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(54) Title: APPARATUS FOR DRIVING LOAD VIA CONVERTER

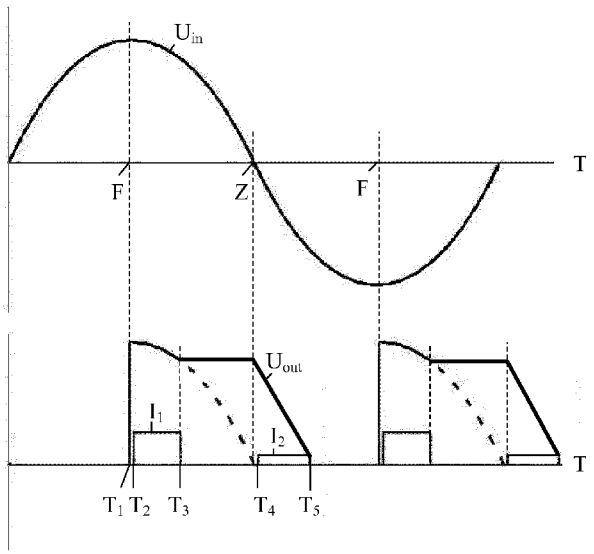

Fig. 2

(57) Abstract: Apparatuses (1, 2) for driving loads (3) via converters (4) comprise first circuits (1) for interfacing phase-cut dimmers (5) and the converters (4). Firing angles of the phase-cut dimmers (5) correspond with first moments in time during periods of voltage signals presented to the phase-cut dimmers (5). The converters (4) draw first current signals from second until third moments in time during the periods. Second circuits (2) control the converters (4) to draw second current signals from fourth until fifth moments in time during the periods, to improve an energy efficiency. The first current signals may be delivered by supplies (6). The second current signals may be delivered by output capacitors (32, 34, 35) of the first circuits (1). The third moments in time may be adaptable. One or more of the first and second and third moments in time may be situated before a zero-crossing of the voltage signal and one or more of the fourth and fifth moments in time may be situated after the zero-crossing. The first circuit (1) comprises a rectifier (11-14) with first and second inputs arranged to be coupled to first and second outputs of the phase-cut dimmer (5) and a filter (31-35) coupled to the rectifier (11-14), the filter (31-35) comprising the one or more output capacitors (32, 34, 35). The first circuit further comprises: a first diode (21) with a first electrode coupled to a first output of the rectifier (11-14) and with a second electrode coupled to the filter (31-35), and a bleeder (41-47) with a main current path (41-43) coupled to the first electrode of the first diode (21) and to the second output of the rectifier (11-14) and with a bias current path (44-47) coupled to the second electrode of the first diode (21) and to the second output of the rectifier (11-14). By withdrawing a bleeder current using the bleeder (41-47), the time-interval during which a current is withdrawn from the phase-cut dimmer (5) may be extended.

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Apparatus for driving load via converter

FIELD OF THE INVENTION

The invention relates to an apparatus for driving a load via a converter. The invention further relates to first and second devices and to a method.

Examples of such a device are converters and loads and phase-cut dimmers. Examples of such a load are light circuits comprising one or more light emitting diodes of whatever kind and in whatever combination.

BACKGROUND OF THE INVENTION

US 2013 / 0021828 A1 discloses an on-time extension for non-dissipative bleeding in a power supply.

US 2011 / 0199017 A1 discloses a circuit for driving luminous means. The circuit interfaces a dimmer and a converter and comprises a rectifier and a capacitor. During a first interval a first current signal is provided to the converter and during a second interval, controlled by a second circuit, a second current signal is provided to the converter.

SUMMARY OF THE INVENTION

It is an object of the invention to provide an improved apparatus. It is a further object of the invention to provide improved devices and an improved method.

According to a first aspect, an apparatus is provided for driving a load via a converter, the apparatus comprising:

- a first circuit for interfacing a phase-cut dimmer and the converter, a firing angle of the phase-cut dimmer corresponding with a first moment in time during a period of a voltage signal presented to the phase-cut dimmer, and the converter being arranged to draw a first current signal from a second moment in time until a third moment in time during the period of the voltage signal, the first circuit comprising a rectifier with first and second inputs arranged to be coupled to first and second outputs of the phase-cut dimmer and a filter coupled to the rectifier, the filter comprising one or more output capacitors, and

- a second circuit for controlling the converter to draw a second current signal from a fourth moment in time until a fifth moment in time during the period of the voltage signal, the fourth and fifth moments in time being situated after the third moment in time,

wherein the first circuit further comprises:

- a first diode with a first electrode coupled to a first output of the rectifier and with a second electrode coupled to the filter, and

a bleeder with a main current path coupled to the first electrode of the first diode and to the second output of the rectifier and with a bias current path coupled to the second electrode of the first diode and to the second output of the rectifier.

A first circuit interfaces a phase-cut dimmer and a converter. The phase-cut dimmer comprises for example a thyristor dimmer or a triac dimmer etc. The converter comprises for example a buck converter or a boost converter or a buck-boost converter or a flyback converter or a switch mode converter etc. A firing angle of the phase-cut dimmer corresponds with a first moment in time during a period of a voltage signal that is presented to and present across inputs of the phase-cut dimmer. At the first moment in time as defined by the firing angle, the phase-cut dimmer goes from a non-conductive state into a conductive state, until the voltage signal crosses zero. The converter is arranged to draw a first current signal from a second moment in time until a third moment in time during the period of the voltage signal. The second moment in time is situated on or after the first moment in time. By having introduced a second circuit for controlling the converter to draw a second current signal from a fourth moment in time until a fifth moment in time during the period of the voltage signal, which fourth and fifth moments in time are situated after the third moment in time, an efficiency of a combination of the apparatus and the converter can be improved when used in combination with the phase-cut dimmer. Such an improved efficiency is a great advantage.

Certain phase-cut dimmers require a bleeder for extending a time-interval during which a current signal flows through the phase-cut dimmer. By having located a main current path of the bleeder before the first diode and by having located a bias current path of the bleeder behind the first diode, the first diode will prevent that the one or more output capacitors can be discharged by the main current path of the bleeder. As a result, most energy stored in the one or more output capacitors becomes available to the converter and can be used between the fourth and fifth moments in time. The amount of energy dissipated by the bias current path of the bleeder is negligible.

Usually, the first to fifth moments in time will each occur twice during a period of the voltage signal presented to the phase-cut dimmer, for a period that is considered to be started with the firing angle or the first moment in time. Usually, this voltage signal will have a sine wave shape comprising a positive half sine wave and a negative half sine wave, and an output signal of the phase-cut dimmer will comprise a part of the positive half sine wave and a part of the negative half sine wave etc.

An embodiment of the apparatus is defined by the first circuit comprising one or more output capacitors, the first current signal being drawn via the first circuit and via the phase-cut dimmer from a supply, and the second current signal being drawn from the one or more output capacitors of the first circuit. By drawing the second current signal from one or more output capacitors of the first circuit, an amount of energy stored in the one or more output capacitors is used to improve said efficiency.

An embodiment of the apparatus is defined by the third moment in time being an adaptable moment in time, and the second circuit being arranged to adapt a next third moment in time in dependence of an amount of energy transferred via the second current signal. In this case, the converter is arranged to reduce an amount of time present between the second and third moments in time and to thereby reduce an amount of energy transferred via the first current signal, which improves said efficiency.

An embodiment of the apparatus is defined by the third moment in time being an adaptable moment in time, and the second circuit comprising an adaptor for adapting a next third moment in time in dependence of an amount of energy transferred via the second current signal. In this case, the second circuit comprises an adaptor arranged to reduce an amount of time present between the second and third moments in time and to thereby reduce an amount of energy transferred via the first current signal, which improves said efficiency.

An embodiment of the apparatus is defined by the first and second and third moments in time being situated before a zero-crossing of the voltage signal, the fourth moment in time being situated on or after the zero-crossing of the voltage signal and the fifth moment in time being situated after the zero-crossing of the voltage signal and before a next first moment in time corresponding with a next firing angle. Before a zero-crossing of the voltage signal, between the second and third moments in time, the converter draws the first current signal from the supply. After the zero-crossing, between the fourth and fifth moments in time, the converter draws the second current signal from the one or more output capacitors of the first circuit. The zero-crossing is a clear borderline: Until the zero-crossing, the supply can deliver the first current signal, and after the zero-crossing, the supply cannot deliver the

first current signal, owing to the fact that the phase-cut dimmer is still in a non-conductive state due to a next firing angle not yet having occurred, and the second current signal is to be delivered by the one or more output capacitors.

An embodiment of the apparatus is defined by the second circuit comprising a zero-crossing estimator for estimating the zero-crossing and an activator for in response to an estimation result from the zero-crossing estimator activating the converter. A zero-crossing estimator estimates the zero-crossing and an activator activates the converter in response to an estimation result from the estimator.

A rectifier such as for example a rectifier bridge may for example comprise four diodes without having excluded other rectifiers. A filter may comprise one or more output capacitors, and a first diode may prevent that the one or more output capacitors can be discharged by circuitry present near the rectifier. As a result, all energy stored in the one or more output capacitors becomes available to the converter and can be used between the fourth and fifth moments in time.

An embodiment of the apparatus is defined by the main current path of the bleeder comprising a serial connection of a first resistor and main electrodes of a transistor and a current source for defining a bleeder current signal, and the bias current path comprising a serial connection of a second resistor and a voltage defining element, a common point of the second resistor and the voltage defining element being coupled to a control electrode of the transistor via a second diode, the control electrode of the transistor being coupled to the second output of the rectifier via a biasing capacitor. The transistor may include one transistor or may comprise a combination of two or more transistors. This is a simple and low cost embodiment, whereby it must be noted that each element of the bleeder may be looked at independently from all other elements.

An embodiment of the apparatus is defined by the first circuit not comprising a resistor coupled in parallel to the first diode, or the first circuit comprising a third resistor having a value larger than 100 kΩ coupled in parallel to the first diode. If present, a value of the third resistor may preferably be chosen larger than 500 kΩ, and may more preferably be chosen larger than 1 MΩ.

An embodiment of the apparatus is defined by the filter further comprising an inductor with a first terminal coupled to the second electrode of the first diode and with a

second terminal arranged to be coupled to a first input of the converter, the second electrode of the first diode being coupled to the second output of the rectifier via a parallel connection of a first output capacitor and a serial connection of a fourth resistor and a second output capacitor, and the second terminal of the inductor being coupled to the second output of the rectifier via a third output capacitor, the second output of the rectifier being arranged to be coupled to a second input of the converter. The filter has two functions, firstly a storage of energy in the one or more output capacitors and secondly a reduction of electromagnetic interference. This is a simple and low cost embodiment, whereby it must be noted that each element of the filter may be looked at independently from all other elements.

An embodiment of the apparatus is defined by the first circuit further comprising

- a first series damper resistor arranged to be coupled to the first output of the phase-cut dimmer and to the first input of the rectifier, and/or
- a second series damper resistor arranged to be coupled to the second output of the phase-cut dimmer and to the second input of the rectifier, and/or
- a voltage dependent resistor arranged to be coupled to the first and second outputs of the rectifier.

The series damper resistors offer serial damping and the voltage dependent resistor offers protection against transient voltages. Alternative damping solutions and alternative protecting solutions are not to be excluded.

According to a second aspect, a first device is provided comprising the apparatus as defined above and further comprising the converter and/or the load. Further, one or more parts of the apparatus or the entire apparatus may be located inside the converter and/or inside the load. Embodiments of the first device correspond with embodiments of the apparatus.

According to a third aspect, a second device is provided comprising the apparatus as defined above and further comprising the phase-cut dimmer. Further, one or more parts of the apparatus or the entire apparatus may be located inside the phase-cut dimmer. Embodiments of the second device correspond with embodiments of the apparatus.

According to a fourth aspect, a method is provided for driving a load via a phase-cut dimmer and via a converter, a firing angle of the phase-cut dimmer corresponding with a first moment in time during a period of a voltage signal presented to the phase-cut dimmer, and the converter being arranged to draw in a first step via a first circuit a first current signal from a second moment in time until a third moment in time during the period

of the voltage signal, the method comprising a second step of controlling by a second circuit the converter to draw via the first circuit a second current signal from a fourth moment in time until a fifth moment in time during the period of the voltage signal, the fourth and fifth moments in time being situated after the third moment in time, and the additional step of extending the time-interval during which a current is withdrawn from the phase-cut dimmer by withdrawing a bleeder current by a bleeder.

An insight is that by providing a first diode and a bleeder, the first diode will prevent that the one or more output capacitors can be discharged by the main current path of the bleeder. As a result, most energy stored in the one or more output capacitors becomes available to the converter and can be used between the fourth and fifth moments in time. The amount of energy dissipated by the bias current path of the bleeder is negligible.

A problem to provide an improved apparatus has been solved. A further advantage is that energy can be used more efficiently, which is of great importance.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

Fig. 1 shows an embodiment of an apparatus,

Fig. 2 shows waveforms, and

Fig. 3 shows an overview.

DETAILED DESCRIPTION OF EMBODIMENTS

In the Fig. 1, an embodiment of an apparatus 1, 2 is shown coupled to a phase-cut dimmer 5 and to a converter 4. In a first circuit 1 of the apparatus 1, 2, first and second outputs of the phase-cut dimmer 5 are coupled via first and second series damper resistors 51, 52 to first and second inputs of a rectifier 11-14 here for example comprising four diodes 11-14 in a rectifier bridge. A first output of the rectifier 11-14 is coupled to an anode of a diode 21. A cathode of the diode 21 is coupled to a first terminal of an inductor 31, and a second terminal of the inductor 31 is coupled to a first input of the converter 4.

The first output of the rectifier 11-14 is coupled via a voltage dependent resistor 53 to a second output of the rectifier 11-14. The first output of the rectifier 11-14 is further coupled via a main current path 41-43 of a bleeder 41-47 to the second output of the rectifier 11-14. The main current path 41-43 comprises a serial connection of a resistor 41,

main electrodes of a transistor 42 and a current source 43 for defining a bleeder current signal. The cathode of the diode 21 is further coupled via a bias current path 44-47 of the bleeder 41-47 to the second output of the rectifier 11-14. The bias current path 44-47 comprises a serial connection of a resistor 44 and a voltage defining element 45 such as for example a zener diode. A common point of this serial connection is coupled via a diode 46 to a control electrode of the transistor 42. This control electrode is further coupled via a capacitor 47 to the second output of the rectifier 11-14. The cathode of the diode 21 is further coupled via a parallel connection of a capacitor 32 and a serial connection comprising a resistor 33 and a capacitor 34 to the second output of the rectifier 11-14. The second terminal of the inductor 31 is further coupled via a capacitor 35 to the second output of the rectifier 11-14, which is further coupled to a second input of the converter 4. The elements 31-35 form a filter 31-35.

The apparatus 1, 2 further comprises a second circuit 2 comprising an adaptor 61, a zero-crossing estimator 62 with one or more inputs to be coupled to one or more of the inputs or to one or more of the outputs of the rectifier 11-14 and/or a zero-crossing estimator 63 with one or more inputs to be coupled to one or more inputs or to one or more of the outputs of the phase-cut dimmer 5, an activator 64 with one or more outputs to be coupled to one or more control inputs of the converter 4 and a storage medium 65. Each one of the units 61-65 is coupled to a controller 66. Alternatively, the controller 66 may be partially or fully integrated into one or more of the units 61-65, or one or more of the units 61-65 may be partially or fully integrated into the controller 66.

In the Fig. 2, waveforms are shown. In the upper graph, a voltage signal U_{in} is shown versus time T. The voltage signal U_{in} is presented to and present across the inputs of the phase-cut dimmer 5. The phase-cut dimmer 5 is considered to be fired at a firing angle F. The voltage signal U_{in} shows some time after the firing angle F a zero-crossing Z. In the lower graph, a voltage signal U_{out} is shown versus time T. The voltage signal U_{out} is present across the capacitor 32 or 35. Clearly, this voltage signal U_{out} is unequal to zero from the firing angle F to the zero-crossing Z, owing to the fact that the phase-cut dimmer 5 is in a conductive state from the firing angle F to the zero-crossing Z. This voltage signal U_{out} is further unequal to zero during a subsequent time-interval situated after the zero-crossing Z, as discussed below. In the lower graph, further a first current signal I_1 and a second current signal I_2 are shown.

In the prior art, wherein the firing angle F of the phase-cut dimmer 5 is considered to correspond with a first moment in time T_1 during a period of the voltage signal U_{in}, the converter 4 will draw the first current signal I_1 from a second moment in time T_2 until

a third moment in time T_3 during the period of the voltage signal U_{in} as shown in the lower graph of the Fig. 2. The second moment in time T_2 is situated on or after the first moment in time T_1. The third moment in time T_3 is situated after the second moment in time T_2. After the zero-crossing Z, until a next firing angle F, the phase-cut dimmer 5 is in a non-conductive state, and from the zero-crossing Z to the next firing angle F, energy cannot be supplied to the converter 4 via the phase-cut dimmer 5. However, energy might still be present inside the first circuit 1. Unfortunately, this energy still present inside the first circuit 1 is not used very efficiently in this prior art configuration.

According to the invention, the second circuit 2 controls the converter 4 to draw a second current signal I_2 from a fourth moment in time T_4 until a fifth moment in time T_5 during the period of the voltage signal U_{in}. These fourth and fifth moments in time T_4 and T_5 are, as shown in the lower graph of the Fig. 2, situated after the third moment in time T_3. As a result, energy that is still present in the first circuit 1 can be used, for example from the zero-crossing Z to the next firing angle F, and this is a great improvement of an energy efficiency of a combination of the apparatus 1, 2 and the converter 4.

At the third moment in time T_3, the converter 4 stops drawing the first current signal I_1. From the third moment in time T_3 until the fourth moment in time T_4, the voltage signal U_{out} substantially keeps its value, owing to the fact that the output capacitors 32, 34, 35 are keeping their charges. From the fourth moment in time T_4 until the fifth moment in time T_5, the voltage signal U_{out} drops to zero in a substantially linear way (in the exemplary case that the converter 4 is drawing a relatively constant current signal), owing to the fact that the output capacitors 32, 34, 35 are being discharged.

Preferably, for the first circuit 1 for example comprising one or more output capacitors 32, 34, 35, the first current signal I_1 may be drawn via the first circuit 1 and via the phase-cut dimmer 5 from a supply 6 shown in the Fig. 3, and the second current signal I_2 may be drawn from the one or more output capacitors 32, 34, 35 of the first circuit 1.

Preferably, the third moment in time T_3 may be an adaptable moment in time, whereby the converter 4 may thereto be arranged to adapt a next third moment in time in dependence of an amount of energy transferred via the second current signal I_2. In other words, a first amount of energy supplied via the phase-cut dimmer 5 may be reduced to compensate for a second amount of energy retrieved between the zero-crossing Z and the next firing angle F.

Preferably, the third moment in time T_3 may be an adaptable moment in time, whereby the second circuit 2 may thereto comprise the adaptor 61 for adapting a next third

moment in time in dependence of an amount of energy transferred via the second current signal I_2. In other words, a first amount of energy supplied via the phase-cut dimmer 5 may be reduced to compensate for a second amount of energy retrieved from the zero-crossing Z to the next firing angle F. The adaptor 61 may thereto comprise a calculator and may thereto communicate with the storage medium 65. The storage medium 65 may store (definitions or representations of) the moments in time and (definitions or representations of) zero-crossings and (definitions or representations of) firing angles and (definitions or representations of) calculation results etc.

Usually, the first and second and third moments in time T_1 and T_2 and T_3 may be situated before the zero-crossing Z of the voltage signal U_{in}, and the fourth moment in time T_4 may be situated on or after the zero-crossing Z of the voltage signal U_{in} and the fifth moment in time T_5 may be situated after the zero-crossing Z of the voltage signal U_{in} and before a next first moment in time corresponding with a next firing angle F. Such a zero-crossing Z is relatively easy to estimate or to detect and forms a good point of reference. The second circuit 2 may thereto comprise a zero-crossing estimator 62 and/or 63 for estimating the zero-crossing Z and an activator 64 for in response to an estimation result from the estimator 62 and/or 63 activating the converter 4 to draw the second current signal I_2.

The amount of time between the first moment in time T_1 and the second moment in time T_2 is usually defined by properties of the first circuit 1 and/or by properties of the converter 4 and/or by the converter 4. The third moment in time T_3 is defined by the second circuit 2 and/or by the converter 4. The fourth moment in time T_4 is defined by the second circuit 2. The fifth moment in time T_5 is defined by the second circuit 2 or by the converter 4 or by the fact that all energy present in the output capacitors 32, 34 and/or 35 has been used.

In the Fig. 3, an overview is shown. A supply 6 such as a mains supply or such as a source is coupled to an input of a phase-cut dimmer 5. A load 3 for example comprising a light circuit is coupled to an output of a converter 4. A first circuit 1 interfaces the phase-cut dimmer 5 and the converter 4. A second circuit 2 controls the converter 4 in response to a communication with the first circuit 1 and/or with the phase-cut dimmer 5.

First and second elements can be coupled directly without a third element being in between or can be coupled indirectly via a third element. An estimation may comprise a relatively rough estimation or a relatively precise estimation or a detection. The contents of the first and second circuits 1 and 2 shown in the Fig. 1 are examples only.

Summarizing, apparatuses 1, 2 for driving loads 3 via converters 4 comprise first circuits 1 for interfacing phase-cut dimmers 5 and the converters 4. Firing angles of the phase-cut dimmers 5 correspond with first moments in time during periods of voltage signals presented to the phase-cut dimmers 5. The converters 4 draw first current signals from second until third moments in time during the periods. Second circuits 2 control the converters 4 to draw second current signals from fourth until fifth moments in time during the periods, to improve an energy efficiency. The first current signals may be delivered by supplies 6. The second current signals may be delivered by output capacitors 32, 34, 35 of the first circuits 1. The third moments in time may be adaptable. One or more of the first and second and third moments in time may be situated before a zero-crossing of the voltage signal and one or more of the fourth and fifth moments in time may be situated after the zero-crossing.

While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

CLAIMS:

1. An apparatus (1, 2) for driving a load (3) via a converter (4), the apparatus (1, 2) comprising:

- a first circuit (1) for interfacing a phase-cut dimmer (5) and the converter (4), a firing angle of the phase-cut dimmer (5) corresponding with a first moment in time during a period of a voltage signal presented to the phase-cut dimmer (5), and the converter (4) being arranged to draw a first current signal from a second moment in time until a third moment in time during the period of the voltage signal, the first circuit (1) comprising a rectifier (11-14) with first and second inputs arranged to be coupled to first and second outputs of the phase-cut dimmer (5) and a filter (31-35) coupled to the rectifier (11-14), the filter (31-35) comprising one or more output capacitors (32, 34, 35), and

- a second circuit (2) for controlling the converter (4) to draw a second current signal from a fourth moment in time until a fifth moment in time during the period of the voltage signal, the fourth and fifth moments in time being situated after the third moment in time,

wherein the first circuit further comprises:

- a first diode (21) with a first electrode coupled to a first output of the rectifier (11-14) and with a second electrode coupled to the filter (31-35), and

- a bleeder (41-47) with a main current path (41-43) coupled to the first electrode of the first diode (21) and to the second output of the rectifier (11-14) and with a bias current path (44-47) coupled to the second electrode of the first diode (21) and to the second output of the rectifier (11-14).

2. The apparatus (1, 2) as defined in claim 1, the first current signal being drawn via the first circuit (1) and via the phase-cut dimmer (5) from a supply (6), and the second current signal being drawn from the one or more output capacitors (32, 34, 35) of the first circuit (1).

3. The apparatus (1, 2) as defined in claim 1, the third moment in time being an adaptable moment in time, and the second circuit (2) being arranged to adapt a next third

moment in time in dependence of an amount of energy transferred via the second current signal.

4. The apparatus (1, 2) as defined in claim 1, the second circuit (2) comprising an adaptor (61) for adapting a next third moment in time in dependence of an amount of energy transferred via the second current signal.

5. The apparatus (1, 2) as defined in claim 1, the first and second and third moments in time being situated before a zero-crossing of the voltage signal, the fourth moment in time being situated on or after the zero-crossing of the voltage signal and the fifth moment in time being situated after the zero-crossing of the voltage signal and before a next first moment in time corresponding with a next firing angle.

6. The apparatus (1, 2) as defined in claim 5, the second circuit (2) comprising a zero-crossing estimator (62, 63) for estimating the zero-crossing and an activator (64) for in response to an estimation result from the zero-crossing estimator (62, 63) activating the converter (4).

7. The apparatus (1, 2) as defined in claim 1, the main current path (41-43) of the bleeder (41-47) comprising a serial connection of a first resistor (41) and main electrodes of a transistor (42) and a current source (43) for defining a bleeder current signal, and the bias current path (44-47) comprising a serial connection of a second resistor (44) and a voltage defining element (45), a common point of the second resistor (44) and the voltage defining element (45) being coupled to a control electrode of the transistor (42) via a second diode (46), the control electrode of the transistor (42) being coupled to the second output of the rectifier (11-14) via a biasing capacitor (47).

8. The apparatus (1, 2) as defined in claim 1, the first circuit (1) not comprising a resistor coupled in parallel to the first diode (21), or the first circuit comprising a third resistor having a value larger than 100 kΩ coupled in parallel to the first diode (21).

9. The apparatus (1, 2) as defined in claim 1, the filter (31-35) further comprising an inductor (31) with a first terminal coupled to the second electrode of the first diode (21) and with a second terminal arranged to be coupled to a first input of the converter (4), the

second electrode of the first diode (21) being coupled to the second output of the rectifier (11-14) via a parallel connection of a first output capacitor (32) and a serial connection of a fourth resistor (33) and a second output capacitor (34), and the second terminal of the inductor (31) being coupled to the second output of the rectifier (11-14) via a third output capacitor (35), the second output of the rectifier (11-14) being arranged to be coupled to a second input of the converter (4).

10. The apparatus (1, 2) as defined in claim 1, the first circuit (1) further comprising:

- a first series damper resistor (51) arranged to be coupled to the first output of the phase-cut dimmer (5) and to the first input of the rectifier (11-14), and/or
- a second series damper resistor (52) arranged to be coupled to the second output of the phase-cut dimmer (5) and to the second input of the rectifier (11-14), and/or
- a voltage dependent resistor (53) arranged to be coupled to the first and second outputs of the rectifier (11-14).

11. A first device comprising the apparatus (1, 2) as defined in claim 1 and further comprising the converter (4) and/or the load (3).

12 The device as defined in claim 11, the third moment in time being an adaptable moment in time, and the converter (4) being arranged to adapt a next third moment in time in dependence of an amount of energy transferred via the second current signal.

13. A second device comprising the apparatus (1, 2) as defined in claim 1 and further comprising the phase-cut dimmer (5).

14. A method for driving a load (3) via a phase-cut dimmer (5) and via a converter (4), a firing angle of the phase-cut dimmer (5) corresponding with a first moment in time during a period of a voltage signal presented to the phase-cut dimmer (5), and the converter (4) being arranged to draw in a first step via a first circuit a first current signal from a second moment in time until a third moment in time during the period of the voltage signal, the method comprising a second step of controlling by a second circuit the converter (4) to draw via the first circuit a second current signal from a fourth moment in time until a fifth moment

in time during the period of the voltage signal, the fourth and fifth moments in time being situated after the third moment in time, and

the additional step of extending the time-interval during which a current is withdrawn from the phase-cut dimmer (5) by withdrawing a bleeder current by a bleeder (41-47).

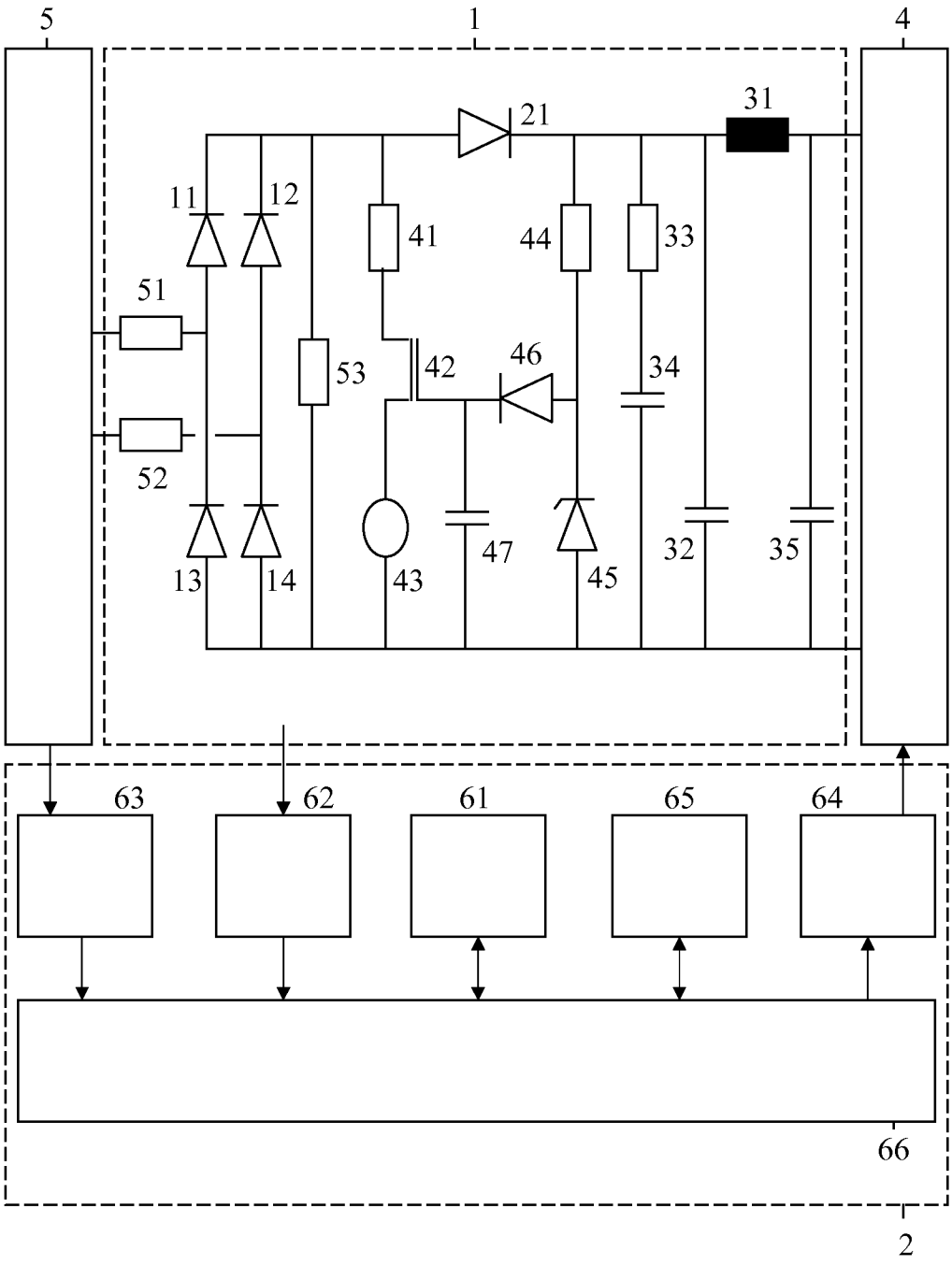
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Fig. 1

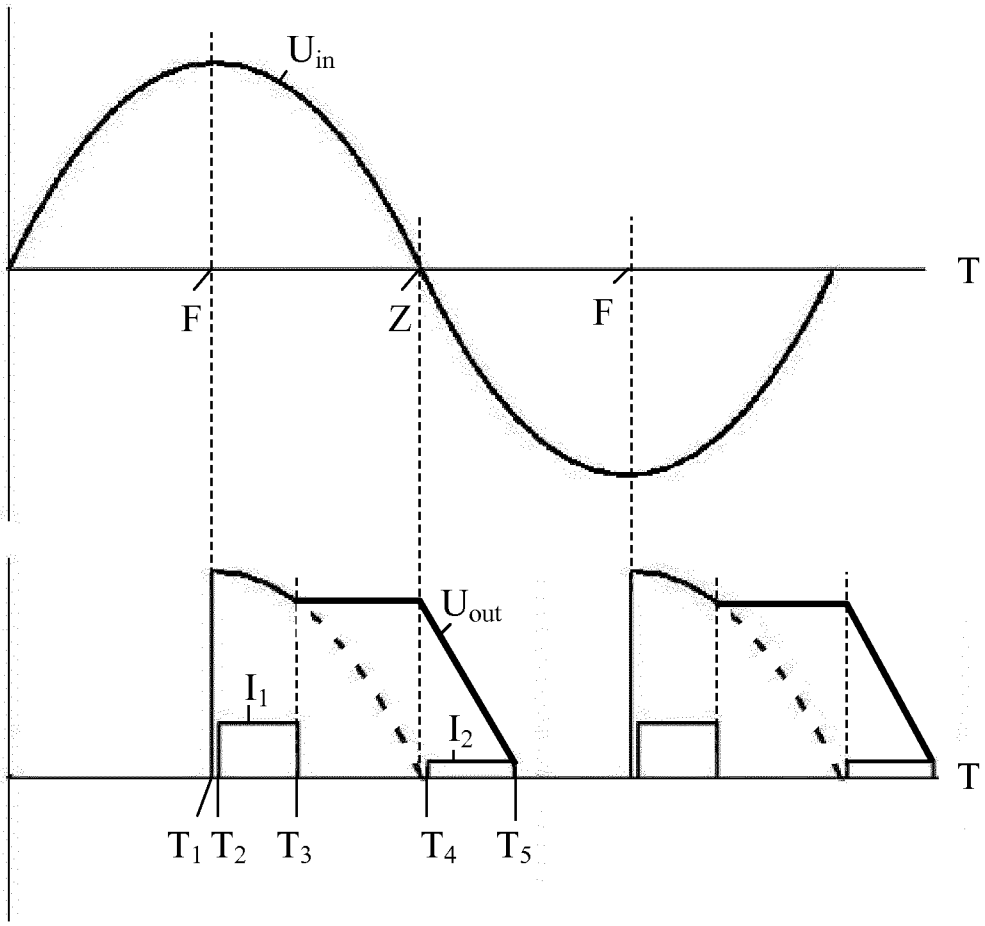

Fig. 2

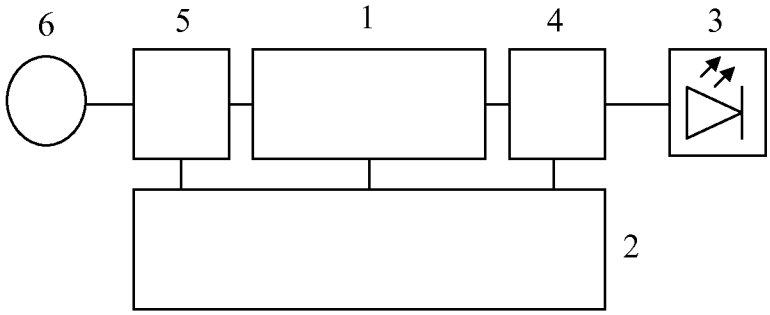

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/065186

A. CLASSIFICATION OF SUBJECT MATTER
INV. H05B33/08
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/199017 A1 (DILGER RICHARD [DE]) 18 August 2011 (2011-08-18)	14
A	the whole document	1-13
A	US 2010/090604 A1 (MARUYAMA YASUHIRO [JP] ET AL) 15 April 2010 (2010-04-15) paragraphs [0061] - [0082]; figures 6,15	1-14

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 September 2014	09/09/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Waters, Duncan

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2014/065186

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