Abstract: A power supply for LED lighting in which constant current regulation is afforded.

FIG. 2
UNIVERSAL POWER SUPPLY FOR LED LIGHTING APPLICATIONS

Technical Field

The present invention relates generally to LED (light emitting diode) signage and illumination, and particularly power supplies therefor.

Background Art

Signage, including signage with channel letters, has long been noted for its effectiveness in advertising a product or otherwise in drawing the attention of passers-by, e.g., to a corporate name on the side of a building. Until recently, signage lighting could only be achieved by using neon, incandescent, or fluorescent technology. With the advent of "high power" LEDs ("high power" referring to those LEDs that put out tens to hundreds of lumens of light), LEDs today emit sufficient light that can be used for such illumination tasks. In such a context, LEDs, which provide the letters' luminescent effect, serve as "light engines". The basics of LED signage, including channel letter signage, are very well known and are disclosed, for example, in co-pending and commonly assigned U.S. Patent Application Serial No. 11/699,219 filed on January 27, 2007, and entitled "Apparatus for Illuminating Channel Letters and Light Boxes".

LEDs have also made inroads into general lighting applications such as traffic lights, freezer/cooler chest illumination, cabinet lighting, and the like. This is due to
their low power consumption, long life, and small footprint. In these applications, LEDs are replacing incandescent and fluorescent lamp technology.

Supplying power for LED illumination applications, however, presents unique challenges that differ from, for example, supplying power to an incandescent (resistive) load. Normally, for applications such as channel letter signage, multiple "high power" LEDs in series need to be powered (e.g., one for each channel letter, or one for each of a number of segments of each channel letter). The "high power" LEDs used in LED signage and illumination applications require tightly regulated currents to ensure both consistent illumination and long operating life. Because of the significant and varying voltage drops at each of the LEDs in series, and changes in these voltages due to operating conditions, current limiting methods commonly used will not otherwise be predictable and consistent, even owing to seemingly insignificant factors such as the color of each LED (wherein certain colors lend themselves to greater voltage drops than others). However, numerous problems have historically been encountered when attempting to effect current regulation in LED signing.

By way of example, there are several methods or approaches used to facilitate the illumination of "high power" LEDs. Since LEDs are current-driven devices whose brightness is proportional to their forward current, the most basic method is that of current limiting using components such as ballast resistors. This, however, creates significant energy losses in the resistive load and is thus inefficient in
controlling the operating current. Off-the-shelf current regulation products are readily available but require additional components (e.g., AC/DC conversion) to provide a complete solution, resulting in more electrical connections and more points of failure. Moreover, these off-the-shelf products do not accommodate the need for a wide range of discrete operating currents required for driving various LED colors (e.g., red LEDs are typically driven at 300-700 mA, while white and blue LEDs are driven at 700-1000 mA), nor do they have the power output capability to drive more than two or three "high power" LEDs.

Overall, no conventional arrangements are known in which current and voltage regulation for higher-wattage applications such as LED signage. A need has thus been recognized in connection with rectifying this shortcoming.

**Disclosure of the Invention**

Broadly contemplated herein, in accordance with at least one presently preferred embodiment of the present invention, is a power supply for LED lighting in which constant current regulation is afforded.

In summary, one aspect of the invention provides: a universal power supply for at least one LED light engine, the power supply comprising: an input; an AC/DC converter downstream of the input; a current regulation module connected downstream of the AC/DC converter; the current regulation module acting to provide current to the LED light engine; and a current setting module in communication with
the current regulation module; the current regulation module and the current setting module acting to provide constant current to an LED light engine.

**Brief Description of the Drawings**

Fig. 1 schematically illustrates a general LED lighting arrangement.

Fig. 2 schematically illustrates a power supply system for LED lighting.

**Modes for Carrying Out the Invention**

For a better understanding of the present invention, together with other and further features and advantages thereof, reference is made to the following description, taken in conjunction with the accompanying drawings, and the scope of the invention will be pointed out in the appended claims.

It will be readily understood that the components of the present invention, as generally described and illustrated in the Figures herein, may be arranged and designed in a wide variety of different configurations. Thus, the following more detailed description of the embodiments of the apparatus, system, and method of the present invention, as represented in Figs. 1 through 2, is not intended to limit the scope of the invention, as claimed, but is merely representative of selected embodiments of the invention.
Reference throughout this specification to "one embodiment" or "an embodiment" (or the like) means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment.

The illustrated embodiments of the invention will be best understood by reference to the drawings, wherein like parts are designated by like numerals or other labels throughout. The following description is intended only by way of example, and simply illustrates certain selected embodiments of devices, systems, and processes that are consistent with the invention as claimed herein.

Fig. 1 schematically illustrates a general LED lighting arrangement 100. As shown, a power supply may be configured to power a light engine 202 (such as an LED) for illuminating a letter (e.g., channel letter) or letter portion 204. As known, an LED in the context illustrated in Fig. 1 may be configured to illuminate a light fiber at letter or letter portion 204. While one light fiber and LED in combination may in many cases be sufficient for illuminating an entire channel letter, it is also often the case that several LEDs, each illuminating a light fiber portion, may be needed for illuminating an entire channel letter (in which case, e.g., the light fiber portions may be placed end-to-end within the channel letter to illuminate the entire
letter). As is well known, the light engine (such as LED) 202 may actually be disposed inside the channel letter 204 (i.e., inside the channel letter "box"), or it could be disposed outside of the channel letter (box) 204. Likewise, it is often the case that a power supply 200 is disposed inside a channel letter (box) 204, but in many instances it is advantageous for the power supply 200 to be remote from the channel letter (box) 204. Preferably, the power supply 200 is in any case better disposed remotely from the light engine 202.

Fig 2, more particularly illustrates a power supply 200 in accordance with a preferred embodiment of the present invention. Preferably, power supply 200 will be configured as a constant current output device for powering one or more light engines (e.g., LED) of a channel letter or other illuminated display. Thus, power supply 200 will preferably act to generate a fixed current, regardless of any variations in voltage drops at different LEDs, or temporal variations at single LEDs, up to a given (maximum) load point.

As shown, leads of a universal AC input preferably feed into an AC to DC power converter, particularly into an AC line filter thereof. The filter, per convention, is preferably provided for environmental purposes. A desired voltage is preferably set at the converter 208 and, in known manner, a voltage feedback loop 209 will preferably ensure that actual output voltage does not vary from the set voltage.
Preferably connected downstream of the AC/DC converter 208 is a current regulator 210. Preferably, current regulator 210 will allow for a constant, maximum current to be generated. On the other hand, a current setting module 212 is preferably connected downstream of the current regulator 210 to permit a particular and adjustable constant operating current to be set during installation, which constant current is then provided via leads 216a/b to LEDs connected in series. A feedback loop 214 will preferably ensure that the operating current remains constant.

Generally, in accordance with at least one presently preferred embodiment of the present invention, a power supply 200 is advantageously configured for providing constant current to a series connection of a significant number of LEDs (e.g., 6 to 8 LEDs but possibly even 10 or more). By way of an illustrative and non-restrictive example, the forward voltage of each LED can range from about 3.0 to 4.0 volts, resulting in a required maximum voltage in the neighborhood of, e.g., about 18 to 32 volts. To provide sufficient voltage and current to a series of LEDs, power supply 200 has been developed to generate output voltages reaching at least 40 volts.

Preferably, the current regulator 210 will govern the maximum possible operating current as discussed above. During installation of the power supply 200, on the other hand, current setting module 212 is preferably employed to select a desired constant operating current up to or including the aforementioned maximum (e.g., via jumper or switch selection). Accordingly, by way of an illustrative and non-
restrictive example, the maximum current associated with the power supply could be
configured as needed per LED specifications (e.g., at 0.300, 0.500, 0.700 or 1.00
amps). If necessary, the power supply 200 will preferably be packaged into an
enclosure for weatherproofing compliance (e.g., ANSI IP67 rating compliance).

In brief recapitulation, it will be appreciated that, in accordance with at least
one presently preferred embodiment of the present invention, a power supply and
LED driver are integrated in a single package for use with LED signage such as
channel letters.

If not otherwise stated herein, it is to be assumed that all patents, patent
applications, patent publications and other publications (including web-based
publications) mentioned and cited herein are hereby fully incorporated by reference
herein as if set forth in their entirety herein.

Although illustrative embodiments of the present invention have been
described herein with reference to the accompanying drawings, it is to be understood
that the invention is not limited to those precise embodiments, and that various other
changes and modifications may be affected therein by one skilled in the art without
departing from the scope or spirit of the invention.
What is claimed is:

1. A universal power supply for at least one LED light engine, said power supply comprising:

   an input;

   an AC/DC converter downstream of said input;

   a current regulation module connected downstream of said AC/DC converter, said current regulation module acting to provide current to the LED light engine; and

   a current setting module in communication with said current regulation module;

   said current regulation module and said current setting module acting to provide constant current to an LED light engine.

2. The power supply according to Claim 1, wherein said current regulation module establishes a constant operating current.

3. The power supply according to Claim 2, wherein said current setting module affords a pre-set selection of operating currents.
4. The power supply according to Claim 3, wherein said current setting module affords a pre-set selection of discrete, constant operating currents.

5. The power supply according to Claim 1, wherein said current regulation module and said current setting module act to provide constant current to a plurality of LED light engines in series.

6. The power supply according to Claim 5, wherein said current regulation module and said current setting module act to provide constant current to at least ten LED light engines in series.

7. The power supply according to Claim 5, wherein said current regulation module and said current setting module act to provide constant current to a plurality of channel letter signage LED light engines in series.

8. The power supply according to Claim 7, wherein said current regulation module and said current setting module act to provide constant current to at least ten channel letter signage LEDs in series.

9. The power supply according to Claim 1, wherein said current setting module is connected downstream of said current regulation module.

10. The power supply according to Claim 1, further comprising a current feedback loop for ensuring a constant current from said current regulation module.
11. The power supply according to Claim 10, wherein said current feedback loop is in communication with said current setting module.

12. The power supply according to Claim 11, wherein said current setting module is connected downstream of said current regulation module.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. H05B33/08

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 practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Citation of document, with indication, where appropriate of the relevant passages</th>
<th>Relevant to claim No</th>
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<td>X</td>
<td>DE 201 13 640 U1 (KOHLS MICHAEL [DE]; BUHK BIRGER [DE]) 6 December 2001 (2001-12-06) page 6, line 4 - page 9, line 4</td>
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<td>CN 1 835 650 A (KANGKAI ELECTRICAL CO LTD SUZH [CN]) 20 September 2006 (2006-09-20) figure 2</td>
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Date of the actual completion of the international search

9 January 2008

Date of mailing of the international search report

18/01/2008

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* Special categories of cited documents

"X" 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

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