



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
05.01.2011 Bulletin 2011/01

(51) Int Cl.:
H05B 41/282 (2006.01)

(21) Application number: **10163702.3**

(22) Date of filing: **24.05.2010**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
 Designated Extension States:
BA ME RS

(71) Applicant: **Helvar Oy Ab**
03600 Karkkila (FI)

(72) Inventor: **Vihinen, Hannu**
02150, Espoo (FI)

(74) Representative: **Sole, Timo et al**
Leitzinger Oy,
Tammasaarekatu 1
00180 Helsinki (FI)

(30) Priority: **30.06.2009 FI 20095737**

(54) **Controlling and measuring the functions of an electronic ballast**

(57) The invention relates to a lamp for producing illuminating radiation, said lamp comprising an electronic ballast 102 for establishing an ignition voltage for the lamp in order to initiate the production of illuminating radiation, said electronic ballast 102 comprising at least two switching transistors Q1, Q2 for supplying current to at least one coil L1 which develops the lamp ignition voltage, and the electronic ballast 102 having a control circuit 104 integrated therewith. The electronic ballast 102 comprises at least two resistors R8 and R10 arranged at least in a series connection relative to each other for measuring and/or regulating the currents of said at least two switching transistors Q1 and Q2, said resistor R8 being in con-

nection with the switching transistor Q2 and the resistor R10 being in a series connection with the resistor R8 and with a voltage source. The electronic ballast 102 comprises the series connection of said resistors R8 and R10 for operating said control circuit 104 in order to detect whether a current passing through the switching transistor Q1 or Q2 is overly high with respect to a limit current value set for the control circuit, and by operating said control circuit 104, for immediately switching off the control of that switching transistor Q1 or Q2 which switching transistor Q1 or Q2 has been found with an overly high passing current and for immediately switching on the current of the other switching transistor Q1 or Q2.

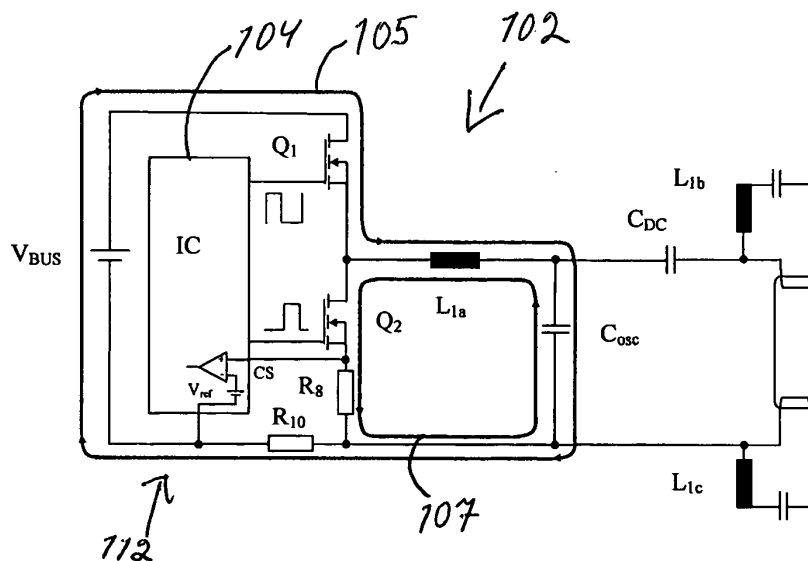


Fig. 2

Description

Field of the invention

[0001] Tubular fluorescent lamps and HID lamps (High Intensity Discharge) are connected by way of electronic ballasts with a supply of electric power, receiving therefrom the energy needed thereby for illumination while being switched to the ON state.

Prior art

[0002] The fluorescent tube of fluorescent lamps and HID lamps is filled with a gas, such as for example argon or krypton. The generation of light further requires "a drop" of mercury which gasifies in response to an electrical discharge, producing ultraviolet radiation as electricity discharges through the fluorescent lamp tube. The fluorescent lamp tube has its inner surface coated with a fluorescent material, converting the ultraviolet radiation, which has been generated by the electrical discharge taking place in mercury vapor, into visible light.

[0003] In addition to a fluorescent tube, the fluorescent lamp and the HID lamp comprise either an electronic ballast or a magnetic inductor. At present, magnetic inductors have been almost completely displaced by electronic ballasts. The current generated in electronic ballasts and flowing through a fluorescent lamp tube is generally 20-100 kHz in frequency, most typically 50-60 kHz.

[0004] Measuring the current of a switching transistor set against earth potential represents prior known technology on the basis of several examples. In fact, this particular method has been and is currently used in a multitude of electronic ballasts available in the marketplace. Publication WO2005/083872A1 comprises measuring the current of a first switching transistor set against earth potential, as well as the voltage of a midpoint between two switching transistors. However, no information can be obtained from this particular voltage about the current of a second switching transistor which is not set against earth potential. Accordingly, the signal produced in the process of measuring the voltage of said midpoint cannot be used as a signal on the basis of which said second switching transistor would be switched off in the event that its current exceeds a predetermined limit value.

[0005] Fig 1 shows a lamp according to the Finnish patent application 20075702, comprising a fluorescent tube 100, and an electronic ballast 102 which has a control circuit 104 integrated therewith so as to enable a measurement for providing separate measuring signals representing the currents of both an upper switching transistor Q1 and a lower switching transistor Q2. The embodiment shown in fig. 1 features a diode couple Q3a and Q3b, which enables a measurement of the current for an ignition capacitor C1 and measurements of the currents for the switching transistors Q1 and Q2 with one resistor R3. Drawbacks in this embodiment include slowness in the establishment of measuring signals and

thereby also in the status transitions of switching transistors based on said measuring signals, and instability in the magnitude of an ignition voltage established for the lamp. Another drawback in this embodiment is that, especially with large manufacturing volumes in mass production, the cost of diodes becomes high.

Brief description of the invention

[0006] An objective of the invention is to provide an electronic ballast assembly, which enables establishing a lamp ignition voltage in a rapid and controlled fashion. This is achieved with a lamp according to the invention for producing illuminating radiation, comprising an electronic ballast for establishing an ignition voltage for the lamp in order to initiate the production of illuminating radiation, said electronic ballast comprising at least two switching transistors Q1, Q2 for supplying current to at least one coil, which develops the lamp ignition voltage, and said electronic ballast having a control circuit integrated therewith. The electronic ballast comprises at least two resistors R8, R10 set in a series connection at least relative to each other for measuring and/or regulating the currents of said at least two switching transistors Q1, Q2, said resistor R8 being in connection with the switching transistor Q2, and the resistor R10 being in a series connection with the resistor R8 and with a voltage source, and said electronic ballast comprising the series connection of said resistors R8, R10 for operating said control circuit in order to detect whether the current passing through the switching transistor Q1 or Q2 is overly high with respect to a limit current value set for the control circuit, and by operating said control circuit, for immediately switching off the control of that switching transistor Q1 or Q2 which switching transistor Q1 or Q2 has been found to have an overly high passing current and for immediately switching on the current of the other switching transistor Q1 or Q2.

[0007] The invention is based on having the electronic ballast comprise at least two resistors R8, R10 set in a series connection relative to each other for measuring and/or regulating the currents of at least two switching transistors Q1, Q2 in such a way that the resistor R8 is in connection with the switching transistor Q2 and the resistor R10 is in a series connection with the resistor R8 and with a voltage source. This enables the elimination of a prior art diode connection, along with drawbacks associated therewith.

[0008] An advantage of the invention is that the establishment of a lamp ignition voltage is expedited in a stable manner. The invention provides economic benefit in terms of the manufacturing costs of ballasts.

List of figures

[0009]

Fig. 1 shows a lamp according to the prior art de-

scribed in patent application FI20075702.

Fig. 2 shows a lamp according to the invention.

Fig. 3 shows currents of the switching transistors Q_1 and Q_2 during the establishment of an ignition voltage in an embodiment according to the prior art.

Fig. 4 shows signals in an embodiment according to the invention during the establishment of an ignition voltage.

Fig. 5 shows an implementation according to a preferred embodiment of the invention pulse by pulse of the switching transistors Q_1 and Q_2 for establishing a current restriction.

Fig. 6 shows oscillator signals in a preferred embodiment of the invention.

Fig. 7 shows control signals for switching transistors and divider circuit output signals in a preferred embodiment of the invention.

Detailed description of the invention

[0010] Fig. 2 shows a lamp of the invention, which enables measuring a peak current for both switching transistors Q_1 , Q_2 and controlling the current pulse by pulse in such a way that, during the establishment of an ignition voltage for the lamp, the current remains essentially constant. As opposed to a prior art lamp shown in fig. 1, the lamp according to the invention makes use of a series connection of the resistors R_8 and R_{10} to establish connections, on the basis of which the prior art use of diodes is replaced by a configuration of improved performance.

[0011] The lamp according to the invention, as shown in fig. 2, includes an electronic ballast 102 comprising the resistors R_8 , R_{10} set in a series connection relative to each other for measuring and/or regulating the currents of the switching transistors Q_1 , Q_2 . The resistor R_8 is in connection with the switching transistor Q_2 and with a comparator connection 112 included in a control circuit 104. The resistor R_{10} is in a series connection with the resistor R_8 and with a voltage source V_{bus} . The electronic ballast 102 comprises the series connection of said resistors R_8 , R_{10} for operating the control circuit 104 through the intermediary of the comparator connection 112 for detecting whether an overly high current is passing through the switching transistor Q_1 or Q_2 to the control circuit 104. In this case, the control circuit 104 is operated for immediately switching off the control of that switching transistor Q_1 or Q_2 which switching transistor Q_1 or Q_2 has been found to have an overly high passing current and for immediately switching on the current of the other switching transistor Q_1 or Q_2 . In the process of switching on and during the switched-on period, the

switching transistor Q_1 or Q_2 is supplied for example with a current in pulse form. A current path 107 represents the route of current in the process of establishing a lamp ignition voltage preceding the lamp ignition as the switching transistor Q_2 is supplied with a current in pulse form.

[0012] Fig. 3 shows currents during a switched-on state of the switching transistors Q_1 , Q_2 as the ignition voltage is developing in the prior art embodiment of fig. 1. Fig. 4 shows signals I_1 during a switched-on state of the switching transistors Q_1 , Q_2 over a current path 105 while Q_1 is on, and I_2 over a current path 107 while Q_2 is on, in the embodiment of fig. 2 according to the invention as the ignition voltage is developing. A pulse form current I_k in fig. 4 represents the output of a current measuring comparator A_1 , which rises up when the current of either switching transistor Q_1 or Q_2 rises over a limit value 120 set for the control circuit 104 and indicated by a dashed line. The regulation setup according to the invention enables controlling the current even upon the saturation of a coil L_1 . In figs. 2 and 5, the coil L_1 is depicted in a distributed fashion as coils L_{1a} , L_{1b} and L_{1c} . Fig. 4 illustrates said currents I_1 and I_2 of the switching transistors Q_1 and Q_2 , which are proportional to the voltage of a CS pin marked in figs. 2 and 5 in the size ratio of the resistors R_8 and R_{10} . Designated in fig. 4 is also a reference voltage V_{comp} of the current measuring comparator A_1 . When this reference voltage is crossed, there will be a change in the output state of the current measuring comparator A_1 .

[0013] Fig. 5 shows an implementation according to a preferred embodiment of the invention for establishing a pulse-by-pulse current restriction for the switching transistors Q_1 and Q_2 .

[0014] Fig. 6 shows oscillator signals relevant to the preferred embodiment of the invention shown in fig. 5.

[0015] Fig. 7 shows control signals for the switching transistors Q_1 , Q_2 and output signals for a distribution circuit 116, also relevant to fig. 5. In the circuitry depicted in fig. 5, an oscillator comparator A_2 functions as a monitor for the voltage between a capacitor C_f and a resistor R_f . When the resistor R_f discharges the charge of the capacitor C_f and the voltage falls below a reference V_{ref2} , the comparator A_2 triggers an RS flip-flop 121. Thus, the output of the flip-flop 121 rises up and the capacitor C_f is charged by a transistor Q_4 back to a circuit operating voltage V_{cc} . The flip-flop output also controls the divider circuit 116, whose complemented outputs operate at a frequency which is half of that of an oscillator circuit 114.

[0016] In further reference to figs. 5, 6 and 7, with the current measuring comparator A_1 in its active state, i.e. when the current limit set for the switching transistors Q_1 and Q_2 has been crossed, the negative input of the oscillator comparator A_2 is pulled down by the current measuring comparator A_1 through the intermediary of a transistor Q_3 and the RS flip-flop 121 is triggered before the oscillator in a prior art solution would be triggered. Thus, in a preferred embodiment of the invention, the lamp ballast 102 has its circuitry maintained at a frequen-

cy level which is higher than it would be if defined solely by the resistor R_f and the capacitor C_f . This enables reaching a status in which the lamp ignition voltage maintains a constant level, even in the event that the coil L1 (L1A, LIB, L1C) of the lamp circuit becomes saturated.

[0017] With regard to what is depicted in fig. 5, there is shown in fig. 6 a negative input or an input signal for the oscillator comparator A_2 as said input signal of oscillator comparator A_2 is driven downward by the output of the current measuring comparator A_1 after the limit current value has been crossed, i.e. in other words, fig. 6 illustrates the signals of the oscillator circuit 114 when operating within a current restriction range of the switching transistors Q1, Q2, preferably set for the control circuit 104. Relating also to fig. 5, there is shown in fig. 7 output voltages V_{div1} , V_{div2} for the divider circuit 116, and control voltages V_{drvQ1} , V_{drvQ2} for the switching transistors which contain a dead time between a switch-off moment of the first switching transistor Q1 or Q2 and a switch-on moment of the second switching transistor Q1 or Q2.

[0018] The lamp comprises some of its circuit implementations in the form of an IC circuit (Integrated Circuits) and, in combination therewith, the rest of its circuit implementation in the form of at least one different circuit topology. The IC circuit (Integrated circuits) can be provided for example in the form of a resistor-capacitor oscillator (RC oscillator). IC circuits are generally prefabricated entities with other circuitry connected to the inputs and/or outputs thereof. Aspects of the invention can also be carried out with any type of circuit topology, such as for example discrete components, ASIC circuits (Application Specific Integrated Circuits) or IC circuits or various combinations thereof.

[0019] Although the invention has been described in the foregoing specification with reference to circuit diagrams and signal examples illustrated in the figures, the invention is not limited to the circuit diagrams and signal examples presented in the specification and figures, but the invention can be varied within the scope defined in the appended claims. One notable example is that the order of a capacitor C_{dc} and a fluorescent tube 100 in the series connection can be other than what is illustrated without the reversal having any essential effect on the functionality of this embodiment of the invention. Respectively, other circuit combinations and component types existing within the limits defined by the appended claims can also be applicable as implementations according to the invention. In various embodiments of the invention, the lamp can be for example a fluorescent lamp or an HID lamp, i.e. a high intensity discharge lamp.

Claims

1. A lamp for producing illuminating radiation, said lamp comprising an electronic ballast (102) for establishing an ignition voltage for the lamp in order to initiate the production of illuminating radiation, said elec-

tronic ballast (102) comprising at least two switching transistors (Q1, Q2) for supplying current to at least one coil (L1) which develops the lamp ignition voltage, and the electronic ballast (102) having a control circuit (104) integrated therewith, **characterized in that** the electronic ballast (102) comprises at least two resistors R8 and R10 arranged at least in a series connection relative to each other for measuring and/or regulating the currents of said at least two switching transistors Q1 and Q2, said resistor R8 being in connection with the switching transistor Q2 and the resistor R10 being in a series connection with the resistor R8 and with a voltage source, and said electronic ballast (102) comprising the series connection of said resistors R8 and R10 for operating said control circuit (104) in order to detect whether a current passing through the switching transistor Q1 or Q2 is overly high with respect to a limit current value set for the control circuit, and by operating said control circuit (104), for immediately switching off the control of that switching transistor Q1 or Q2 which switching transistor Q1 or Q2 has been found with an overly high passing current and for immediately switching on the current of the other switching transistor Q1 or Q2.

2. A lamp according to claim 1, **characterized in that** the lamp is a fluorescent lamp.
3. A lamp according to claim 1, **characterized in that** the lamp is an HID (High Intensity Discharge) lamp.
4. A lamp according to claim 1, **characterized in that** the control circuit (104) comprises a comparator connection (112) coupled with the resistor R8 for maintaining the lamp ignition voltage in a substantially constant magnitude, said comparator connection comprising a current measuring comparator A1 coupled with the resistor R8 and a transistor Q3 coupled with the current measuring comparator A1 by way of a resistor R11.
5. A lamp according to claim 3, **characterized in that** the electronic ballast (102) comprises said comparator connection (112) coupled with the resistor R8 for maintaining the lamp ignition voltage in a substantially constant intensity in the event that the at least one coil L1, comprised by the electronic ballast (102), becomes essentially saturated.
6. A lamp according to claim 1, **characterized in that** the lamp comprises some of its circuit configurations in the form of an IC circuit (Integrated Circuits), and in combination therewith, the rest of its circuit implementation in the form of at least one different circuit topology.
7. A lamp according to claim 6, **characterized in that**

the lamp comprises, functioning as an IC circuit (Integrated Circuits), a resistor-capacitor oscillator (RC oscillator).

5

10

15

20

25

30

35

40

45

50

55

5

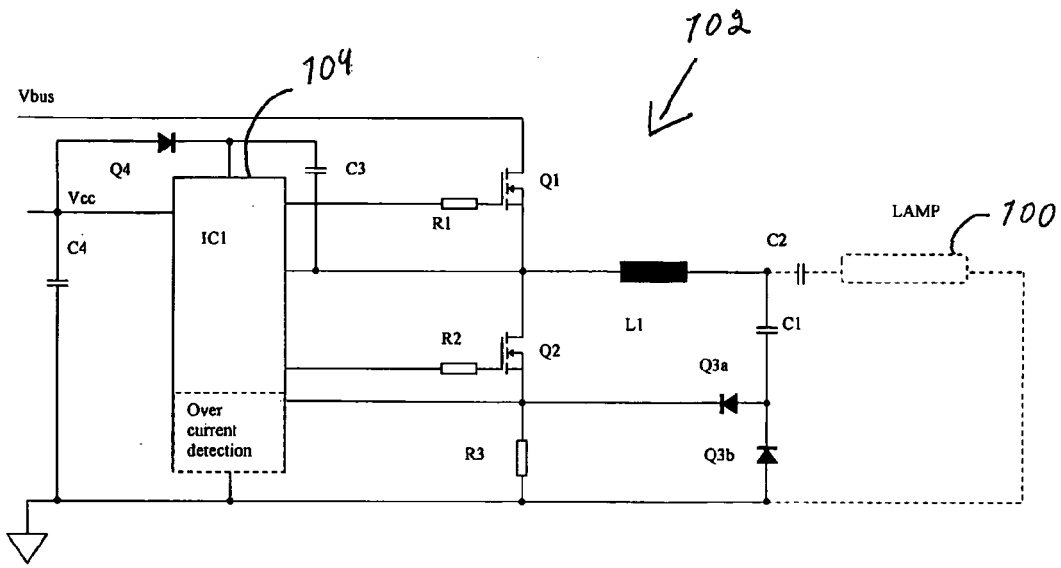


Fig. 1

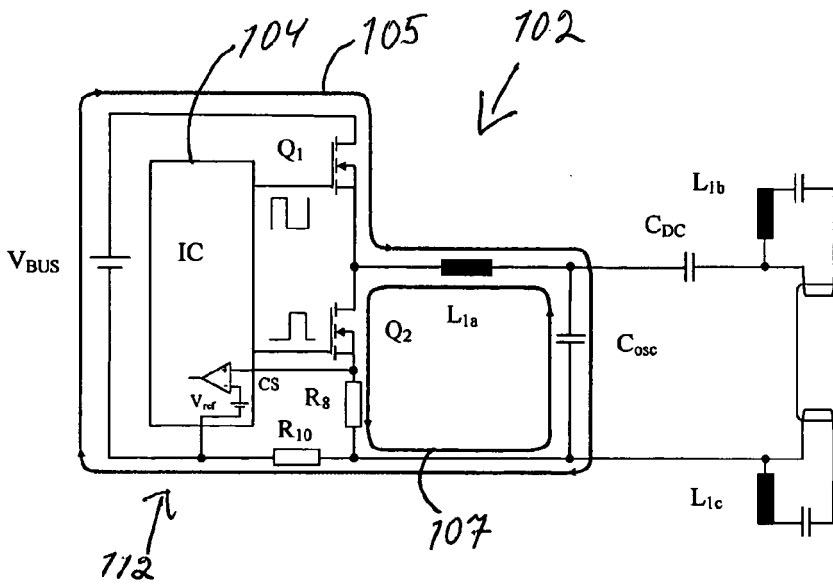


Fig. 2

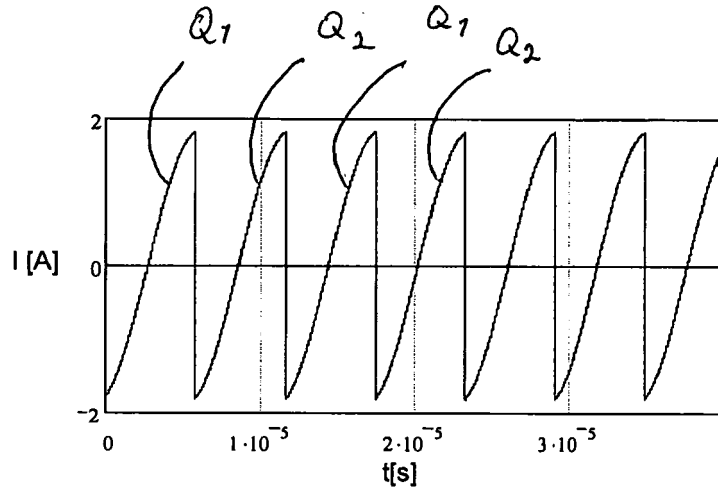


Fig. 3

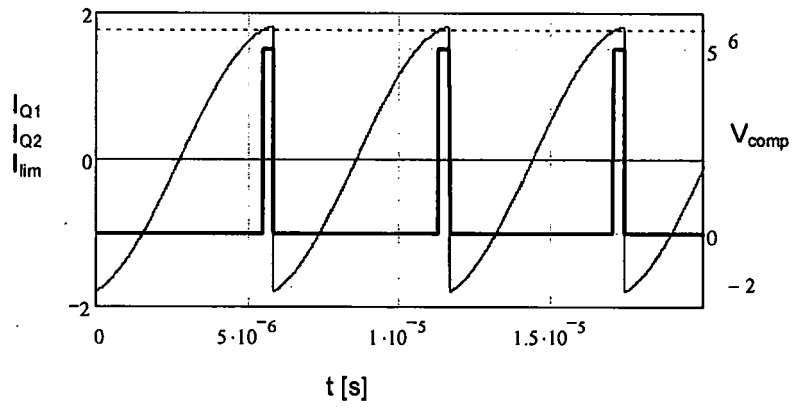


Fig. 4

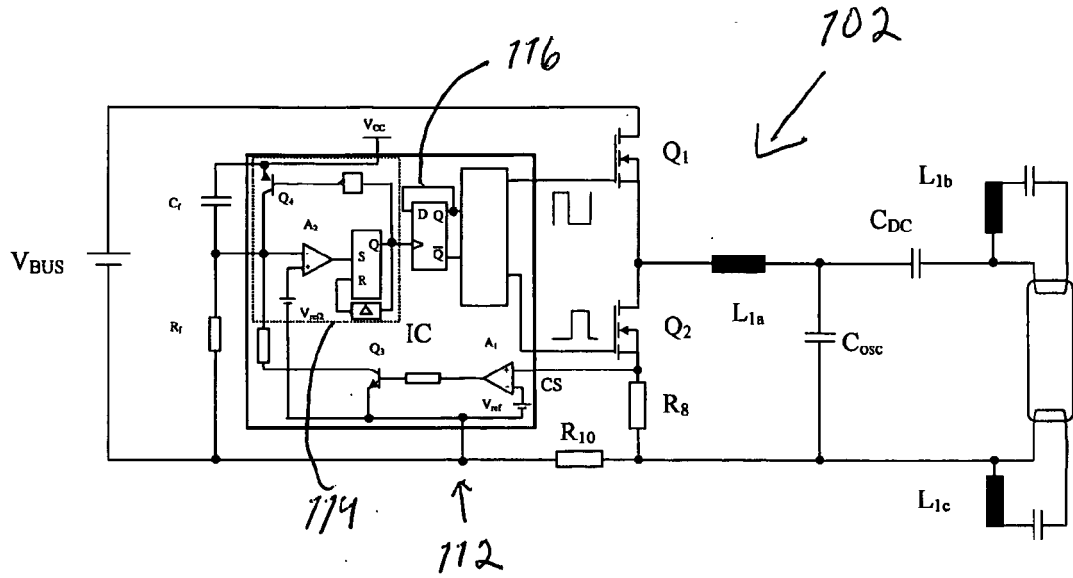


Fig. 5

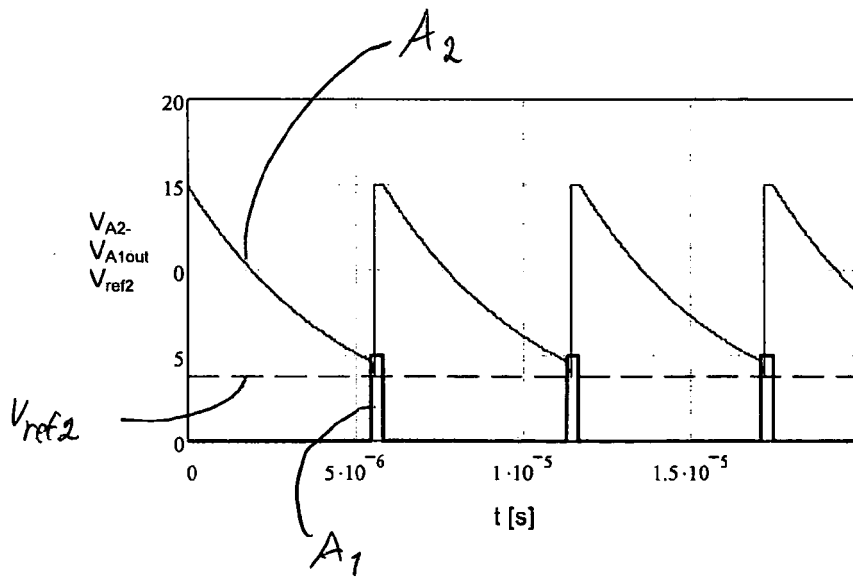


Fig. 6

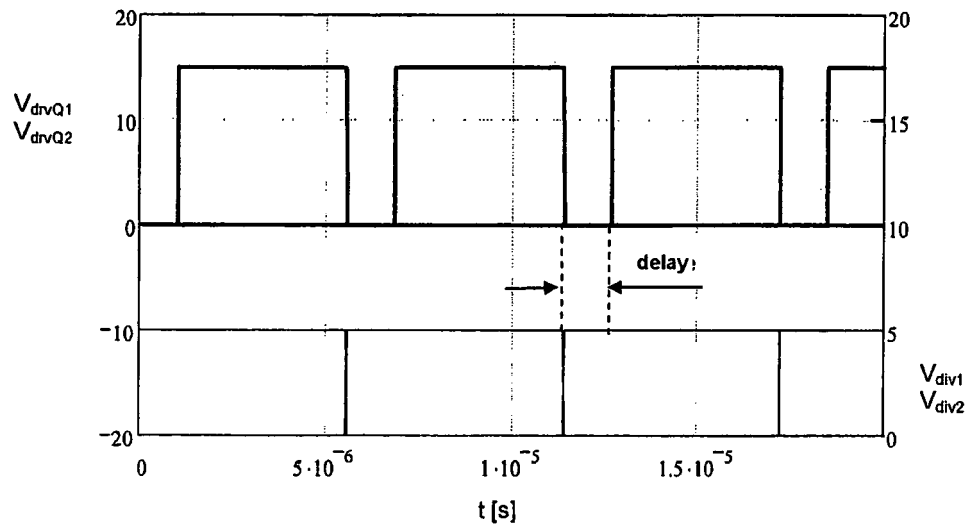


Fig. 7

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 2005083872 A1 [0004]
- FI 20075702 [0005] [0009]