

DIMMER FOR ENERGY SAVING LAMP



159159



G00002

FIELD OF INVENTION

The present invention relates to circuits, devices and apparatuses for
5 dimming electrical lighting. More particularly, this invention relates to dimming
circuits, devices and apparatuses for use with energy saving lamps or compact
fluorescent lamps.

BACKGROUND OF THE INVENTION

Compact fluorescent lamps, more commonly known as energy saving
10 lamps, are widely used nowadays because of the many advantages including a
high power efficiency and a long operating life.

It is well known that fluorescent lamps appear as a variable or non-linear
load to a power supply depending on their operating modes. In order to supply an
appropriate amount of current for proper lamp operation regardless of the
15 instantaneous operating mode, a ballast is always provided between the main
power supply and the fluorescent lamp. In general, a ballast must provide a
required high starting voltage and current as well as limiting the current which can
pass through the lamp during steady-state operation.

In many occasions, it is desirable to be able to dim the electric lightings.
20 However, dimming of fluorescent lamps has been historically difficult and requires
complicated circuit arrangements and topologies. A typical type of dimmer for
fluorescent lamps is provided by periodically blocking the supply voltage to the

light source by clipping a portion of the AC sinusoidal by reference to the phase angle of the AC power light input. These dimmers are commonly referred to as "phase control dimmers" which can be a forward phase dimmer or a reverse phase dimmer. A forward phase dimmer usually utilizes a thyristor, such as a silicon controlled rectifier (SCR) or, more commonly, a triac as an electronic blocking device or switch. On the other hand, a reverse phase dimmer allows the passage of the portion of the half-cycle of the AC line input immediately after the zero crossing of the AC line and blocks the portion of the half-cycle before the zero-crossing. In both types, the portion or angle of the half-cycle which is to be blocked is adjustable to control dimming. A major shortcoming of this phase control dimmers is that zero crossing detection is a pre-requisite of operation.

However, in circumstances in which the detection of zero crossing is difficult, for example, in the case of a fluorescent lamp with an electronic capacitive ballast, such phase control dimmers will not be suitable. Furthermore, because of the difficulty in dimming fluorescent lamps, most commercially available dimmable fluorescent lamps have the dimmer integrated with the ballast which means remote dimming of conventional fluorescent lamps with integrated electronic ballasts at remote switching locations such as wall-mounted switches is not possible. Hence, it would be highly desirable if there can be provided a simple dimmer or dimmer circuit which can be remotely installed from a compact fluorescent lamp so that dimming of the lamps can be controlled at locations remote from the lamps. In order that the dimmers can be installed at locations reserved for, or already installed with, conventional standard wall sockets, it would be highly desirable if the dimming circuitry is simple enough to be received within a confined space commonly allowed for a standard wall socket. Furthermore, it

will be highly desirable if there can be provided a two-wire dimmer for a compact fluorescent lamp so that the dimmer can be retro-fittable without the need of additional wiring.

OBJECT OF THE INVENTION

5 It is therefore an object of the present invention to provide improved circuits, devices and apparatuses for dimming a fluorescent lamp, especially a compact fluorescent lamp or an energy saving lamp. In particular, it will be an object of the present invention to provide simple dimmers for use with a compact fluorescent lamp which can be remotely located from the fluorescent lamp. It is
10 also another object of the present invention to provide simple circuitry which can be utilized to dim a compact fluorescent lamp without the need of zero-crossing detection of the AC input line to alleviate the complicated circuitry required for such detection. Furthermore, it is an object of the present invention to provide a two-wire dimmer for a fluorescent lamp or the like.

15 It is at least an object of the present invention to provide the public with the choice of a dimmer which can be used with a fluorescent lamp, such as compact fluorescent lamp or an energy saving lamp. Of course, the above objects are each to be read disjunctively with the object of providing the public with a useful choice.

SUMMARY OF THE INVENTION

20 According to a first aspect of the present invention, there is provided a dimming device including an input terminal for connecting to an alternate current power supply, an output terminal for connecting to a load, and a switched mode power supply wherein said switched mode power supply includes an electronic switching means with first and second switch terminals, switching control means,

inductive means and capacitive means, said inductive means being generally connected in series with said switching terminals of said switching means and said capacitive means being connected generally in parallel with the series connection including said switching device and said inductive means and wherein
5 the switching frequency of said electronic switching means is controllable and variable by said switching control means.

According to a second aspect of the present invention, there is provided a two-terminal dimming device for a compact fluorescent lamp including a switched mode power supply which includes rectifying means, electronic switching means,
10 an inductive member, a capacitive member and a switching control means, said rectifying means is connected to said switching means via said inductive member, said capacitive member is connected generally in parallel to the series connection of said inductive member and said switching means, and said switching control means provides switching signals to said switching means, the frequency of said
15 switching signals is substantially higher than that of the input power.

According to a third aspect of the present invention, there is provided a dimming device including an input terminal for connecting to an alternate current power supply, an output terminal for connecting to a load, and a switched mode power supply arrangement, said switched mode power supply includes an
20 electronic switching means with first and second switch terminals, switching control means, an inductor and a capacitor, said first and second terminals of said electronic switching means, said inductor and said capacitor being arranged in a circuit loop, wherein the switching frequency of said electronic switching means is controllable and variable by said switching control means.

According to a preferred embodiment, an inductor is connected between the output of said switched mode power supply and said output terminal of said dimming device.

5 According to a preferred embodiment, said switching frequency of said electronic switching means is substantially higher than that of the frequency of said alternate current power supply.

According to a preferred embodiment, said switching control means include a micro-controller or micro-processor sending out pulse-width modulated (PWM) switching signals.

10 According to a preferred embodiment, said switching frequency of said switching means is between 1 kHz and 50 kHz.

According to a preferred embodiment, said electronic switching device can be a bipolar transistor, a MOSFET or an IGBT.

15 According to a preferred embodiment, said inductive means include an inductor and said capacitive means include a capacitor.

According to a preferred embodiment, said device further including rectifying means for providing rectified power supply to said switching means.

According to a preferred embodiment, an additional inductive member is connected at the output of said device.

20 According to a preferred embodiment, said series connection of said switching device and said inductive means is further connected in series with a rectifying means, said capacitive means being connected in parallel with the

series connection of said switching device, said inductive means and said rectifying means.

According to a preferred embodiment, said switching signals include a pulse train of signals with levels corresponding to "ON" or "OFF" switching states
5 and that the relative duration of the "ON" and "OFF" pulses can be gradually varied.

According to a preferred embodiment, said series connection of said switching device and said inductive means is further connected in series with a rectifying means, said capacitive means being connected in parallel with the
10 series connection of said switching device, said inductive means and said rectifying means.

According to a preferred embodiment, one terminal of the dimming device is for connecting to the AC mains and the other terminal is for connecting to the electronic ballast of a compact fluorescent lamp.

15 According to a further aspect of the present invention, there is provided a lighting system including the above-mentioned dimming device and a compact fluorescent lamp.

Preferably, the position of said dimming device is independent of that of said compact fluorescent lamp.

20 According to yet a further aspect of the present invention, there is provided a lighting arrangement including a compact fluorescent lamp with an electronic ballast and a dimming device of the above characteristics.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the present invention will be explained in further detail by way of examples and with reference to the accompanying drawings in which:-

Fig. 1 is a simplified schematic circuit diagram showing the general arrangement of an embodiment of a basic schematic building block of a switching or switched-mode power supply of the dimming circuitry of the present invention,

Fig. 2 is a simplified schematic diagram showing the general concept of a first preferred embodiment of a dimming circuitry of the present invention,

Fig. 3 is a simplified schematic diagram showing a second preferred embodiment of the dimming circuitry of the present invention,

Fig. 4 is a simplified schematic circuit diagram showing a third preferred embodiment of the dimming circuitry of the present invention,

Fig. 5 is a simplified schematic circuit diagram showing a fourth preferred embodiment of the dimming circuitry of the present invention,

Fig. 6 is a simplified schematic diagram showing a fifth preferred embodiment of the dimming circuitry of the present invention,

Fig. 7 is a simplified schematic diagram showing a circuit including a dimmer of the fourth embodiment of the present invention utilising a MOSFET, instead of a bipolar transistor, as a switching control means and an energy saving lamp, and

Fig. 8 is a simplified schematic diagram showing the embodiment of Fig. 7 with an equivalent circuit representing the energy saving lamp and equivalent oscillating circuit representing the switching control.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

5 To assist understanding of the present invention, a basic schematic building block of a switching or switched-mode power supply for the dimmer circuitry of the present invention is shown in Fig. 1. This basic schematic building block **10** includes a controllable electronic switch **11** which is connected in series with inductive means **12** such as an inductor **L1**. A capacitive means **13** such as
10 a capacitor **C1** is connected in parallel across the series connection of the controllable electronic switch **11** and the inductor **L1**. The input node **20** of this circuit connection, which is the node between the switching device **Z1** and the capacitor **C1**, is for connecting to an input alternate current (AC) power source. The output node of this basic building block, which is the node **30** intermediate
15 between the inductor **L1** and the capacitor **C1**, is for connecting to the electronic ballast of a compact fluorescent lamp or other similar fluorescent lamps, although it will become clear in the description below that an inductive means will be inserted between the output node and the input of the electronic ballast.

Referring to Fig. 2, a schematic circuit diagram of a first preferred
20 embodiment **101** of a dimming block of the present invention is shown. In this preferred embodiment, the circuit arrangement of the dimming block includes the switching or switched-mode power supply building block of Fig. 1 plus an additional inductor **L2** which is connected at the output node **30** of the basic building block **10** of Fig. 1. This additional inductor **L2** is to be connected between
25 the output of the switching power supply **10** and the input of the electronic ballast

of a compact fluorescent lamp. The value of inductance of this additional inductor **L2 (14)** is largely dependent on the impedance of the capacitive electronic ballast at the operating chopping frequency of the controllable switch **11** and is usually larger than that of **L1**. The output node of this dimming block is designated with numeral **40**.

Referring to Fig. 3, a second preferred embodiment **102** of the present invention is shown. In this preferred embodiment, a bipolar transistor **Q1 (111)**, as an example of a switching device, is inserted in the place of the switching device **Z1** of Figs. 1 and 2. A uni-directional or an one-way electronic device, which is a diode **D1** in the present case, is inserted in series between the bipolar transistor **111** and the input node **20**. This diode **D1** as an one-way electronic device is added to protect the transistor from possible damage due to excessive reverse biasing and may be inserted between the transistor **Q1 (111)** and the inductor **L1 (12)**. This one-way electronic device is generally characterised in that it has a very low-impedance when it is appropriately biased so that a direct current can flow in one direction but has a very high-impedance to substantially prevent direct current flow in the opposite direction when it is reverse biased.

Referring to Fig. 4, there is shown a third preferred embodiment **103** of the dimming circuitry of the present invention. It will be noted that this circuit connection is generally identical to that of Fig. 3 except that a second series connection of a bipolar transistor **Q2 (112)** and a diode **D2** is connected in parallel across the first series connection of the first transistor **Q1 (111)** and the diode **D1**. It will be noted that the direct current flowing directions in the first and second transistor diode pairs are generally opposite.

Referring to Fig. 5, a fourth preferred embodiment **104** of the dimming circuitry of the present invention is shown. In its embodiment, the series connection of the inductor **L1 (12)** and the switching device **Q1 (111)** as shown in Fig. 1 is embedded into a rectifying circuitry so that, when the input node **20** of the dimming circuitry is connected to an AC source, the switching device (**111**), which is a bipolar transistor **Q1 (111)** in this embodiment, is supplied with full-wave rectified power during full cycles of the AC sinusoidal input. Embodiment 4 is generally similar to embodiment 3 except that a single switching device (**111**) is used instead of requiring two separate switching devices as in embodiment 4.

10 A fifth embodiment **105** of the present invention is shown in Fig. 6 in which the embodiment is generally identical to embodiment 4 except that an additional filtering stage including an additional inductor **L3 (16)** is connected in series with the output inductor **L2 (14)** and an additional capacitor **C2 (15)** branches out from the node **40** between the output inductors **L2** and **L3** and is then connected to the
15 input node **20** of the dimming circuitry or the input node of the rectifying circuit. The new output node is designated with numeral **50**.

Turning now to the general operating principles of the present invention by referring firstly to the simplified chopping power supply circuit arrangement **10** of Fig. 1, this switching device **Z1** is an electronic controllable switching device which
20 can be switchable at frequencies much higher than the AC line frequency of 50-60 Hz. This electronic switching means can be switchable, that is, turned "ON" and "OFF", by a switching signal originating from a switching control means. The switching control means can, for example, be an oscillator or a micro-controller unit which sends out switching control signals, for example, switching pulses of an
25 appropriate amplitude, to the control terminal of the switching device or means.

The switching control signals can be, for example, pulse-width-modulated (PWM) signals with variable switching pulse duration so that the relative duration between adjacent ON and OFF pulses can be varied.

By high frequency chopping of a portion of the available power from the AC line during a half cycle of the AC input, part of the AC power supply will be blocked and the power output from the dimming circuitry can be adjustable by varying the relative duration of the ON and OFF pulses. The suitable range of switching frequency suitable for use with currently available compact fluorescent lamps can be in the region of 2 kHz to 50 kHz. Where appropriate, other appropriate frequencies may be suitable for other types of fluorescent lamps.

While it is generally known that high frequency variable pulse width chopping, or more commonly known as pulse-width-modulation (PWM), of an AC source can be utilized to vary the amount of power output from the AC source, the direct application of high frequency chopping of the AC source to a compact fluorescent lamp with a capacitive electronic ballast does not usually work satisfactory. It is known that the impedance of a capacitive load decreases when the frequency increases and a high frequency input current may damage the capacitive load and the more sensitive components.

In general, a typical compact fluorescent lamp includes an electronic ballast at its power input and the electronic ballast is essentially a capacitive load usually designed for use with a low frequency power source such as the 50 or 60 Hz mains supply. When this capacitive load is connected to a high frequency power source, for example, a switched mode power supply, such as a PWM power supply, with a chopping frequency in the kHz range, the impedance of this capacitive load will be substantially lowered and a damaging surge current may

flow into the capacitive electronic ballast. Hence, it will be problematic if a conventional variable chopping frequency type of dimmers is connected between the AC power source and the electronic ballast.

In order to alleviate the above problem, an inductor or an inductive means
5 is connected between the output of the high frequency chopped power source and the input of the electronic ballast of the compact fluorescent lamp to limit the surge current that can flow into the electronic ballast. This inductive means will suppress the high frequency component of the chopped power signal so that only an acceptable level of the adverse high frequency current will flow into the
10 capacitive load.

However, the inclusion of the inductive means will bring about a high voltage surge (Ldi/dt) which will appear across the terminals of the switching device when the switching device is switched from the "ON" state to the "OFF" state. To overcome this voltage surge problem, a capacitive means is connected
15 across the terminals of the switching device to provide a low impedance shunt or by-pass to limit the maximum voltage surge. On the other hand, the addition of this voltage surge protection capacitor may in turn result in a large discharge current in the loop comprising the capacitor and the electronically controllable switching device when the switching device is initially closed. This discharge
20 current may damage the switching device or can cause breakdown of the electronic switching device. To alleviate this problem, an inductive means is connected in series with the switching device to limit the maximum discharge current that can flow in the loop now comprising the switching means, the capacitor and the switching device protecting inductor.

In general, it will be noted that the inductance value of the inductor (L2 or 14 in the Figures) which is connected between the dimmer power output and the ballast input (node 40) is dependent on the impedance of the capacitive electronic ballast at the chopping frequency of the dimmer power output. The capacitive value of the shunting or by-passing capacitor (C1 or 13 in the Figures) is dependent on the value of output inductor (L2 or 14 in the Figures) and the chopping frequency. The inductive value of the inductor in the switching device-capacitor C1 loop will depend on the value of C1 and the current limit of the switching device (Z1 or 11 in the Figures).

It will be appreciated that in the embodiments of Figures 2 to 7, the components L1, L2 and C1 are arranged as a "T"-filter including a pair of serially connected inductors and a capacitor which branches out from between the inductors to the input node. Such an arrangement alleviates the adverse effects of the high frequency chopped power input on the capacitive load as well as protecting the switching device Z1.

Hence, it will be appreciated that the long well-known problem of applying high frequency PWM power to a compact fluorescent lamp can be alleviated by utilizing a switching device in connection with three simple passive components L1, L2 and C1 as shown in the above preferred embodiments. These three simple components are arranged in a simple three-component "T" shaped form which can be easily accommodated within a confined space. Also, it will be understood that the symbol Z1 used in Figures 1 and 2 is merely used to illustrate an electronic switching device. In actual applications, the switching device will be an electronic switching device capable of high frequency switching between, for example, 1 to 50 kHz. Suitable electronic controllable switching means satisfying

this requirement include bipolar transistors, field effect transistors (FETs), MOSFETs or insulated gate bipolar transistors (IGBTs).

Referring now to Fig. 3, the circuit arrangement **102** is generally identical to that shown in Fig. 2 except that the switching means is replaced by a diode **D1** and a bipolar transistor **Q1**. The bipolar transistor is provided as an example of a suitable high frequency switching device and the serially connected diode is included to protect the bipolar transistor from damage due to reverse biasing.

The embodiment **103** shown in Fig. 4 is generally identical to that shown in Fig. 3 except that an additional pair of transistor **Q2** and protective diode **D2** is provided so that pulse-width modulation switching can occur during the positive and negative cycles of the AC line source. By allowing pulse-width modulation during the full cycle of the AC line source, a wider range of power adjustment can be achieved.

To achieve the effect of the embodiment of Fig. 4 while minimizing the number of switching devices and therefore the associated control, the two pairs of switching devices in embodiment 3 are replaced by a full wave rectifier together with a series connection of an inductor **L1** and a switching means **Q1**. This series connection of an inductor **L1** and a switching means **111** forms a conducting part in both the forward and reverse paths of the rectifying means.

The fifth embodiment **105** of Fig. 6 illustrates the possible use of an additional filter stage including a further serially connected inductor **L6** and a further shunt connected capacitor **C2** to further protect the capacitive load while allowing high frequency chopping of the input AC source. It will be noted that by

including additional filtering stages, the filtering characteristics can be better controlled and the values of the reactive elements can be reduced.

The system of Fig. 7 illustrates an AC source, a dimmer circuit **106** similar to the fourth embodiment **105** of the present invention with the switching device **11** controlled by a micro-controller (MCU) **200**, and a compact fluorescent lamp **300** with an electronic ballast **301** and a fluorescent tube **302**. A main power switch **S1 (400)** is also illustrated to indicate the switching on and off of the main power to the compact fluorescent lamp **300**. When the main power supply to the compact fluorescent lamp **300** is turned on, the luminous level of the compact fluorescent lamp can be controlled and varied by the micro-controller by sending PWM switching controlling signals to the switching device **Z1**. By varying the relative duration of the ON and OFF pulses of the PWM signal, the power output that can be supplied to the electronic ballast can be adjusted. By gradually varying the duty cycle, i.e., the ratio between the duration of the ON cycle to the OFF cycle of the PWM pulses, dimming can be gradually effected. It will be noted that a MOSFET is used as the switching device **Z1** in the present example.

A series connection of a capacitor **CZ (18)** and a resistor **RZ (17)** is further connected in parallel across the terminals of the switching device **Z1** in order to protect the switching device from damage due to high voltage surge as a result of high frequency switching at its control terminals.

A simplified equivalent circuit **107** of the arrangement of Fig. 7 is shown in Fig. 8 and an IGBT is used as an example of switching device in this example. In this example, the energy saving lamp **300** including an electronic ballast is illustrated in equivalent form as including a parallel connection of a capacitor and a resistor together with a rectifying bridge. The various problems that have to be

overcome in order to achieve a simple and versatile dimming device will become apparent from this capacitive equivalent circuit of the compact fluorescent lamp.

The tables below set out examples of some component values for reference.

- 5 Example 1 22W energy saving lamp
 Z1: MOSFET 900V/8A
 Rz = 25Ω Cz = 1,000 pF

Switching Frequency	L1	L2	C1
20kHz	2mH	100μH	0.015μF
5kHz	3mH	120μH	0.022μF

- 10 Example 2 44W energy saving lamp

Switching Frequency	L1	L2	C1
20kHz	2.5mH	110μH	0.02μF

- 15 On the other hand, if other conditions remain, the value of the reactive components can be lower by increasing the number of filtering stages.

- 20 From the embodiments described above, it will be clear that a dimming circuit suitable for use with a compact fluorescent lamp can be achieved by simple connection of a small number of electronic components. These components, including the switching control signal which is, for example, a single chip micro-processor generating by co-processor, can be accommodated in a very confined space such as the size of a conventional wall socket. With this simple and versatile design, wall-mountable dimmers can be installed in wall sockets replacing conventional "ON" and "OFF" only switches for dimming and switching of energy saving lamps and other fluorescent lamps using electronic ballast.

For example, the dimming circuit including the switching device, the rectifying means, the passive filtering elements and the switching signal generating CPU or MCU can all be mounted on a single wall-mount housing with an input terminal and an output terminal suitable for retro-fitting in existing wall sockets.

As an example of a possible modification or variation from the above-described embodiments, it will be appreciated that a dimmer switch may include the basic switching power supply building block of Fig. 1 while the output inductor **L2** is connected as a part of the fluorescent lamp and immediately before the input of the electronic ballast.

In general, it will be appreciated that the dimming circuitry of the present invention includes a switched mode power supply circuit which includes a controllable switching means (**Z1**) with a first and a second switching terminal, a capacitor **C1** and an inductor (**L1**), which are included in a circuit loop. The capacitor **C1** and the inductor **L1** are for protecting the switching means respectively from voltage and current surges.

While the present invention has been explained by reference to the preferred embodiments described above, it will be appreciated that the embodiments are only examples provided to illustrate the present invention and are not meant to be restrictive on the scope and spirit of the present invention. The scope and ambit of this invention should be determined from the general principles and spirit of the invention as described above. In particular, variations or modifications which are obvious or trivial to persons skilled in the art, as well as improvements made on the basis of the present invention, should be considered as falling within the scope and boundary of the present invention. Furthermore,

while the present invention has been explained by reference to compact fluorescent lamps, it should be appreciated that the invention can apply, whether with or without modification, to fluorescent lamps.

Reference Number List

10	dimmer block
11	electronic switch
30	Output node of switched power supply
40	Output node of dimmer
C1	capacitor
C2	filtering capacitor
D1	diode
D2	diode
L1	inductor
L2	additional inductor
L3	additional inductor
Q1	bipolar transistor
Q2	bipolar transistor
S1	main power switch
Z1	switching device

CLAIMS

1. A dimming device including an input terminal for connecting to an alternate current power supply, an output terminal for connecting to a load, and a switched mode power supply wherein said switched mode power supply
5 includes an electronic switching means with first and second switch terminals, switching control means, inductive means and capacitive means, said inductive means being generally connected in series with said switching terminals of said switching means and said capacitive means being connected generally in parallel with the series connection including
10 said switching device and said inductive means and wherein the switching frequency of said electronic switching means is controllable and variable by said switching control means.
2. A dimming device according to claim 1, wherein an inductor is connected between the output of said switched mode power supply and said output
15 terminal of said dimming device.
3. A dimming device according to any of the preceding claims, wherein said switching frequency of said electronic switching means is substantially higher than that of the frequency of said alternate current power supply.
4. A dimming device according to any of the preceding claims, wherein said
20 switching control means include a micro-controller or micro-processor sending out pulse-width modulated (PWM) switching signals.

5. A dimming device according to any of the preceding claims, wherein said switching frequency of said switching means is between 1 kHz and 50 kHz.
6. A dimming device according to any of the preceding claims, wherein said electronic switching device can be a bipolar transistor, a MOSFET or an IGBT.
7. A dimming device according to any of the preceding claims, wherein said inductive means include an inductor and said capacitive means include a capacitor.
8. A dimming device according to any of the preceding claims, further including rectifying means for providing rectified power supply to said switching means.
9. A dimming device according to any of the preceding claims, wherein an additional inductive member is connected at the output of said device.
10. A dimming device according to any of the preceding claims, wherein said series connection of said switching device and said inductive means is further connected in series with a rectifying means, said capacitive means being connected in parallel with the series connection of said switching device, said inductive means and said rectifying means.
11. A two-terminal dimming device for a compact fluorescent lamp including a switched mode power supply which includes rectifying means, electronic switching means, an inductive member, a capacitive member and a switching control means, said rectifying means is connected to said

switching means via said inductive member, said capacitive member is connected generally in parallel with the series connection of said inductive member and said switching means, and said switching control means provides switching signals to said switching means, the frequency of said switching signals is substantially higher than that of the input power.

12. A two-terminal dimming device according to claim 11, wherein said switching signals include a pulse train of signals with levels corresponding to "ON" or "OFF" switching states and that the relative duration of the "ON" and "OFF" pulses can be gradually varied.
- 10 13. A two-terminal dimming device according to claims 11 or 12, wherein said series connection of said switching device and said inductive means is further connected in series with a rectifying means, said capacitive means being connected in parallel with the series connection of said switching device, said inductive means and said rectifying means.
- 15 14. A two-terminal dimming device according to any of claims 11 to 13, wherein one terminal of the dimming device is for connecting to the AC mains and the other terminal is for connecting to the electronic ballast of a compact fluorescent lamp.
- 20 15. A lighting arrangement including a compact fluorescent lamp with an electronic ballast and a dimming device of any of claims 1 to 14.
16. A lighting system including a dimming device of any of claims 1 to 14 and a compact fluorescent lamp with an electronic ballast, wherein the position of said dimming device is independent of that of said compact fluorescent lamp.