

ENERGY SAVING CIRCUIT FOR ELECTRONIC BALLASTS

FIELD OF INVENTION

This invention relates to fluorescent lamps and more specifically, to control electronic ballast commonly used to operate fluorescent lamps.

BACKGROUND OF THE INVENTION

Saving power and energy are gaining importance day-by-day in commercial and residential establishments throughout the world. Lighting equipments, and more specifically fluorescent lighting, are major consumers of power and there is a good potential to manage power consumption of the same. Electronic ballasts are being increasingly used with fluorescent lamps. Electronic ballasts with non-regulated outputs are widely used for the general lighting of common areas like corridors, walkways and staircases as they are less expensive compared to regulated output electronic ballasts. As a result, the lamps are always operated at full illumination, even at times when full illumination is not required such as during the night.

Electronically dimmable ballasts are available to reduce the illumination when desired, but these are comparatively more expensive. Additionally, the dimming circuitry is integral to the complete unit and cannot be added separately. Hence, a user or an organization wishing to incorporate the dimming facility in their lighting system has to completely replace their non-dimmable ballast units.

Accordingly, it is the object of the present invention to solve the long-standing problems indicated above by providing dimmable electronic ballasted fluorescent systems, which are less complex and substantially less costly.

SUMMARY OF THE INVENTION

The first embodiment of the energy saving circuit for use with a power source and an electronic ballast of a fluorescent lamp, the first embodiment comprising a transformer, a pair of rectifier circuits, a pair of switches, a switch connected to the transformer and rectifier in series and the other switch connected directly to the other rectifier in series, wherein an alternative toggling of the switches connect the power supply to the electronic ballast through a rectifier alone or through a combination of the transformer and rectifier to achieve maximum and minimum illumination of the lamp respectively and the second embodiment comprising a rectifier and buck converter for achieving reduced illumination of the fluorescent lamp.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig 1 is a schematic diagram of one preferred embodiment of the invention comprising a step down voltage transformer

Fig 2 is a schematic diagram of another preferred embodiment of the invention comprising a buck converter

DETAILED DESCRIPTION

The invention, as disclosed in Fig 1 is an energy saving circuit 10, which is implemented by electrically connecting it between an AC power supply 12 and an electronic ballast 35 of a fluorescent lamp 36.

The energy saving circuit 10 is low in component count, operates at a standard frequency and generates negligible loss in its switching operations. Therefore, it has an intrinsic long operational life. The energy saving circuit is connected to AC power supply 12, which acts as the power source for the entire circuit. The AC power supply is connected to control switches 20 and 22, which control the internal operation of the energy saving circuit. Any type of switch can be used in the present invention, but triac switches are preferred because of advantageous operating characteristics. Switch 20 is connected to input 29 of a low frequency transformer 24. The transformer is a fixed output transformer with a standard output such as 115V-0V-115V at 50/60 Hz and 12VA. A transformer with a different specification can also be used depending on the requirements and the specifications of other components in the energy saving circuit. The function of the transformer is to step down the AC voltage, such as from 230V to 115V. Output 27 of the transformer is coupled to a full-wave bridge rectifier circuit 28. The function of the bridge rectifier circuit is to convert AC voltage to DC voltage.

Switch 22 is directly connected to a second bridge rectifier circuit 26. The function of second bridge 26 is also to convert AC voltage to DC voltage. The energy saving circuit is designed in such a way that only one switch, either 20 or 22 can be turned on at any point of time. The outputs of bridge

rectifier circuits 26 and 28 are connected to output terminals 30 and 31. The output terminals are connected to electronic ballast 35.

The present invention operates as follows. When switch 22 is turned off and switch 20 is turned on, the current flows through switch 20 to transformer 24 through output 27, thereby stepping the voltage down and flowing to bridge rectifier 28, wherein it is converted to DC voltage. The output of bridge rectifier 28 is routed to output terminals 30 and 31 through lines 28a and 28b. When switch 22 is turned on and switch 20 is turned off, the current flows directly to the bridge rectifier 26 without the voltage being stepped down. The AC is then rectified by rectifier 26 into DC and routed to output terminals 30 and 31 through lines 26a and 26b. The current from the output terminals flows to electronic ballast 35 and finally to fluorescent lamp 36.

Accordingly, it is apparent that when switch 20 is turned on and switch 22 is turned off, the voltage to the fluorescent lamp is reduced resulting in dimming of the lamp, and in the other scenario, when the switch 20 is turned off and switch 22 is turned on, the voltage to the lamp is maximum and it results in full illumination.

It will also be understood from the above description that two or more transformers of appropriate ratings together with additional switches may be used to produce light intensities of the lamp at three or more levels, thereby enabling the lamp to operate at multiple levels of light intensity as may be desired.

While control switches 20 and 22 may be controlled manually, or automatically by any number of different types of control systems, it has been found that the use of a microcontroller is preferred for a number of reasons as will become more fully apparent. Accordingly, a microcontroller 32 in combination with the Passive Infra-red (PIR) detector 34 as illustrated in Fig 1 supplies on/off voltage to operate triac switches 20, 22.

The microcontroller uses the alternating current (AC) voltage zero crossing as a stable time-base for embedding a lighting schedule. As each AC cycle has a definitive period (20 ms for 50 Hz AC supply), accurate timings can be embedded onto the microcontroller. For instance, the microcontroller can be programmed to switch fluorescent lamp 36 to operate at full-illumination for the first four hours of operation. It could then be programmed to operate at half-illumination for the next six hours. During these six hours, it would rely on the output of the PIR detector to switch back to full-illumination momentarily until the passer-by has moved away. Finally, for the last hours into dawn, the microcontroller can switch back to full-illumination permanently. Control outputs 37 and 38 from the microcontroller 32 as illustrated in Fig 1 provide the signals for controlling switches 20 and 22.

It is apparent that by programming the microcontroller 32 to control the switches, half or full illumination can be obtained and therefore is more cost-effective in utilizing electricity for general illumination.

Another preferred embodiment is disclosed in Fig 2. The energy saving circuit 40 is implemented by electrically connecting it between an AC power supply 42 and an electronic ballast 44 of the fluorescent lamp 46.

The energy saving circuit receives the electrical input from the AC power supply, which acts as the power source. The AC power supply is connected to a bridge rectifier circuit 48. The bridge rectifier circuit converts AC into DC. The bridge rectifier circuit is connected to a buck converter circuit 50 through terminals 51 and 51'. The buck converter is a step-down DC-to-DC converter and consists of a transistor 52, a diode 54, an inductor 56 and a capacitor 58. The operation of the buck converter is fairly simple in that by alternate toggling of the switch at a definitive periodic cycle, it goes between the positions of connecting the inductor 56 directly to the DC voltage from the rectifier, thereby storing energy in the inductor and simultaneously powering the electronic ballast when the switch is closed, and discharging the charge in the inductor into the electronic ballast 44 when the switch is opened. The switch may be operated by a digital pulse train generated by a suitable source at a relatively high frequency such as 40 KHz to 250 KHz. The operational characteristics of the buck converter is such that its output voltage is dependent on the duty cycle of the pulse train that controls the operation of the switch 52. The buck converter is connected to electronic ballast 44 of fluorescent lamp 46 through output terminals 53 and 53' of the energy saving circuit 50.

Accordingly, it is apparent that by varying the duty cycle of the pulse train, a stepping down of the input voltage is achieved, which enables varying the illumination of the lamp 46 from maximum to minimum.

As further illustrated in Fig 2, a microcontroller 60 in conjunction with a Passive Infrared (PIR) detector 62 is used for controlling the switch, the

technique being described fully hereinafter. The PIR detector in operation can sense the presence of a heat generating body within its range and thereby enables detecting the presence of a person. The signals from the PIR detector are acquired by the microcontroller and accordingly, the microcontroller issues a pulse train of a specified duty cycle to the switch 52, thereby increasing or decreasing the illumination of the lamp 46.

The microcontroller 60 operates in the same manner as previously described.

Accordingly, by programming the microcontroller to control the switch 52, variation in illumination can be achieved and therefore is more cost-effective in utilizing electricity for general illumination.

It is to be understood that the foregoing description of several preferred embodiments is intended to be purely illustrative of the principles of the invention, rather than exhaustive thereof, and that changes and variations will be apparent to those skilled in the art, and that the present invention is not intended to be limited other than expressly set forth in the following claims.

CLAIMS

1. An energy saving circuit for use with a power source and an electronic ballast of a fluorescent lamp, the energy saving circuit comprising:
 - (a) a step-down voltage transformer having a first output,
 - (b) first and second rectifier circuits, wherein the second rectifier circuit is connected to the first output of the transformer,
 - (c) first and second switches, wherein the first switch is electrically connected to the input of the step down voltage transformer and the second switch is connected to the first rectifier circuit, and
 - (d) wherein by switching on the second switch and switching off the first switch, current at maximum voltage is supplied directly through the first rectifier so as to provide maximum current to the electronic ballast resulting in maximum illumination of the lamp, and
by switching on the first switch and switching off the second switch, current is supplied through the step down voltage transformer and the second rectifier so as to provide current at reduced voltage to the electronic ballast resulting in dimming of the lamp.
2. The energy saving circuit according to Claim 1, including a microcontroller or microprocessor, wherein switching on and switching off of the switches are controlled by the microcontroller or microprocessor.
3. The energy-saving circuit according to Claim 2, wherein the microcontroller or microprocessor further includes an alternating current (AC) voltage zero crossing operating as a lighting schedule.

4. The energy saving circuit according to Claims 2 or 3, including a passive infrared detector, wherein the microcontroller or microprocessor is further electrically connected to the passive infrared detector to detect the presence of a person.

5. An energy saving circuit for use with a power source and an electronic ballast of a fluorescent lamp, the energy saving circuit comprising:

- (a) a rectifier circuit having a first output,
- (b) a buck converter circuit for stepping down the voltage including an input terminal, an output terminal and a switch, wherein the input terminal is electrically connected to the first output of the rectifier, the output terminal is electrically connected to the electronic ballast and the switch with a first input being used to control the operation of the buck converter,
- (c) a microcontroller or a microprocessor connected to the first input of the switch, being used to control the operation of the switch at a range of duty cycles, and
- (d) wherein by opening and closing the switch by the microcontroller or microprocessor and varying the duty cycle, the illumination of the fluorescent lamp is varied from minimum to maximum.

6. The energy-saving circuit according to Claim 5, wherein the microcontroller or microprocessor further includes an alternating current (AC) voltage zero crossing operating as a lighting schedule.

7. The energy saving circuit according to Claims 5 or 6, including a passive infrared detector, wherein the microcontroller or microprocessor is further electrically connected to a passive infrared detector to detect the presence of a person.