply circuit according to claim 8, **characterised in that** a second comparator device (PI) is used to inhibit the recognition of said fluorescent lamp (LF) during the preheating step of the filaments, the output (OUT) of said second comparator (PI) being connected to said low voltage reference (LVR).

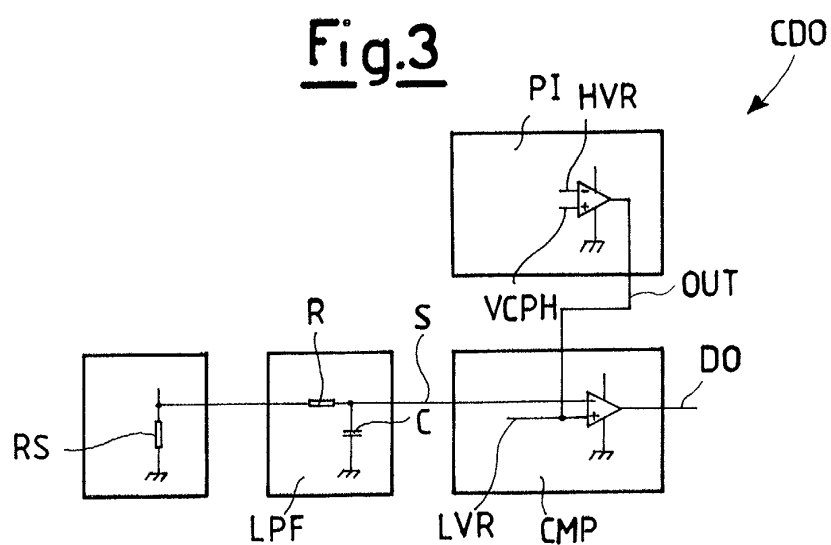
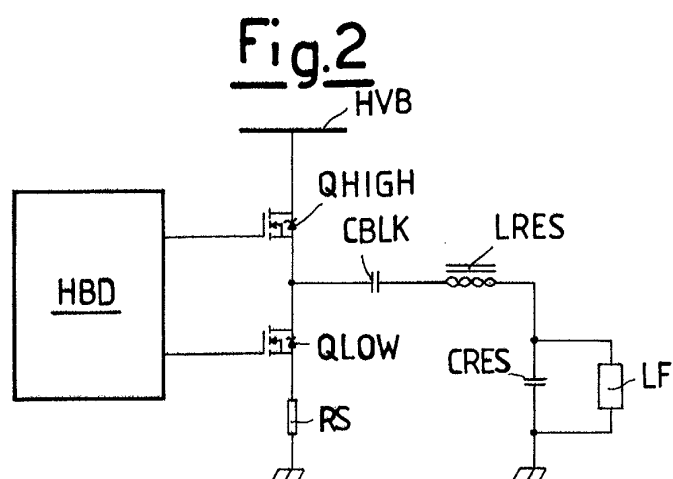
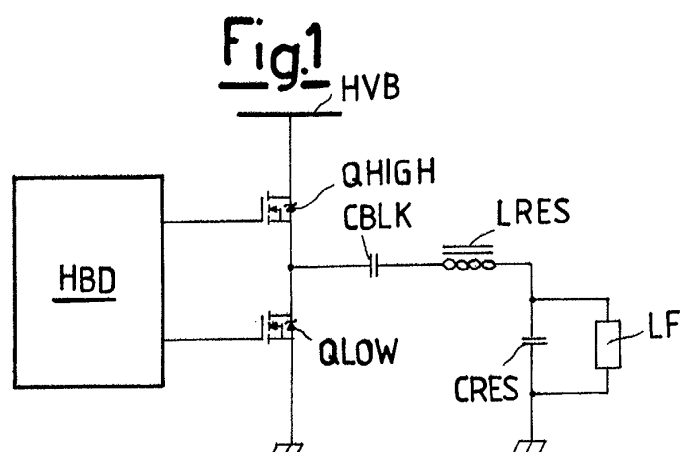


Fig.4

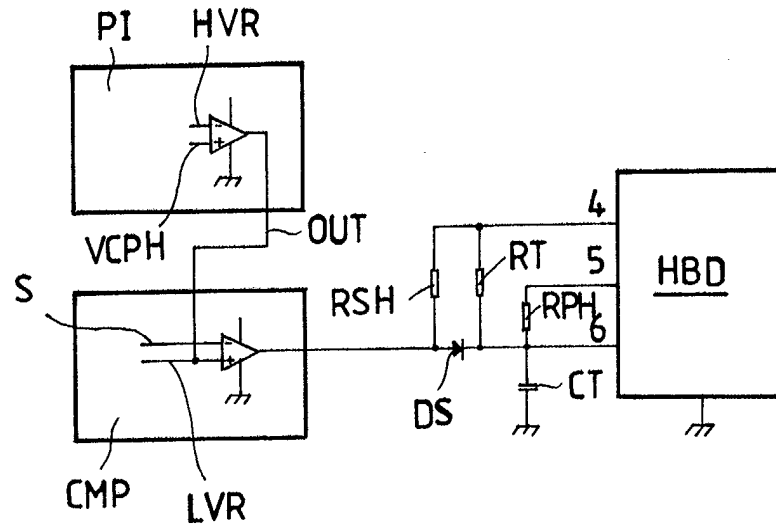


Fig.5

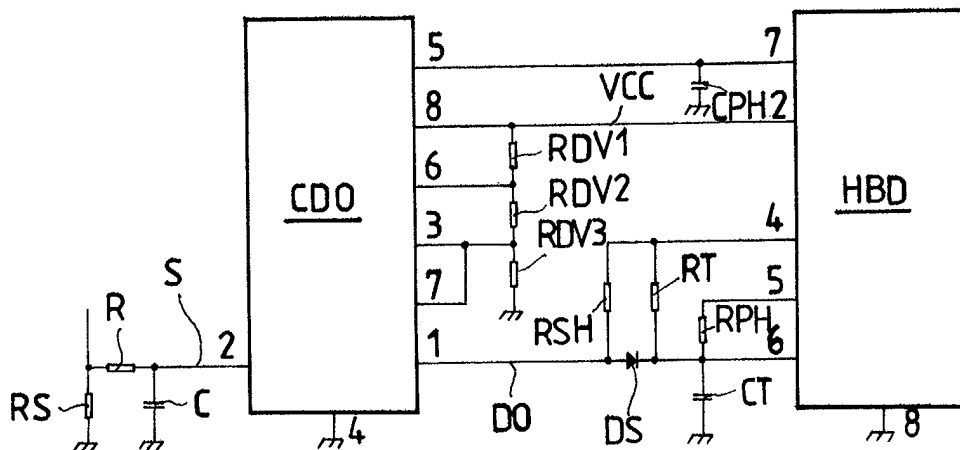


Fig.6

