

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

JIAWEI TECHNOLOGY (HK) LTD., JIAWEI TECHNOLOGY (USA) LTD.,
SHENZHEN JIAWEI PHOTOVOLTAIC LIGHTING CO., LTD., ATICO
INTERNATIONAL (ASIA) LTD., ATICO INTERNATIONAL USA, INC.,
CHIEN LUEN INDUSTRIES CO., LTD., INC. (CHIEN LUEN FLORIDA),
CHIEN LUEN INDUSTRIES CO., LTD., INC. (CHIEN LUEN CHINA),
COLEMAN CABLE, LLC, NATURE'S MARK, RITE AID CORP., SMART
SOLAR, INC., AND TEST RITE PRODUCTS CORP.,
Petitioner,

v.

SIMON NICHOLAS RICHMOND,
Patent Owner.

U.S. Patent No. 7,429,827 to Richmond.
IPR Case No. Unassigned

**DECLARATION OF PETER W. SHACKLE, PH.D.,
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW**

I. INTRODUCTION

A. Engagement

1. My name is Peter W. Shackle. I have been retained by counsel for Petitioners as an expert witness in the above-captioned proceeding. I have been asked to provide analysis and my opinion about the state of the art of the technology described in U.S. Patent No. 7,429,827 (the '827 Patent") and on the patentability of claims 31–34 ("the challenged claims") of the '827 patent.

B. Background and Qualifications

2. I reside at 112 Aspen Way, Rolling Hills Estates, CA 90274. I hold a bachelor's degree in physics from the University of Birmingham (United Kingdom) and a Ph.D. in physics from the University of Cambridge (United Kingdom).

3. I have over twenty years' experience in lighting electronics, with particular emphasis on light emitting diode ("LED") drivers and electronic ballasts. I am the President of Phtalume, a consulting company I founded in 2012. Before that, I was Director of Power Supply Products at Light-Based Technologies, and I also served as Chief Technology Officer for Lightech Electronics, Inc. Additionally, I held vice president positions at Fulham Co, Inc., Universal Lighting Technologies, and Robertson Worldwide.

4. I am an elected senior life member of the Institute of Electrical and Electronics Engineers, and I am a member of the Illuminating Engineering Society.

5. While I am an expert in many areas of electrical engineering, I am not an expert computer scientist. However, during the relevant timeframe, I had ordinary skill in programming computers and have written computer programs. In addition, I frequently work with or supervise computer programmers having ordinary or expert skill. Therefore, I am familiar with the ordinary skill necessary to implement the lighting device of the '827 patent.

6. My testimony on below is from the point of view of the person of ordinary skill in the art, despite the fact that I am an expert in several areas.

7. I am a named inventor of fifty-five U.S. patents, and I have three patent applications pending before the U.S. Patent and Trademark Office. I have also authored eight publications in refereed journals and nine publications in trade journals, the most recent of which pertains to LED technology. My *curriculum vitae* is attached as Appendix A.

C. Compensation and Prior Testimony

8. I am being compensated at a rate of \$350 per hour to provide analysis and testimony in this *inter partes* review proceeding. My compensation is not contingent on the outcome of any matter or the specifics of my testimony. I have no financial interest in the Petition.

9. I have previously provided expert testimony in one other patent-related matter. My *curriculum vitae* discloses the details of this activity.

D. Materials and Information Considered

10. My findings are based on my years of education, research, experience, and background in the fields discussed above, and my investigation and study of relevant materials. In forming my opinions, I have considered the materials I identify in this declaration and those are listed in Appendix B.

11. I know of information generally available to, and relied upon by, persons of ordinary skill in the art at the relevant times, including technical dictionaries and technical reference materials (including textbooks, manuals, technical papers and articles); some of my statements below are expressly based on such awareness.

12. Due to procedural limitations for *inter partes* reviews, the grounds of unpatentability discussed are based solely on prior patents and other printed publications. I understand that Petitioner reserves all rights to assert other grounds for unpatentability or invalidity, not addressed herein, at a later time. Thus, the absence of discussion of such matters here should not be taken as indicating there are no such additional grounds for unpatentability and invalidity of the '827 patent.

II. LEGAL STANDARDS FOR PATENTABILITY

A. General

13. In expressing my opinions and considering the subject matter of the challenged claims of the '827 patent, I am relying upon certain basic legal principles provided.

14. I understand that in this proceeding Petitioners must prove that the challenged claims of the '827 patent are unpatentable by a preponderance of the evidence. I understand that under “a preponderance of the evidence” standard, Petitioners must show that a fact is more likely true than it is not.

15. I understand that for an invention claimed in a patent to be found patentable, it must be, among other things, new and not obvious from what was known before the invention was made.

16. I understand the information used to evaluate whether a claimed invention is patentable is generally referred to as “prior art” and includes patents and printed publications (*e.g.*, books, journal publications, articles on websites, product manuals, etc.).

17. I understand there are two ways in which prior art may render a patent claim unpatentable. First, the prior art can be shown to “anticipate” the claim. Second, the prior art can be shown to have made the claim “obvious” to a person of ordinary skill in the art. My understanding of the two legal standards is set forth below.

B. Priority Dates for Claimed Subject Matter

18. I understand that to be considered “prior art,” patents or printed publications must predate the priority dates for the subject matter claimed in the '827 patent.

19. I have been informed that a patent is only entitled to a priority date based on an earlier filed application if the earlier filed application meets the requirements of 35 U.S.C. § 112. Specifically, I have been informed that 35 U.S.C. § 112, ¶ 1 requires that the specification of a patent or patent application must “contain a written description of the invention, and the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the [invention]” I understand that the requirements of this provision are commonly called the written description requirement and the enablement requirement.

20. I have been informed that compliance with both the written description requirement and enablement requirement must be determined as of the effective filing date of the application for which priority is sought.

21. I have been informed that to satisfy the written description requirement a patent’s specification should reasonably convey to a person of skill in the art that the inventor had possession of the claimed invention as of the effective filing date of the application.

C. Claim Construction Standard

22. I understand that in this proceeding, the claims must be given their broadest reasonable interpretation of the claim language. The claims after being

construed in this manner are then to be compared to the information in the prior art, which for this proceeding is limited to patents and printed publications. I also understand that, at the same time, absent some reason to the contrary, claim terms are typically given their ordinary and accustomed meaning as understood by one of ordinary skill in the art.

23. I understand that in other forums, such as in federal courts, different standards of proof and claim interpretation control, which are not applied by the U.S. Patent and Trademark Office for *inter partes* review. Accordingly, any interpretation or construction of the challenged claims in this proceeding, either implicitly or explicitly, should not be viewed as constituting, in whole or in part, Petitioner's own interpretation or construction, except as regards the broadest reasonable construction of the claims presented.

D. Anticipation

24. I understand that the following standards govern the determination of whether a patent claim is "anticipated" by the prior art.

25. I understand that, for a patent to be "anticipated" by the prior art, every limitation of the claim must be found, expressly, implicitly or inherently, in a single prior art reference. I further understand that the requirement of strict identity between the claim and the reference is not met if a single element or limitation required by the claim is missing from the applied reference.

26. I understand that claim limitations that are not expressly described in a prior art reference may still be there if they are implicit or inherent to the thing or process being described in the prior art. I have been informed that to establish inherency, the extrinsic evidence must clarify that the missing descriptive matter is necessarily present in the thing described in the reference and that it would be so recognized by persons of ordinary skill in the art. I have been informed that inherency cannot be established just because a certain thing may result from a set of circumstances.

27. I understand that it is acceptable to consider evidence other than the information in a particular prior art document to determine if a feature is necessarily present in or inherently described by that reference.

E. Obviousness

28. I understand that for a single reference or a combination of references to render obvious a claimed invention, a person of ordinary skill in the art must have been able to arrive at the claimed invention by altering or combining the applied references.

29. I have been informed that a patent claim can be found unpatentable as obvious where the differences between the subject matter taught to be patented and the prior art are such that the subject matter as a whole would have been obvious when the invention was made to a person of ordinary skill in the relevant field.

Specifically, I understand that the obviousness question involves a consideration of:

- the scope and content of the prior art;
- the differences between the prior art and the claims at issue;
- the knowledge of a person of ordinary skill in the pertinent art; and
- whatever objective factors indicating obviousness or non-obviousness may be present in any particular case—referred to as “secondary considerations.”

30. Such secondary considerations include: (a) commercial success of a product due to the merits of the claimed invention; (b) a long-felt, but unmet need for the invention; (c) failure of others to find the solution provided by the claimed invention; (d) deliberate copying of the invention by others; (e) unexpected results achieved by the invention; (f) praise of the invention by others skilled in the art; (g) the taking of licenses under the patent by others and (h) the patentee proceeded contrary to the accepted wisdom of the prior art. Secondary considerations are relevant where there is a connection, or nexus, between the evidence and the claimed invention.

31. In addition, I understand that the obviousness inquiry should not be done in hindsight, but must be done using the perspective of a person of ordinary skill in the relevant art as of the effective filing date of the patent claim.

32. I understand that in order for a claimed invention to be obvious, there must be rationale for combining cited references as proposed.

33. Obviousness may also be shown by demonstrating that it would have been obvious to modify what is taught in a single piece of prior art to create the patented invention. Obviousness may be shown by establishing that it would have been obvious to combine the teachings of more than one item of prior art. In determining whether a piece of prior art could have been combined with other prior art or with other information within the knowledge of one of ordinary skill in the art, the following are examples of approaches and rationales that may be considered:

- (A) Combining prior art elements according to known methods to yield predictable results;
- (B) Simple substitution of one known element for another to obtain predictable results;
- (C) Use of a known technique to improve similar devices (methods, or products) in the same way;
- (D) Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;

(E) Applying a technique or approach that would have been “obvious to try” (i.e., choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success);

(F) Known work in one field of endeavor may prompt variations for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art; or

(G) Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention. I also understand this suggestion or motivation may come from such sources as explicit statements in the prior art, or from the knowledge or common sense of one of ordinary skill in the art.

34. I understand that an invention that might be an obvious variation or modification of the prior art may be non-obvious if one or more prior art references discourages or lead away from the line of inquiry disclosed in the reference(s). A reference does not “teach away” from an invention simply because the reference suggests that another embodiment of the invention is better or preferred. My understanding of the doctrine of teaching away requires a clear indication that the

combination should not be attempted (*e.g.*, because it would not work or explicit statement saying the combination should not be made).

III. THE PERSON OF ORDINARY SKILL IN THE RELEVANT FIELD AND IN THE RELEVANT TIMEFRAME

35. Based on my review of these materials, I believe that the relevant field for the '827 patent is solar powered lights and more particularly but not exclusively to solar powered lighting that produces a light of varying color and a continuous color changing cycle. ('827 patent, Ex. 1101, Col. 1:11–14, Col. 12:6-30.)

36. As described above, I have extensive experience in the relevant field, including experience relating to control of LEDs to produce varying colors. Based on my experience, I have an established understanding of the relevant field.

37. I understand that a “person of ordinary skill in the art” is presumed to know of all pertinent art as of the relevant timeframe, thinks along conventional wisdom in the art, and is a person of ordinary creativity. I understand that the level of skill in the art is evidenced by the prior art references. It is my understanding that the '827 patent is to be interpreted based on how it would be read by a person of ordinary skill in the art. It is my understanding that factors such as the education level of those working in the field, the sophistication of the technology, the problems encountered in the art, the prior art solutions to those problems, and the speed at which innovations are made may help establish the level of skill in the art. I understand that a person of ordinary skill in the art is not a specific real

individual, but rather is a hypothetical individual having the qualities reflected by the factors above.

38. I understand the relevant timeframe for evaluating a claim is at the time of the invention, which is based on the effective filing date of each claim, or the date at which the subject matter of the claim was first disclosed in an application in such full, clear, concise, and exact terms as to enable the person skilled in the art to make and use the claimed invention. For my analysis, I assume that the effective filing date of the '827 patent is December 23, 2003. In my opinion, given the relevant field and relevant timeframe of the '827 patent, a person of ordinary skill in the art would have: 1) a graduate degree in electrical or electronics engineering or physics with demonstrable experience in circuit design, or 2) a bachelor's degree in electrical or electronics engineering or physics with two years industrial experience and demonstrable experience in circuit design.

39. Based on my experience, I understand the capabilities of a person of ordinary skill in the relevant field as of 1978 and directed many such persons during my career.

IV. Technical Background

40. Light is one of many forms of electromagnetic radiation. The nature of electromagnetic radiation was quantified by James Clark Maxwell in approximately 1865 in the relations that have become known as Maxwell's

equations. *See* Observer, Tech Monthly Section, “What are Maxwell’s Equations?,” Sept. 14, 2013 at 27, available at <http://www.theguardian.com/science/2013/sep/15/maxwells-equations-electrify-world>. Maxwell developed the theory that describes how a changing electric field can generate a magnetic field. *See id.* Similarly a changing magnetic field generates an electric field. *See id.* If the variation is sinusoidal, then its rate of change is also sinusoidal; therefore, a sinusoidally varying electric field will produce a sinusoidally varying magnetic field that will, in turn, produce a sinusoidally varying electric field. *See id.* In other words, the excitation reproduces itself and propagates through space, hence the nature of electromagnetic radiation.

41. The exact manifestation of electromagnetic radiation is controlled by its frequency. It is possible to create electromagnetic radiation at frequencies corresponding to sound, for example, 3–30 KHz. The lowest frequencies commonly used are for AM radio that has a wavelength of around 300 m. It is much more common to characterize electromagnetic radiation by its wavelength rather than by its frequency. However, wavelength and frequency are linked by the speed of light. *See* David L. DiLaura *et al.*, Illumination Engineering Society, The Lighting Handbook 1.2, 10th ed., 2011.

42. Short wave radio transmissions use wavelengths down to 120 m and television broadcasts use wavelengths from 5 m to 20 cm. Microwaves, for radars

near airports, use wavelengths of approximately a few centimeters down to a few millimeters. Wavelengths from 1 mm down to 0.75 μm (750 nm) represent the transmission of heat and are infrared (IR) frequencies. Decreasing the wavelength further results in radiation that the human eye can detect as light—the deepest red color has a wavelength of around 780 nm and the deepest violet color has a wavelength of around 400 nm. *See id.* at 3.1. The sun gives out radiation at even shorter wavelengths known as ultraviolet light (UV) that cannot be seen by the human eye, but can cause, for example, reddening or even blistering of human skin

43. “For applied lighting, the optical radiation of interest can be divided into three components: UV, 100 to 400 nm; visible, 400 to 780 nm; and IR, 780 to 1 mm.” *See id.* For LED lighting, we are concerned primarily with the visible light wavelengths from approximately 780 nm down to 400 nm. Figure A shows a spectrum of sunlight. This is the spectrum of light that the human eye can perceive. Note there is light at every wavelength. *See id.* at 6.6.

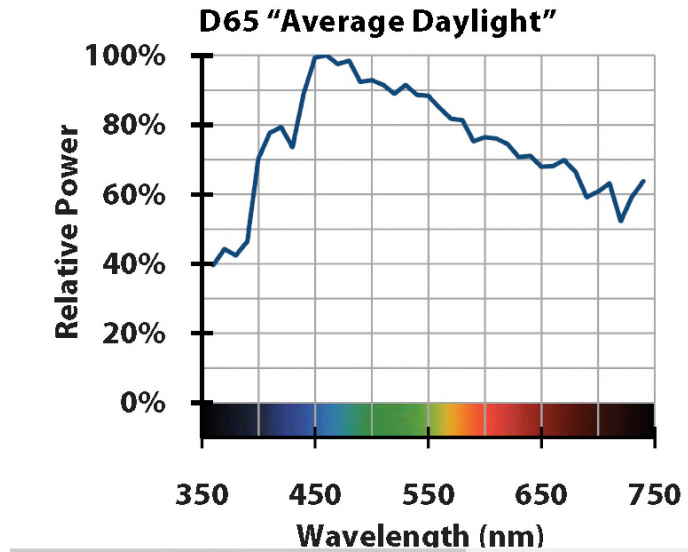
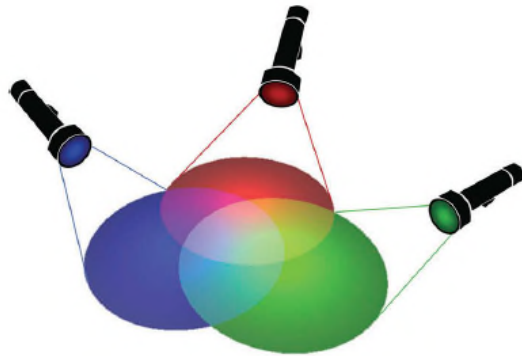


Figure A: Spectrum of daylight in the United States.

44. Although, there are many colors across the spectrum, the human eye only perceives three primary colors. *See id.* at 2.5. All other colors are made up from combinations of these wavelengths. *See id.* For example, a fluorescent lamp can emit the primary colors of red, green and blue, plus some yellow. The human eye perceives this combination as white light. With solid state (LED) lighting, LEDs that are respectively red, green, and blue can be combined in specific proportions and are interpreted by the human eye as white light.

45. Figure B shows the overlap of red, blue and green light including the creation of white light when the three colors are added together. *See id.* at 6.7.



Additive Color Mixing

The primaries shown are red, green, and blue. The secondary colors created where two primary beams overlap are yellow, magenta, and cyan. White light is created in the center where the three beams overlap, or "add together".

Figure B: White light produced from Red, Green, and Blue light.

46. To create varying color that can cover the spectrum of colors, one or more of the LEDs is varied in intensity, and the human eye perceives a varying color. *See id.* at 6.8.

47. A continuous color changing cycle or varying color can be done by simply switching each of three LEDs (*e.g.*, Red, Green, and Blue) on or off, which can produce a matrix of seven colors. For example, if Red and Blue are switched on and Green is off, then the resulting color is Magenta; if Red and Green are both switched on and Blue is off, then the resulting color is yellow; if Red, Blue and Green are all switched on, then the resulting color is white, etc. To produce over seven colors, each LED must be able to driven to change in brightness or intensity, not just switched on or off.

48. The use of Pulse Width Modulation to vary color and produce a continuous color changing cycle is well known in the prior art and can be used to produce a spectrum of colors. For example, U.S. Patent No. 7,064,498 to Dowling, filed March 13, 2001 and issued June 20, 2006, states, “[t]he '038 patent discloses LED control through a technique known as Pulse-Width Modulation (PWM). This technique can provide, through pulses of varying width, a way to control the intensity of the LED's as seen by the eye. Other techniques are also available for controlling the brightness of LED's and may be used with the invention. By mixing several hues of LED's, many colors can be produced that span a wide gamut of the visible spectrum. Additionally, by varying the relative intensity of LED's over time, a variety of color-changing and intensity varying effects can be produced. Other techniques for controlling the intensity of one or more LEDs are known in the art, and may be usefully employed with the systems described herein. In an embodiment, the processor 2 is a Microchip PIC processor 25 12C672 that controls LEDs through PWM, and the LEDs 4 are red, green and blue.” (Dowling, col. 6:1-26) (emphasis added).

49. Dowling further explains how the output color can be made to change continuously. “When the device is powered on, it may enter a first mode 8. for example, under control of a program executing on the processor 2 of FIG. 1. The first mode 8 may provide a color wash, in which the LEDs cycle continuously

through the full color spectrum, or through some portion of the color spectrum.”
(Dowling, col 6: 31-35.)

50. The frequency or rate at which the color changes cycle through can be controlled by a parameter in the control software. (Dowling, col 6: 36-38) (“a rate of the color wash may be determined by a parameter stored, for example, in the memory 6 shown in FIG. 1 A”).

51. The human eye cannot perceive rapid variations in intensity. If a light is modulated at 50 Hz, most people can perceive a rapid flashing on and off. If this frequency is increased to 100 Hz, many people may not discern the variation. By a frequency of 120 Hz, a majority of people cannot perceive the fluctuation but instead see steady light. Above 200 Hz, essentially no one can detect the fluctuation by directly looking at it. *See* David L. DiLaura *et al.*, Illumination Engineering Society, The Lighting Handbook 1.2 at 7.69. Lighting technologists take advantage of this by using very rapid pulses of light from 400 to 1000 pulses per second to controllably modulate light. The width of each pulse is varied; this is called pulse width modulation. *See id.*

52. When PWM is done, the human eye perceives a light that grows bright and dim, even though electronic instruments may record that the peak of each pulse is actually the same. *See id.* A pulse width modulator is commonly used to control the LED’s intensity. A color spectrum is achieved by continuously

changing intensity level by varying the level of power to each LED. The result is a mixture of colors; for example, if red, blue and green light is used, that combination can produce color changes across the color spectrum.

53. In some LED color changing work, it is assumed that the pulse width modulation is taking place at a frequency which is much higher than the human eye can perceive. Frequencies from 400 Hz to 1000 Hz are commonly used. When this pulse width modulation is used to produce what the human eye perceives as a repeatedly varying or changing color, another, much lower, frequency is used, for example one cycle every few seconds, in which the system may go through a prearranged sequence of colors and then can start over again when programmed to repeat.

54. This repetition rate may be called the cycle frequency, although other terminology is used, for example, Dowling describes this a “a rate of the color wash may be determined by a parameter stored, for example, in the memory 6 shown in FIG. 1 A.” (Dowling at 6:36)

55. Light output from a source is measured in lumens. The lumen is a simple measure of the total energy being emitted as light, over the whole visible spectrum and in all directions. *See* David L. DiLaura *et al.*, Illumination Engineering Society, The Lighting Handbook 1.2 at 5.9. Commonly light bulbs are sold according to how many lumens they output. For example, 1000 lumens is a

very bright lamp for indoor purposes. The intensity of light is a measure of how much light is being emitted per solid angle. *See id.* at 5.13. Thus, intensity does not depend on the distance from the lamp. You can also increase the intensity in a given direction by using a lens or a reflector to direct more light in that direction. Intensity is measured in lumens per steradian or candela. *See id.* Intensity is directly proportional to the amplitude of the electric and magnetic waves that comprise the light, but the term “amplitude” is not normally used in the lighting industry.

56. Since the preceding paragraph involves the first use of the word “lens” in this declaration, I will clarify that an array or sheet of lenses is often used to diffuse light coming out of a luminaire. *See id.* at 8.4. These diffusers are thus called lenses. In addition, when a plane sheet of glass or plastic is used around a light source, such a structure is referred to as a lens. *See id.* Such a structure may be rendered translucent to conceal the shape of a light source within the structure. For these reasons in the rest of this declaration the terms “lens” and “diffuser” are treated as equivalents, reflecting common practice in the lighting industry in the context of luminaires.

57. In the lighting industry the technology of controllably making lights brighter and dimmer is very important. Several terms are used to quantify this process. For example, we have already defined intensity above. When a surface is

illuminated by a light, it gives out light, and the amount of light given out per steradian per unit area is called luminance. *See id.* at 5.14. The commonplace term brightness used to describe the intensity or luminance of light has no mathematical representation but is defined simply as the perceived luminance. *See id.*

58. A light sensitive switch comprises at a minimum a) a light responsive element that can be a photodiode, phototransistor, photovoltaic cells, photoTRIAC, photoSCR, a phototransistor or any other circuit element that changes some parameter of its circuit characteristics in response to light; b) a power switch that operates to activate or deactivate a circuit in response to a signal from the light responsive element. Such a switch might be a bipolar transistor, a field effect transistor, a silicon-controlled rectifier (SCR), an insulated gate bipolar transistor or any electronic power switch known to those skilled in the art. Each of these categories has many sub categories, for example, bipolar transistors may be NPN, PNP, Darlington, etc. The light sensitive switch is not required to be a mechanical switch.

59. It is possible that one device may comprise the entire function of a light sensitive switch. A phototransistor will turn on in response to light and turn off again when the light is removed. Inside the chip, one can distinguish a photodiode part and a transistor part, but the product is sold as a single device. There are other similar devices such as a photoSCR and a photoTRIAC.

Sometimes it may be convenient to have some intermediate circuitry in between the light responsive element and the power switch. Most commonly this will comprise amplification or buffering to allow thresholds for switching to be adjusted, or incorporating hysteresis (*e.g.*, Schmitt trigger circuits) to make the switching decisive and free from jitter.

60. Furthermore, the light responsive element might have multiple purposes inside a product, for example, a photovoltaic cell may be used not only to generate a signal voltage but may also generate energy for the purposes of the system. Likewise, a photoresistor that operates on an inverse relationship with light intensity may be used as a conventional resistor and still provide a function even in the absence of light.

V. STATE OF THE ART

61. Solar powered lights are lighting products that produce light using stored energy obtained from sunlight. Garden/memorial lights, illuminated wind chimes and wind indicators represent a particular subset of solar powered lights. Solar lights may involve a combination of elements such as a photovoltaic cell, a rechargeable battery, a lamp and ambient light sensing control circuitry used to determine when to turn the lamp on, and lighting circuitry often using integrated circuits to determine which colors and patterns to display.

62. A first key ingredient for solar powered lighting is a compact, lightweight rechargeable battery. Nickel metal hydride batteries were first released in 1989 and were soon improved upon by the lithium ion battery, which first became available in 1991. *See, e.g.*, U.S. Patent No. 5,062,028 to Frost, issued October 1991 (generally describing a solar lamp on a ground stake powered by rechargeable nickel metal hydride batteries).

63. The second key ingredient for solar powered lighting is the availability and effectiveness of photovoltaic cells. By the year 2000, a relatively small solar cell could generate enough power in one day to keep a discharge lamp operating for several hours during the night.

64. Early attempts at making solar powered lights used lead acid batteries, for example, as described by Doss in U.S. Patent No. 4,841,416, filed in March 1988 and issued in June 1989. This product used a 12V incandescent lamp. Also with using incandescent lamp but now with a battery the shape and size of a nickel metal hydride battery, is the invention described by Frost in U.S. Patent No. 5,062,028, which was filed in August 1989 and issued in October 1991. This product featured a stake to be driven into the ground and on top of this was a translucent compartment containing a lamp. A photovoltaic array was mounted on the top surface. This product could only produce light for a relatively short period because it still used an inefficient incandescent lamp as the light element.

65. Other inventors exploited more efficient light sources to achieve extended duration of light output. Hung, in U.S. Patent No. 5,055,984, filed in August 1989, mentions using a gas discharge lamp. An early use of LEDs in a garden light was described by Ouyang in November 1993 in CN 2145314Y. This publication disclosed a LED lighting wind chime product that used LED lights and could be powered either from a power line step down transformer or from a battery. (Ouyang, Specification.) Clark described a solar powered lamp which used LEDs for the light source in June 2002 PCT Application No. WO 02/101285. Clark also described an ambient light sensor providing for the light to come on only at night or dusk. Such light sensitive circuits are not novel and are well known in the art. For example, U.S. Patent 5,211,470 by Frost *et al.* issued on May 18, 1993 disclosed light sensitive circuitry using a photovoltaic cell, a diode, a battery, and a transistor. These components were arranged to charge the battery in the presence of sunlight, and to run the light off the battery in the absence of light. (See Frost *et al.*, Col. 4:21–40.)

66. The next technology leap to affect the business of solar powered lighting was the improvement of LED lamp efficacy. LED devices had been around since 1962, but in the 1960s and 1970s they were only bright enough to make indicator lights and low powered displays such as on calculators. However with continual R&D, in the time interval from 1965 to 1990 the light output per

LED that could be obtained had increased 1000 times so that, during the 1990s it was now possible to make a useful luminaire with an efficacy already many times that of an incandescent lamp, and outputs of several lumens could be produced from an LED lamp.

67. In October 1993, U.S. Patent No. 5,255,170 issued to Plamp described a solar powered memorial light using early LEDs as the light source. This invention brought together LEDs, photovoltaic cells and batteries.

68. In 1999, another technology line was evolving as engineers were realizing it was possible to switch LEDs on and off so rapidly (say 1000 times/sec) that the human eye would detect instead a steady light with a brightness corresponding to the fraction of time the LED was switched on. By operating a red, a blue, and a green LED simultaneously, any desired color could be synthesized. This could be accomplished by using an inexpensive microcontroller, for example, the Philips 51LPC family has three PWM (pulse width modulator) outputs that can output pulses with a width under program control.

69. U.S. Patent No. 5,924,784 by Chliwnyj, filed on August 15, 1996 and published on July 20, 1999, successfully combined solar power, a rechargeable battery and color varying/changing. Chliwnyj specifically disclosed an illuminated garden/memorial lighting device using solar energy, a rechargeable battery and an integrated circuit using pulse width modulators to drive the intensity of a plurality

of differently colored LEDs to produce a varying color. This lighting device was one of the first to incorporate the capability of varying color in a solar battery powered device. The lighting device was used in a garden setting, *e.g.*, a gravesite memorial. Chliwnyj describes program code that modulates the brightness and frequency of each of the variously colored LEDs on a repetitive basis. (Chliwnyj, Ex. 1105, col 6:63–7:6.) (“Sinusoidal wave values were initially used as fundamental excitation values for each of LEDs 7a–e. As shown in FIG. 12, the program code may use a table 21 of stored sine wave values, which table 21 is indexed (see index 22) at varying rates to generate differing period waveforms for each of LEDs 7a–e. For each of LEDs 7a–e a circular buffer pointer 26 may be used to access the sine table 21. Additionally the data structure for each of LEDs 7a–e may have a pointer to the start of the current waveform table and the end of the table so that the circular buffer pointer 26 may wrap to the beginning of the stored waveform when it gets to the end.”). In this manner, Chliwnyj programmed each color LED to go through a cycle of brightness levels, so that the assembly of LEDs would put out a repetitive cycle of different colors. Chliwnyj also taught a “prescaler” variable to change the frequency of each LED sine wave in the circular buffer pointer.

70. In U.S. Patent No. 6,241,362 by Morrison (“Morrison,” Ex. 1114), filed in July 1999 and issued in June 2001, Morrison disclosed an ornament that

has a microprocessor driving red, green, and blue LEDs and which uses a battery. The light level coming from each LED is controlled by pulse width modulator under program control, so a sequence of slowly varying color changes can be exhibited. No solar power or light sensor is involved. Morrison describes: “Each of the LEDs 26a 30 through 26c is cycled from zero to one hundred percent output and back to zero and to the beginning of the cycle over a period of twenty four seconds (represented by six time intervals, each comprising four seconds). As noted above, the micro control unit 52 may be programmed to provide other time intervals as desired.” (Morrison, Ex. 1114, col. 9:29-36). “The above described cycle repeats over intervals six through twelve on the graph 64, and may be made to repeat endlessly as desired so long as electrical power is supplied to the circuit.” (*Id.* at 10:30-35).

71. U.S. Patent No. 6,431,719 to Lau, filed in September 2000 and issued in August 2002, described the same technology, but was powered from an AC power line instead of a battery. This invention used the technology to make a color varying nightlight. Lau describes: “The displayed light patterns vary smoothly and continuously from monochrome to different color combinations of light, with the cycle repeating over a cycle period that may be sixty seconds or so in length.” (Lau, Ex. 1107, col. 1:36-40).

72. U.S. Patent No. 7,064,498 to Dowling, filed March 13, 2001 and issued June 20, 2006, described a general purpose technology for controlling different colored LED lights using pulse width modulation, which could be used for making any desired sequence of light colors over time. Dowling described a pulse width modulator for each LED under the control of a microprocessor. In Fig.2A, Dowling describes how the software can be used to produce either a static color, a random color, or a color wash effect, which as previously explained is Dowling's terminology for repetitively cycling through a sequence of colors. The applications were for essentially any kind of lighting. (Dowling at Fig. 2A.).

73. In U.S. Patent Publication No. US 2003/0201874 filed on April 24, 2002, Chih Hsien Wu disclosed a garden illumination device using multiple lenses, a plurality of colored LEDs that flash alternately, an on/off switch, a photovoltaic cell, and a rechargeable battery. As the technology trend and prior art shows, the invention of combining a garden light device with color varying circuitry was well known prior to the '827 patent, indeed.

74. The development of a solar powered light device using color varying circuitry was a logical and predictable variation.

VI. THE '827 PATENT

A. Background of the '827 Patent

75. The challenged '827 claims are directed to the interplay between a solar garden light apparatus and electronic circuitry to produce a varying color changing effect using a plurality of light emitting elements.

76. The '827 patent discloses electrical components and circuitry to power light sources through solar power and a rechargeable battery to produce varying colors. The lighting device also charges the battery during the day and the battery later powers the light emitting elements to emit light in low light ambient conditions.

77. The '827 patent is broadly directed to directed to a lighting device having a lens, rechargeable battery, solar cell, and circuitry to produce light of varying color. ('827 Patent, Ex. 1101, Col. 1:39–59.) The '827 patent attempts to overcome the well known disadvantages of the current art of light emitting diodes system that produce variable color, by producing more uniform desired colors and greater ease of adjusting the various light functions. ('827 Patent, Ex. 1101, Col. 1:17–20.) The '827 patent admits “the invention of LED systems to produce variable color” is well known. ('827 Patent, Ex. 1101, Col. 1:17–18.) The Patent Owner also admits that using solar-powered garden lights using rechargeable batteries is also well known in the art. ('827 Patent, Ex. 1101, Col. 1:20–25.)

78. The prior art teaches using a plurality of different colored LEDs and ramping and/or controlling power to the light sources to vary intensity to create color varying. The prior art also discloses switches that allow a user to select a desired color and power the circuitry on and off. The prior art teaches circuitry with programs in memory to produce a multitude of desired lighting patterns. Together the prior art renders obvious all of the challenged claims of the '827 patent.

B. Prosecution History of the '827 Patent

79. The '827 patent was filed on April 7, 2005 and issued on September 30, 2008. During prosecution, rejections were made based on double-patenting in light of Richmond's U.S. Patent No. 7,196,477 (the "'477 patent") and certain other references. In an Office Action dated March 17, 2008, the examiner rejected claims 42–58 on the grounds of non-statutory obviousness-type double patenting as unpatentable over claims of the '477 patent in view of U.S. Patent No. 6,384,570 (sic) to Frost. Claims 73–76 were rejected based on double patenting as unpatentable over claims of the '477 patent in view of Frost and in further view of U.S. Patent No. 6,517,217 to Liao. Claims 30–41 and 59–72 were allowed. To traverse these rejections, Richmond canceled the claims so rejected and added new claims (77–85) and filed a terminal disclaimer to render any double-patenting rejection moot. In light of the terminal disclaimer and the cancelation of claims

rejected, the examiner issued a notice of allowance on August 7, 2008. ('827 File History, Ex. 1003.)

80. I have been instructed that the patentee's purported earliest priority date for the challenged claims is December 23, 2003.

C. Construction of Terms Used in the Challenged Claims

81. I understand in this proceeding before the U.S. Patent and Trademark Office that the broadest reasonable interpretation of the claims in light of the specification is to be used to determine what the claims encompass. I also understand that, at the same time, absent some reason to the contrary, claim terms are typically given their ordinary and accustomed meaning as understood by one of ordinary skill in the art. I have used this standard in evaluating what the claims define, as well as terms used in the claims.

82. The term "*lamp*" is in independent claim 32. The claim states "circuit having at least two lamps of different colours" and as I understand it is construed to mean, "an electrical device, the primary purpose of which is to create light of a single color, and which is physically connected to a source of electricity."

83. The term "*varying colour*" is in independent claim 32. The claim states "including a varying colour," and is construed to mean, "perceptible changing of color over time." IPR2014-00936 at 8 (construing "varying color" in the '477 patent).

84. The term “*color changing cycle*” is in independent claim 32 and dependent claim 31. The claim states “to produce a continuous color changing cycle;” and is construed to mean, “a series of perceptible changes of color over time, with or without repetition.” I was informed that the Board’s decision in a similar case that defined cycle broadly as a “series of events, with or without repetition.” IPR2014-00877, paper 10 at 6–7; (quoting Ex. 1110). I agree with this decision. Just because a cycle does not repeat does not mean it is not a cycle. I can think of many instances, such as the 11-year sunspot cycle cited by the Board in ex. 1113, in which cycles occur but are not exactly the same. In other words, random cycles are still cycles. Therefore, I believe the broadest reasonable interpretation of “color changing cycle” is “a perceptible changing of color over time, with or without repetition.”

85. However, the Board may use the patent owner’s narrower construction requiring repetition, despite the ’827 patent not requiring it. Therefore, another proposed construction of the term “*color changing cycle*,” is “ramping up and down intensity of light emitted over time in a series of changing colors that repeats by said at least two light sources.” For the reasons discussed above in ¶ 84, I do not believe this is the broadest reasonable interpretation.

86. I understand that petitioner believes the Board may adopt the following construction: “pattern or scheme of perceptible changes of color over

time, with or without repetition.” For the reasons discussed above in ¶ 84, I do not believe this is the broadest reasonable interpretation.

87. It is my opinion that the prior art teaches a “continuous color changing cycle” because Chliwnyj in view of Wu and Lau teaches each construction, whereas the narrower definitions are a subset of the broadest reasonable interpretation.

88. The term “*switch being accessible by a user*” is in independent claim 27 and dependent claim 33. The term is construed to mean, “the switch is accessible to the user without substantial effort, tools, or destruction.” Therefore, a switch need not be exposed and the user can disassemble the device, *e.g.*, remove a few screws, unscrew a lens, etc., to gain access to the switch.

VII. PATENTABILITY ANALYSIS OF CLAIMS 31-34 OF THE '827 PATENT

A. Overview of the Prior Art

1. U.S. Patent No. 5,924,784 (“Chliwnyj”)

89. Chliwnyj was filed on August 15, 1996, published on July 20, 1999 and is therefore prior art to the '827 patent. Chliwnyj discloses an illumination device using solar cells, a rechargeable battery, a plurality of colored lamps, and an integrated circuit including a pulse width modulator to drive the plurality of different colored LEDs to produce a varying color and a continuous color changing cycle. Chliwnyj allows for changes to intensity and frequency under program

control or manual control. The device is suitable for outdoor areas such as a memorial site, *e.g.*, a garden environment. (Chliwnyj, Ex. 1105, Background of the Invention.)

2. U.S. Patent Application Pub. No. US 2003/0201874 A1 (“Wu”)

90. Wu was filed on April 24, 2002, published on October 30, 2003 and is therefore prior art to the '827 patent. Wu discloses a garden illumination device using solar energy to illuminate light emitting elements of different colors. The device is suitable for outdoor areas such as courtyards and parks and scenic environments. (Wu, Ex. 1106, Background of the Invention.)

3. U.S. Patent No. 6,431,719 (“Lau”)

91. Lau was filed on September 22, 2000, issued on August 13, 2002 and is prior art under 35 U.S.C. § 102(b). Lau is a night light that contains an array of differently colored light emitting diodes used to entertain and soothe the viewer. Lau teaches that the night light can output a display of dynamic light that can be frozen in a desired light pattern. Lau also teaches continuous color changing cycles. (Lau, Ex. 1107, Background of the Invention and Summary of the Present Invention.)

B. THE CLAIMS OF THE '827 PATENT ARE OBVIOUS

92. I have analyzed four combinations to determine that the claims of the '827 patent are all obvious in view of the prior art.

Ground 1 - Chliwnyj, Wu and Lau render claims 31–34 obvious;

93. Claims 27¹, 31–34 of the '827 patent are reproduced below. For ease of reference, where claims have multiple limitations, I have been parsed them into elements and given each a unique numerical identifier.

U.S. Patent No. 7,429,827	
[27.0]	A lighting device to produce light of varying colour, said device including:
[27.1]	a lens,
[27.2]	a circuit having at least two lamps of different colours to produce a varying colour,
[27.3]	said lamps being mounted to direct light through said lens,
[27.4]	connections for at least one rechargeable battery to power said circuit,
[27.5]	a solar cell mounted so as to be exposed to light and operatively associated with said connections to charge said battery,
[27.6]	and a user operated switch operable to control said circuit, with said switch being accessible by a user thereby enabling said user to manipulate said switch to control delivery of power to said lamps; and
[27.7]	a spike for positioning said connections above a ground surface.
[31]	The lighting device of claim 27, wherein said circuit includes a light sub-circuit connected to said lamps to deliver power thereto, wherein said light sub-circuit varies said power to each of said lamps so as to vary both intensity of light emitted and frequency of changes to said intensity to produce a continuous color changing cycle.
[32.0]	A lighting device to produce light of varying color, said device including:..
[32.1]	a lens;
[32.2]	a circuit having at least two lamps of different colors mounted to direct light through said lens,
[32.3]	an activation sub-circuit to provide power to said lamps only at low light levels, and
[32.4]	a light sub-circuit to independently control delivery of power to each of said lamps so as to vary intensity of light emitted over time to produce a continuous color changing cycle,

¹ Claim 31 depends from claim 27. Therefore, claim 31 includes all the limitations from claim 27.

U.S. Patent No. 7,429,827	
[32.5]	connections for at least one rechargeable battery to power said circuit, and
[32.6]	at least one solar cell mounted so as to be exposed to light and operatively associated with said connections to charge said battery; and
[32.7]	a spike for positioning said connections above a ground surface.
[33]	The lighting device of claim 32, further comprising at least one user operated switch operable to control said circuit, with said switch being accessible by said user thereby enabling said user to manipulate said switch to control delivery of power to said lamps.
[34]	The lighting device of claim 32, wherein said light sub-circuit further independently controls delivery of power to each of said lamps so as to vary frequency changes to said intensity.

C. Ground 1: Claims 31–34 are rendered obvious by Chliwnyj in view of Wu and further in view of Lau

94. It is my opinion that claims 31-34 of the '827 patent are rendered obvious by Chliwnyj in view of Wu further in view of Lau.

Claim 27

95. In my opinion claim 27 of the '827 patent is rendered obvious by Chliwnyj in view of Wu and Lau. Reference to the numbered claim elements will be used extensively in my analysis below.

Claim element 27.0 - A lighting device to produce light of varying colour, said device including:

96. Chliwnyj discloses a lighting device to produce light of varying colour.

97. As Chliwnyj states in the abstract “[t]he preferred embodiment has a plurality of lighting elements in a plurality of colors which are modulated in intensity by a control circuit with a stored program. The control program includes stored amplitude waveforms for the generation of a realistic flame simulation. The program further contains random elements to keep the flame constantly changing.” (Chliwnyj, Ex. 1105, Abstract.) Chliwnyj further states that randomness should not be apparent. (Chliwnyj, Ex. 1105, 4:32.) This does not mean that there can be no repetition, and indeed, as explained in at least ¶¶ 163–165, Chliwnyj teaches repeating cycles, which sometimes happen so quickly that the human eye will not perceive them. For example, microcontrollers often repeat tens, hundreds, thousands, even millions of cycles per second, and the human eye cannot perceive these cycles because they happen so fast.

98. Further, Chliwnyj states “[t]he turning on and turn off of the LEDs, caused by a pulse width modulation of an LED current, tends to broaden the spectrum of the LEDs. This leads to an increased apparent brightness of the flame. Super Brite™ light emitting diodes (Super Brite™ LEDs), which may be supplied by high power AlInGaP amber and reddish-range LED lamps, have a wider spectrum than other LEDs. Super Brite™ LEDs may also enhance the flame motion due to color changes.” (Chliwnyj, Ex. 1105, Col. 5:18–25.)

99. “The controlling program comprises stored instructions for generating the amplitude modulated time waveforms for controlling the current to the lighting elements. Pulse Width modulation (PWM) may be performed in either hardware or program code, provided that sufficient microprocessor “bandwidth” may be available to perform the program-code operations. Drivers provide the necessary drive current for the respective lighting element.” (Chliwnyj, Ex. 1105, Col. 5:34–43.)

100. Figure 2 shows a functional block diagram of the solar-powered flame-simulation circuitry. It discloses a Pulse Width Modulator to control each LED to produce a varying color.

101. One of ordinary skill in the art would recognize that the block diagram of Figure 2 is a powerful and versatile architecture that allows for essentially unlimited control of the brightness and color of the light being produced over time. Besides temporal variations, Chliwnyj discloses (as shown in example Figure 5) spatial separation of the LEDs, so not only can the light output vary in brightness and color, but can also appear to move around. Chliwnyj describes the use of a microprocessor with separate pulse width modulators, one of which is used for each LED. The pulse width modulators are controlled by the microprocessor to output pulse trains at a frequency so high that the human eye cannot perceive the individual pulses, instead perceiving only the average light output from that LED.

As the pulse width of these high frequency pulse trains is adjusted, the brightness of the perceived light can be varied over a wide range, for example, from zero to 100 percent. Chliwnyj describes using LEDs of different colors, so the net result of their combined light seen through a diffuser or lens would be perceived by the human eye as fluctuations in color. The pulse width modulators are operated under stored program control by the microprocessor, and can be made to output essentially any desired pattern of brightness and color, including slow ramps of brightness and color as the intensity of the individual colored LEDs is ramped up and down. It would be obvious for one of ordinary skill in the art to use the circuitry of Chliwnyj to produce ramping patterns of intensity and color for ornamental outdoor lighting.

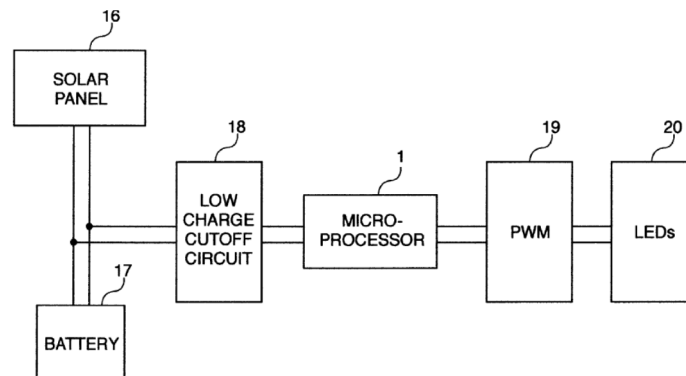
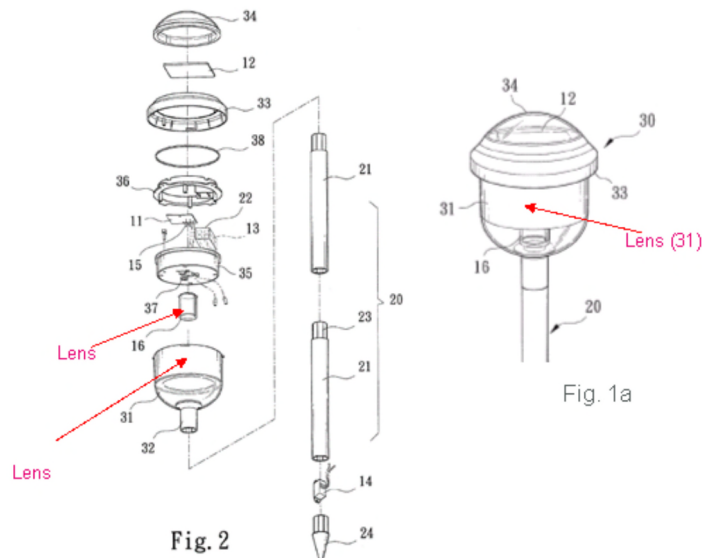


Figure 2

Claim element 27.1 - a lens,

102. Wu discloses a lens generally enclosing a chamber.

103. As seen in Figures 1a and 2 below, Wu discloses a lens and chamber.



Claim element 27.2 - a circuit having at least two lamps of different colours to produce a varying colour,

104. Chliwnyj discloses a circuit including at least two lamps of different colours to produce a varying colour.

105. As explained in Chliwnyj “[a] microprocessor-based simulated electronic flame in its best mode uses multiple LEDs as controlled lighting elements to give the appearance of flame motion, typically when viewed through a diffuser. The plurality of controlled lights allow the simulated flame motion.” (Chliwnyj, Ex. 1105, Col. 5:11–14.). “The preferred embodiment has a diffuser with a frosted base to blend the different colors of light together and also provide a screen on which the movement of the flame is visible.” (Chliwnyj, Ex. 1105, Col. 9:7–10.). One of skill in the art would have known at the time of the invention that the blending together of different colored lights with a diffuser will produce a

different, blended, color. If the amplitude of one of these colored lights is varied, then the color of the resulting blended light will vary accordingly.

106. “FIG. 1 shows a functional block diagram of a microprocessor-based prototype circuit comprising a flame simulation circuitry. The device 8 initially consisted of a set of five Super Brite™ LEDs 7a, 7b, 7c, 7d, and 7e (LEDs 7a–e) in 2 or 3 different colors. The Super Brite™ LEDs may be supplied by High power AlInGaP Amber and Reddish-orange Lamps from Hewlett Packard. Also known as Super Brite™, or Ultra Brite™, the LEDs are high efficiency LEDs and are known to be available in red, amber, and yellow colors. However, light-emitting diodes are generally available in a number of suitable colors from many different manufacturers.” (Chliwnyj, Ex. 1105, Col. 6:25–36.)

107. Figure 1 is shown below illustrating these features.

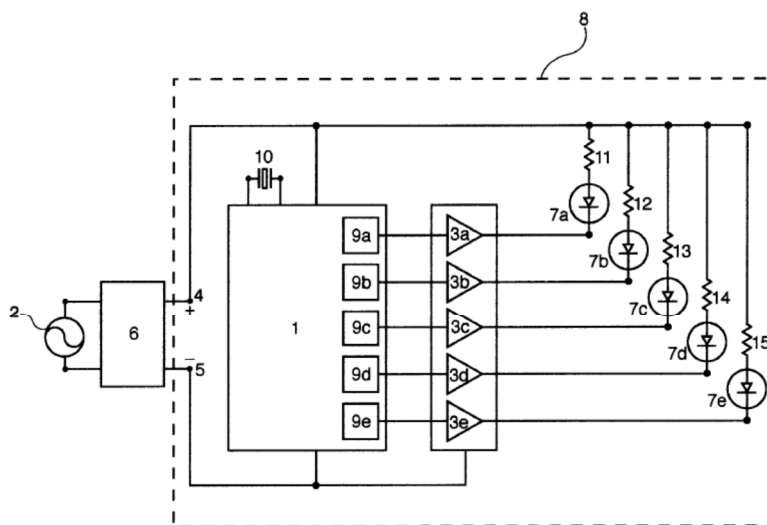


Figure 1

108. Above, Figure 1 discloses five Pulse Width Modulators to control the brightness of each respective LED so that when the intensity of any one is changed, the blended together composite light seen through a diffuser will change in color. Thus the light from at least two lamps of different color is combined together to produce varying colors, depending on the intensity of the individual lamps.

109. Figure 2 of Chliwnyj discloses a block diagram with the Pulse Width Modulators to control each LED to produce a varying color.

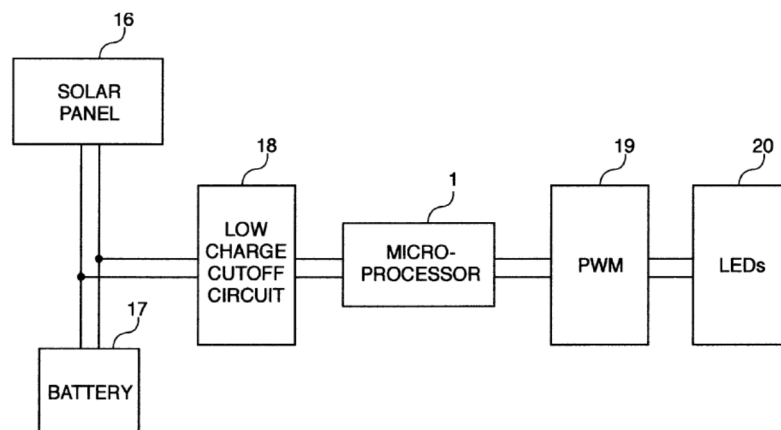
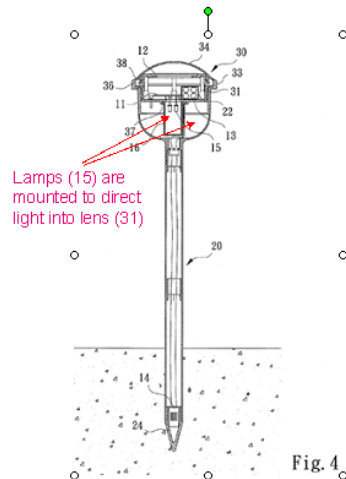


Figure 2

Claim element 27.3 - said lamps being mounted to direct light through said lens,

110. Wu discloses lamps mounted to direct light through said lens.

111. Figure 4 of Wu discloses the light emitting elements (lamps) 15 mounted to direct light through said lens.



Claim element 27.4 - connections for at least one rechargeable battery to power said circuit,

112. Chliwnyj discloses connections for at least one rechargeable battery to power the circuit. As explained in Chliwnyj and with respect to Figure 7, “[a]nother specific embodiment is the combination of an in-ground memorial with a solar powered memorial. An in-ground memorial is commonly found placed in-ground at a cemetery with its memorial face visible and even with the ground. Preferably built of bronze or granite, the memorial 56 may have **solar panels 54a—b exposed** with an eternal flame combination of LEDs and diffuser 55 built into the monument 56. The electronics and **batteries are hidden in the unit**. A bronze ring 57 is provided for replacing or removal of **rechargeable batteries** from the top on a periodic basis. FIG. 7 is a drawing of a solar powered ‘eternal flame’ combined with a flush memorial.” (Chliwnyj, Ex. 1105, Col. 12:20–31) (emphasis added).

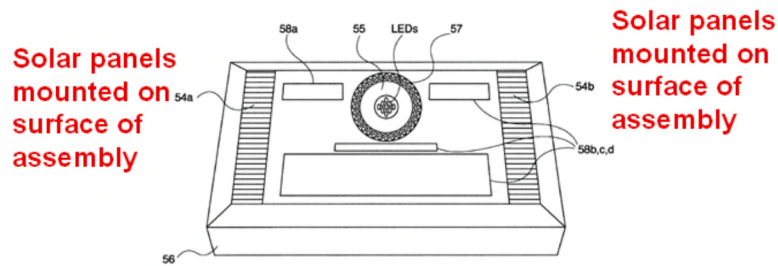


Figure 7

Claim element 27.5 - a solar cell mounted so as to be exposed to light and operatively associated with said connections to charge said battery,

113. It is my opinion that claim element 27.5 of the '827 patent is rendered obvious by Chliwnyj in view of Wu and Lau for the reasons explained with respect to claim element 27.4 above.

Claim element 27.6 - and a user operated switch operable to control said circuit, with said switch being accessible by a user thereby enabling said user to manipulate said switch to control delivery of power to said lamps; and

114. Chliwnyj discloses a user operated switch operable to control said circuit, with said switch being accessible by a user thereby enabling said user to manipulate said switch to control delivery of power to said lamps.

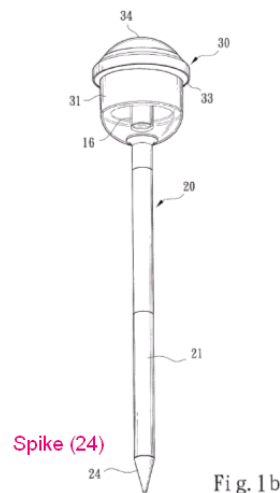
115. Chliwnyj discloses a switch operated to control delivery of electric power from the battery to operate said circuit. As explained, “A plurality of rechargeable batteries 28a–d, for example, AA **rechargeable batteries, may be housed in a battery holder 35 and connected through a switch to the circuit**

card 29, all of which may be located inside the hollow base 27.” (Chliwnyj, Ex. 1105, Col. 10:66–Col. 11:3) (emphasis added).

Claim element 27.7 - a spike for positioning said connections above a ground surface.

116. Wu discloses a spike for positioning said connections above a ground surface.

117. As seen Figure 2 below, Wu discloses a spike 24 for positioning the connections above a ground surface. It is obvious to one of ordinary skill in the art that the spike of Wu can be placed in the soil to position the lighting device above the ground.



Claim 31 - The lighting device of claim 27, wherein said circuit includes a light sub-circuit connected to said lamps to deliver power thereto, wherein said light sub-circuit varies said power to each of said lamps so as to vary both intensity of light emitted and frequency of changes to said intensity to produce a continuous color changing cycle

118. It is my opinion that claim 31 of the '827 patent is rendered obvious by Chliwnyj in view of Wu and Lau as applied to claim 27 and further that Chliwnyj discloses a circuit that includes a light sub-circuit connected to said lamps to deliver power thereto, wherein the light sub-circuit varies said power to each of the lamps to vary both intensity of light emitted and frequency of changes to said intensity to produce a continuous color changing cycle.

119. As stated previously, Chliwnyj's Figure 1 discloses a circuit that comprises a microcontroller with Pulse Width Modulators 9 that deliver power to the lamps through drivers 3, and also varying the intensity and frequency of modulation of intensity of each LED. Chliwnyj teaches that "[t]he LEDs may be driven by drivers 3a, 3b, 3c, 3d, and 3e, each of which boost the current drive capability of the respective one of five PWM outputs 9a, 9b, 9c, 9d, and 9e of the microprocessor." (Chliwnyj, Ex. 1105, Col. 6:37–40.)

120. It is of my opinion based on the availability of operating the circuit in manual mode or under program control that Chliwnyj allows for changing intensity and frequency of each of a plurality of LEDs to produce a continuous color changing cycle in the light output when the light from all the LEDs is blended through a diffuser and perceived by the human eye.

121. Chliwnyj teaches a circuit with a microprocessor, PWM and LED drivers that power the lamps (LEDs). "FIG. 1 shows a functional block diagram of

a microprocessor-based prototype circuit comprising a flame simulation circuitry. The device 8 initially consisted of a set of five Super Brite™ LEDs 7a, 7b, 7c, 7d, and 7e (LEDs 7a–e) in 2 or 3 different colors. . . . However, light-emitting diodes are generally available in a number of suitable colors from many different manufacturers.” (Chliwnyj, Ex. 1105, Col. 6:23-36.)

122. Chliwnyj teaches repetitively cycling the LEDs using sine wave data to produce a color changing cycle. Chliwnyj teaches a “circular buffer pointer that is commonly used in program code to repetitively cycle a loop endlessly or until a change is requested. “Sinusoidal wave values were initially used as fundamental excitation values for each of LEDs 7a–e. As shown in FIG. 12, the program code may use a table 21 of stored sine wave values, which table 21 is indexed (see index 22) at varying rates to generate differing period waveforms for each of LEDs 7a–e. For each of the LEDs, a circular buffer pointer 26 may be used to access the sine table 21. Additionally the data structure for each of LEDs may have a pointer to the start of the current waveform table and the end of the table so that the circular buffer pointer 26 may wrap to the beginning of the stored waveform when it gets to the end.” (Chliwnyj, Ex. 1105, Col. 6:63-7:6.)

123. Chliwnyj discloses that an object of the invention is to modulate or vary the intensity of the LEDs by modulating the intensity or amplitude of the light emitting diodes. “Another object of the present invention is to provide a flame

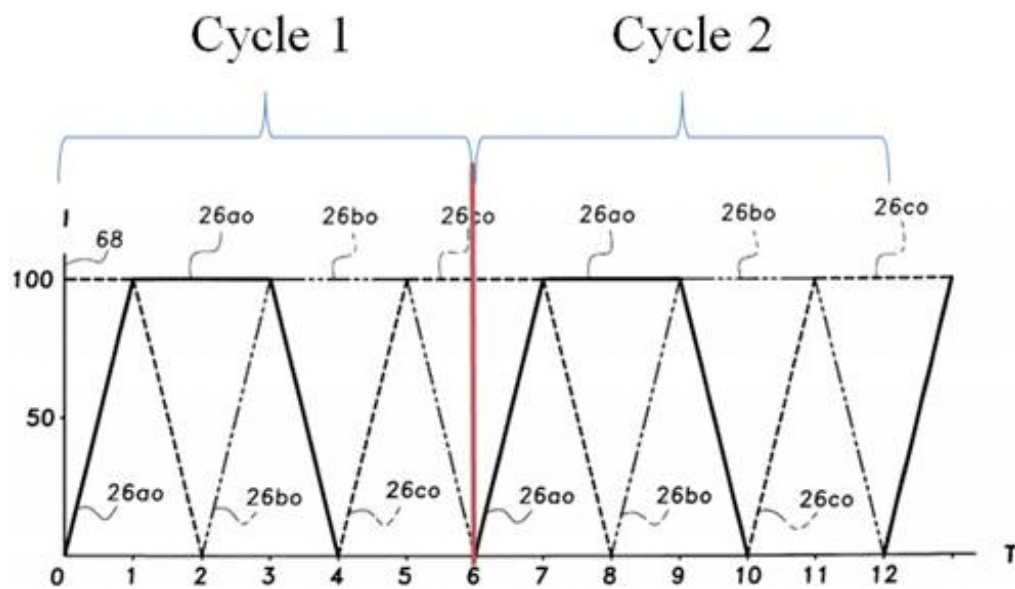
simulation by modulating the intensity of the Super Brite™ light emitting diodes.” (Chliwnyj, Ex. 1105, Col. 3:9–11.)

124. Additionally, “[t]he use of PWM is an economical and a very low-power approach to controlling current in electronic circuits. **The use of PWM also yields a wide range of apparent and continuous brightness levels.**” (Chliwnyj, Ex. 1105, 3:13–21.) (emphasis added).

125. Furthermore, “[t]he controlling program comprises stored instructions for generating **the amplitude modulated time waveforms** for controlling the current to the lighting elements. Pulse Width modulation (PWM) may be performed in either hardware or program code, provided that sufficient microprocessor ‘bandwidth’ may be available to perform the program-code operations.” (Chliwnyj, Ex. 1105, 5:34–41) (emphasis added).

126. In addition to teaching varying the intensity, Chliwnyj teaches varying the frequency using a prescaler variable. “To run the individual sinusoid at different frequencies a prescaler is used.” (Chliwnyj, Ex. 1105, Col. 7:24-25.) Chliwnyj teaches that the prescaler can be set for each sine wave (LED) and can be set for multiple LEDs at once. Thereby, the individual sine waves can have different frequencies and the color pattern **enhanced**. Similarly, a person of ordinary skill in the art would have understood that the prescaler for each LED could be set to the same value, and the lights would cycle together at the same rate

to produce a repetitive lighting pattern. Moreover, the LEDs can produce color changes if the LEDs are out of phase, such as Chliwnyj teaches at 8:51–53. Morrison, discussed in ¶ 70, contains an example of LEDs cycling at the same rate, and therefore repeating a lighting pattern during each period of one cycle. This is similar to the teaching in Lau of repeating cycles. *See, e.g.*, (Morrison, Ex. 1114 at 9:9–10:35 (“The above described cycle repeats over intervals six through twelve on the graph 64, and may be made to repeat endlessly”)) and FIG. 5. A person of ordinary skill of the art at the time of the invention would have at once understood that by simply setting the prescalers to be equal, and setting the signals to be out of phase (Chliwnyj, Ex. 1105, 8:51–53), Chliwnyj could produce similar cycles.



(Morrison, Ex. 1114, Fig. 5) (annotations added).

127. Chliwnyj teaches that “[t]he controlling program comprises stored instructions for generating the amplitude modulated time waveforms for

controlling the current to the lighting elements. Pulse Width Modulation may be performed in either hardware or program code, provided that sufficient microprocessor “bandwidth” may be available to perform the program-code operations. Drivers provide the necessary drive current for the respective lighting element.” (Chliwnyj, Ex. 1105, Col. 5:34–41) (emphasis added).

128. Chliwnyj at Col. 3:13–21 explains that “[a]nother object of the present invention is to provide flame simulation with the use of a **pulse width modulation (PWM) technology to turn LEDs on and off at a frequency** that is far above the ability of the human eye to resolve. The use of PWM is an economical and a very low-power approach to controlling current in electronic circuits. **The use of PWM also yields a wide range of apparent and continuous brightness levels.**” (Chliwnyj, Ex. 1105, Col. 3:13–21.)

129. Further, Chliwnyj explains, “[a] significant advantage of the invention is **the smooth change in the frequency of modulation of a single LED with time**. Like a real flame the change in frequency is continuous and not abrupt. The modulation of a LED is accomplished by indexing through a stored sine wave table with a pointer as described above. At the end of a full cycle of the stored waveform the change requested flag is checked to see if a change is pending. If so the divisor for the counter for stepping through the waveform is incremented or decremented as required. The pointer is updated. This has the net effect of having the slowly

modulated LEDs change smoothly in frequency over time.” (Chliwnyj, Ex. 1105, Col. 7:55–66) (emphasis added).

130. Chliwnyj discloses program code that the circuitry used to run various program modes by changing the intensity and frequency through stored sinusoidal waves. The current values to each LED can be different thereby generating different intensities for each of the LEDs to produce a continuous color changing cycle. Each sine wave to each LED can be different based on stored sine wave values indexed at varying rates. It is my understanding that Chliwnyj discloses varying frequency and intensity ability: “As shown in FIG. 12, the prototyped flame simulation is table driven. Each LED has a code structure associated with it that contains all the data for the specific state of the LED and the simulation. Limits for how fast or how slow the sinusoid should be allowed to go for a LED are in the table [**frequency**]. The maximum allowed brightness and minimum allowed brightness for the individual LED are also in the table [**intensity**] for a particular state.” (Chliwnyj, Ex. 1105, Col. 8:43-50) (emphasis added).

131. The sine waves run out of phase to effect color changing of a multitude of colors. If the sine waves ran in phase at the same frequency, the color produced would never change although the brightness would fluctuate up and down. Chliwnyj acknowledges that the sine waves run out of phase: “The start-up code specifically starts the simulation in a known state so that the phases of the

individual sinusoids are different to prevent the LEDs from all starting out in phase.” (Chliwnyj, Ex. 1105, Col. 8:51-55) (emphasis added)

132. It is my opinion that Chliwnyj also teaches that the duty cycle of the PWM applied to each LED can be different, since each LED has its own pulse width modulator. With varying duty cycles applied to the individual LEDs, the LEDs combined colors will vary to create a continuous color changing cycle. Chliwnyj discloses “[a]s shown in FIG. 11, at each timer interrupt the interrupt handler code loads the PWM register with the desired duty cycle for the LED.” (Chliwnyj, Ex. 1105, Col. 7:15-18.).

133. It is my opinion that Chliwnyj discloses a “circuit that includes a light sub-circuit connected to said lamps to deliver power thereto, wherein said light sub-circuit varies said power to each of said lamps so as to vary both intensity of light emitted and frequency of changes to said intensity to produce a continuous color changing cycle” as described *supra*.

134. In case the Board does not agree that Chliwnyj discloses a color changing cycle (under the claim constructions provided in VI. C) by the use of a circular cyclical buffer that runs endlessly until a change is requested, Lau is presented to show that the prior art taught repeating continuous cycles.

135. Therefore, it is of my opinion that Lau discloses “a circuit that includes a light sub-circuit connected to said lamps to deliver power thereto,

wherein said light sub-circuit varies said power to each of said lamps so as to vary intensity of light emitted to produce a continuous color changing cycle.”

136. It is my opinion that Lau teaches a circuit (microcontroller and LED drivers) to power the lamps. In Figure 2, the intensity to the LEDs can be controlled by the LED drivers.

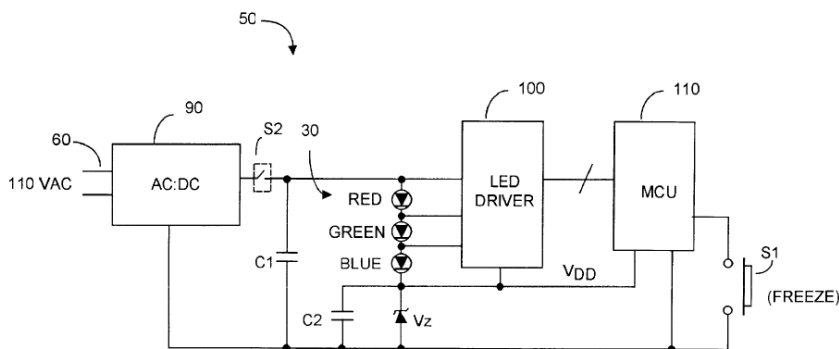


FIG. 2

137. Lau teaches, “[t]he housing contains an array of differently colored, preferably light emitting diode. Light sources that can dynamically output different patterns of differently colored light in response to drive signals. A microcontroller executes a sequence of instructions causing the controller to output different sequences of signals that are coupled to a driver unit that drives the light sources. The result is that the array dynamically produces different patterns of differently colored light.” (Lau, Ex. 1107, Abstract.)

138. Lau describes the circuitry in more detail: “In the preferred embodiment, LED array 30 includes three separate LEDs: a red LED, a green

LED, and a blue LED, so labeled in FIG. 2. Each LED may be driven independently of each other LED by an appropriate logic high or low state provided by an LED driver 100. In the preferred embodiment, the three differently colored LEDs are series connected, and the voltage at the bottom of the series stack is established by a Zener diode V_z , whose relatively constant voltage V_{DD} is provided as operating potential to LED driver 100 and to a microcontroller unit (MCU) 110. MCU 110 preferably is programmed by burning one or more mask layers to carry out a set of instructions that have the effect of controlling LED driver 100 to drive the LED array 30 in a desired sequence of light patterns. LED drivers and MCU units are well known to those skilled in the art of circuit design, and further details are therefor deemed unnecessary.” (Lau, Ex. 1107, Col. 2: 45-60.)

139. It is my opinion that driving each LED individually allows for the intensity of each LED to be set independently and different color patterns of colored light can be produced. As Lau states, circuitry like microcontrollers, microprocessors, drivers, pulse width modulators, etc., were known to those skilled in the art.

140. Lau discloses a circuit that includes a light sub-circuit connected to said lamps to produce a continuous color changing cycle: “Preferably the light array comprises several differently colored light emitting diodes (LEDs) that are

driven by electronics within the housing such that the array output, as viewed through the light diffuser, is a **dynamically changing pattern of light**. **The displayed light patterns vary smoothly and continuously from monochrome to different color combinations of light, with the cycle repeating over a cycle period that may be sixty seconds or so in length**. Preferably the electronics includes a microcontroller unit that executes a sequence of instructions causing a light driver unit to switch on various of the light emitters during various portions of a pattern cycle.” (Lau, Ex. 1107, Col.1:33–44) (emphasis added).

141. Lau continues to explain that the continuous color changing cycles that repeat and the intensity controlled by the duty cycle can be manipulated using three LEDs of different colors and varying the intensity of one or more LEDs: “Under control of MCU 110, LED driver 100 may cause **only the blue LED to be on, or to be on for some fraction of a cycle period**. Alternatively **only the green or the red LED might be on for some fraction of a cycle period**, *e.g.*, a typically several second period over which a pattern of light output by array 30 occurs and then starts to repeat. It is understood that MCU 110 may cause **LED driver 100 to switch more than one LED on simultaneously**, and **indeed duty cycle to each LED may differ**. For example, one might drive the red LED with a higher duty cycle than the green and blue LEDs such that red is the predominant color as viewed through diffuser 40 by a user.” (Lau, Ex. 1107, Col. 3:13–23).

142. It is of my opinion that Lau discloses a continuous color changing cycle that repeats: “a viewer seeing night light 10 is treated to a **pastel of smoothly and continuously changing color patterns**. The light display may start out with a deep blue color that gradually becomes bluish-purple, then a lavender pink color that gradually becomes a red-orange color. The red-orange color gradually becomes a deep red-pink color that gradually becomes a light purple color that gradually becomes a blue color, and then back to a deep blue color, whereupon the cycle will repeat.” (Lau, Ex. 1107, Col. 3:36–44) (emphasis added).

Claim 32

143. In my opinion claim 32 of the '827 patent is rendered obvious by Chliwnyj in view of Wu and Lau. Reference to the numbered claim elements will be used extensively in my analysis below.

Claim element 32.0 - A lighting device to produce light of varying color, said device including:

144. It is my opinion that claim element 32.0 of the '827 patent is rendered obvious by Chliwnyj in view of Wu and Lau for the reasons explained with respect to claim element 27.0 above.

Claim element 32.1 - a lens;

145. It is my opinion that claim element 32.1 of the '827 patent is rendered obvious by Chliwnyj in view of Wu and Lau for the reasons explained with respect to claim element 27.1 above.

Claim element 32.2 - a circuit having at least two lamps of different colors mounted to direct light through said lens,

146. It is my opinion that claim element 32.2 of the '827 patent is rendered obvious by Chliwnyj in view of Wu and Lau for the reasons explained with respect to claim element 27.2 and 27.3 above.

Claim element 32.3 - an activation sub-circuit to provide power to said lamps only at low light levels, and

147. It is my opinion that claim element 32.3 of the '827 patent is rendered obvious by Chliwnyj in view of Wu and Lau and that Wu discloses an activation sub-circuit to provide power to said lamps only at low light levels.

148. Wu at para. 20 states “[r]eferring to FIG. 4, when in using of the present invention, it needs only to insert the present invention into the soil firmly, when it is irradiated by the sun light in the daytime, by transparency of the transparent hood 34 mounted on the housing 30, the solar-energy powered electricity generating element 12 generates power by irradiation of the sun light, the electric energy is stored in the rechargeable battery 13 ready for use by the buzzer 14 and the light emitting element 15.” (Wu, Ex. 1106, ¶ 20.)

Claim element 32.4 - a light sub-circuit to independently control delivery of power to each of said lamps so as to vary intensity of light emitted over time to produce a continuous color changing cycle,

151. It is my opinion that claim element 34 of the '827 patent is rendered obvious by Chliwnyj in view of Wu and Lau for the reasons explained with respect to claims 27 and 31 above.

Claim element 32.5 - connections for at least one rechargeable battery to power said circuit, and

152. It is my opinion that claim element 32.5 of the '827 patent is rendered obvious by Chliwnyj in view of Wu and Lau for the reasons explained with respect to claim element 27.4 above.

Claim element 32.6 - at least one solar cell mounted so as to be exposed to light and operatively associated with said connections to charge said battery; and

153. It is my opinion that claim element 32.6 of the '827 patent is rendered obvious by Chliwnyj in view of Wu and Lau for the reasons explained with respect to claim elements 27.4 and 27.5 above.

Claim element 32.7 - a spike for positioning said connections above a ground surface.

154. It is my opinion that claim element 32.7 of the '827 patent is rendered obvious by Chliwnyj in view of Wu and Lau for the reasons explained with respect to claim element 27.7 above.

Claim 33 - The lighting device of claim 32, further comprising at least one user operated switch operable to control said circuit, with said switch being accessible by said user thereby enabling said user to manipulate said switch to control delivery of power to said lamps.

155. Chliwnyj discloses lighting device, further comprising at least one user operated switch operable to control said circuit, with said switch being accessible by said user thereby enabling said user to manipulate said switch to control delivery of power to said lamps.

156. Chliwnyj discloses an accessible switch operated to control delivery of electric power from the battery to operate said circuit. “A plurality of rechargeable batteries 28a—d, for example, AA rechargeable batteries, may be housed in a battery holder 35 and **connected through a switch to the circuit card 29, all of which may be located inside the hollow base 27.**” (Chliwnyj, Ex. 1105, Col. 10:66–Col. 11:3) (emphasis added).

Claim 34 - The lighting device of claim 32, wherein said light sub-circuit further independently controls delivery of power to each of said lamps so as to vary frequency changes to said intensity.

157. It is my opinion that claim element 34 of the '827 patent is rendered obvious by Chliwnyj in view of Wu and Lau for the reasons explained with respect to claims 27 and 31 above.

Rationale to Combine the References

158. The Patent Owner has admitted that lighting devices that produce a variable color were well known in the art. ('827 Patent, Ex. 1101, Col. 1:17–18.) Chliwnyj and Wu are both solar power lighting devices. Chliwnyj teaches a variable color lighting device placed on or in the ground having “a plurality of lighting elements in a plurality of colors which are modulated in intensity by a control circuit with a stored program.” (Chliwnyj, Ex. 1105, Abstract and Col. 12:20–22.) In my opinion, the process of varying color using a microprocessor and Pulse Width Modulator in Chliwnyj provides for a greater visual affect in the form of a simulated flame motion. *See* Claims 27.0 and 27.2. While Chliwnyj does not expressly teach a lighting device utilizing a stake, in my opinion, it was well known to utilize solar staked/spiked lighting devices that placed the light above ground level, as shown by Wu. *See* Claims 27.7 and 32.7.

159. Wu discloses a similar a solar lighting device, with a stake for going in the ground, that can provide different multiple colors. (Wu, Ex. 1106, ¶ 22.) In my opinion, it would have been obvious to one of ordinary skill in the art at the time of the invention to provide Chliwnyj with the spike of Wu, thereby providing the device of Chliwnyj with a spike to place the lighting device in the ground as taught and suggested by both Wu and Chliwnyj. Furthermore, in my opinion, it would have been obvious for one of ordinary skill in the art at the time of the invention to provide the device of Chliwnyj with a spike to place the lighting

device in the ground to provide light at an elevated position relative to the ground, as taught by Wu. Elevated lighting enhances that safety and reduces potential injuries. The elevated lighting illuminates an area to expose any obstacles or turns in a path thereby reducing or preventing potential injuries. The elevated lighting device can also enhance the security of the area as well. Well lit areas keeps prowlers away. Therefore, in my opinion, it would have been obvious to one of ordinary skill in the art to look to the combination of Chliwnyj and Wu in combination to provide the predictable results of having a solar lighting device with circuitry that varies color and a lighting device that utilizes a spike for placing it above ground.

160. In my opinion, it was also well known in the lighting industry at the time of the invention to include ambient light detectors in outdoor solar lighting products to preserve power and only provide illumination when it can be most readily visible, as shown by, among other references, Wu. *See* Claim 32.3. Wu teaches a solar powered lighting device having a light sensitive switch for operating at low light levels. *See* Claim 32.3. Therefore, in my opinion, it would have been obvious to modify Chliwnyj's circuit to incorporate a light sensitive switch so the lights run only during the night to achieve the predictable result of preserving energy and enhancing the aesthetic appeal of the lighting devices.

161. Chliwnyj and Lau are both lighting devices with similar circuitry.

Varying or continuously changing color using a microprocessor, Pulse Width Modulator and LED drivers in Chliwnyj provide for a greater visual affect in the form of a simulated flame motion and a greater visual effect of realizing the spectrum of colors. *See* Claims 27.0, 27.2, and 31. Varying or continuously changing color using a microcontroller and LED drivers in Lau also provides for a greater visual effect of continuous color changing patterns over time that repeat.

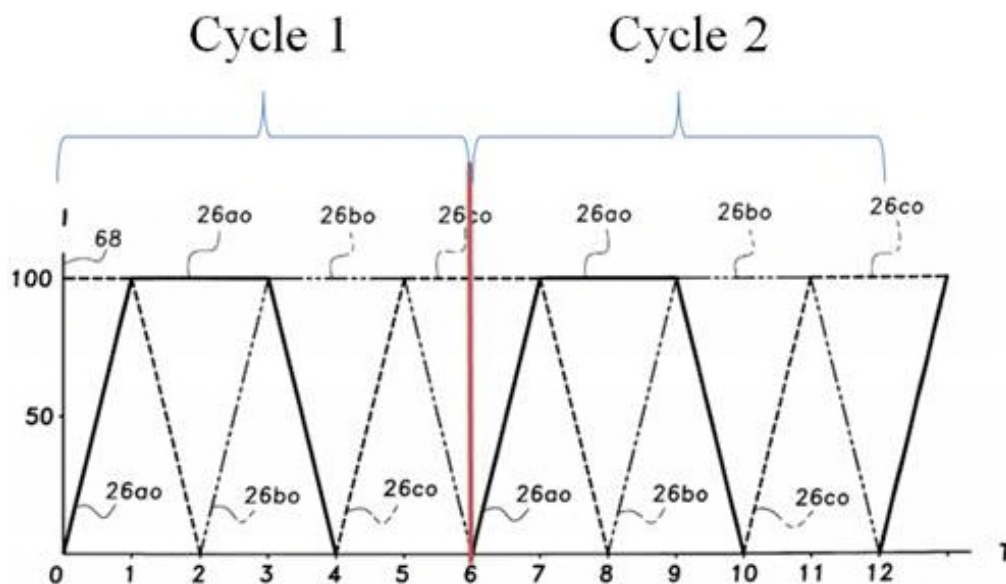
162. Figures 1 and 2 of Chliwnyj disclose the circuitry used to power the LEDs. The circuit includes a microprocessor, a PWM and LED drivers for the plurality of LEDs. In conjunction with the microprocessor, a circular buffer is used to hold and index the respective sine waves for the LEDs.

163. Chliwnyj describes a color changing cycle by describing the operation of the program code. Chliwnyj describes how to cycle through the sine waves for n LEDs using a “circular buffer pointer” that endlessly wraps the sine wave table index until told otherwise. One of skill in the art would have known at the time of the invention that a “circular buffer, cyclic buffer or ring buffer” is a data structure that uses a single, fixed size buffer as if it were connected end-to-end in an endless loop. Hence, the index of sine waves will continue to loop endlessly until the program parameters are changed to indicate otherwise.

164. Chliwnyj allows both modulating the intensity of the LEDs and changing the “prescaler” parameter for the sine wave frequency controls used to

vary the individual frequency of multiple LEDs to produce a continuous color changing cycle. One of ordinary skill in the art would know that although Chliwnyj allows randomization because it is interesting, one could choose not to set the parameter to inject randomization. With no randomization selected, the circular buffer would continue to wrap end-to-end of the sine wave table creating a continuous color changing cycle that that repeats over time. Hence, the parameters for randomization are optional, and one of skill in the art would have known at the time of the invention how to set the randomization based on the desired pattern, *e.g.*, a cyclic repeating color changing pattern.

165. Similarly, a person of ordinary skill in the art would have understood that the prescaler for each LED could be set to the same value, and the lights would cycle together at the same rate to produce a repetitive lighting pattern. Moreover, the LEDs can produce color changes if the LEDs are out of phase, such as Chliwnyj teaches at 8:51–53. U.S. Morrison, discussed in ¶ 70, contains an example of LEDs cycling at the same rate, and therefore repeating a lighting pattern during each period of one cycle. This is similar to the teaching in Lau of repeating cycles. *See, e.g.*, (Morrison, Ex. 1114 at 9:9–10:35 (“The above described cycle repeats over intervals six through twelve on the graph 64, and may be made to repeat endlessly”)) and FIG. 5 (annotations added)



and (Lau, Ex. 1107, 3:40–44 “The red-orange color gradually becomes a deep red-pink color that gradually becomes a light purple color that gradually becomes a blue color, and then back to a deep blue color, whereupon the cycle will repeat.”) A person of ordinary skill of the art at the time of the invention would have at once understood that by simply setting the prescalers to be equal, and setting the signals to be out of phase (Chliwnyj, Ex. 1105, 8:51–53), Chliwnyj could produce similar cycles.

166. Like Chliwnyj, Lau also teaches a lighting device that produces varying color and a continuously changing color through driving the LEDs to vary in intensity using the “duty cycle, amplitude, and repetition of an on-portion of a drive signal.” (Lau, Ex. 1106, Claim 5.) Similarly, to Chliwnyj, Lau uses a Microcontroller and LED drivers to produce a continuous color changing cycle. One of skill in the art at the time of the invention would have understood either circuitry at the time of the invention. Therefore, both Chliwnyj and Lau are

lighting devices with similar circuitry, *e.g.*, microprocessor vs. microcontroller, used to achieve a similar result. They are essentially the same, and are commonly used interchangeably. Generally, a microcontroller is a microprocessor that also has internal program memory, data memory, and other peripheral circuitry, whereas a microprocessor may have program and data memory stored externally.

167. Lau discloses continuous color changing cycles using additive primary colors, red, blue and green. Instead of describing in program code, Lau focuses less on the program code and solely on the result. Lau explicitly describes the continuous color changing cycles with statements such as “displayed light patterns vary smoothly and continuously from monochrome to different color combinations of light, with the cycle repeating over a cycle period that may be sixty seconds or so in length” and “a viewer seeing night light 10 is treated to a pastel of smoothly and continuously changing color patterns. The light display may start out with a deep blue color that gradually becomes bluish-purple, then a lavender pink color that gradually becomes a red-orange color. The red-orange color gradually becomes a deep red-pink color that gradually becomes a light purple color that gradually becomes a blue color, and then back to a deep blue color, whereupon the cycle will repeat.” To incorporate repeating cycles, a person of ordinary skill would have programmed Chliwnyj’s circuitry to carry out a set of instructions to repeat a pattern of colors continuously and repeatedly—

inserting no random cycles. The person of ordinary skill in the art could have accomplished this simply by activating options in the program intended to cause cyclical repetition of the same sequence of colors or patterns.

168. Also, a person of ordinary skill could allow the program code for the stored sine wave table that indexed through the LEDs to wrap when it reached the end to create a repeated cycle, which Chliwnyj teaches. Chliwnyj provides a commonly known data structure, a circular buffer, to perfect this endless repetition. One of skill in the art would have known at the time of the invention how to program in C program language. Unless a change is made to the sine wave variables, the circular buffer will continue to repeat the same data (waveform) without overwriting with any new data. While Chliwnyj allegedly did not find repetition as interesting as randomization, repeating cycles was well known at the time of the invention.

169. Lau's objective was producing a light to give a "visual effect [that] is both pleasing and comforting, and may promote sleep including promoting sleep for young children. Sufficient light is output to serve the purpose of a night light, yet the output light is not a monotonous flashlight-like monotone but a dynamic kaleidoscope of colors that gradually and pleasingly changes in appearance." (Lau, Ex. 1107, 3:45–50.).

170. Chliwnyj's objective was to achieve "very pleasing, soothing, and

almost mesmerizing visual effects.” (Chliwnyj, Ex. 1105, Col. 2:51-52.). One of ordinary skill in the art at the time of the invention would be motivated to look to Lau for designing a lighting device that had the same objective as Chliwnyj. A person of ordinary skill in the art at the time of the invention would be motivated to program Chliwnyj with the option to produce a symbolic flame that that could be any colors or patterns. One of skill in the art would have known at the time of the invention that the circuitry taught in Chliwnyj allows for a plurality of LEDs that can be any available color (*e.g.*, amber, red, blue, green, yellow, etc.) and the circuit could be programmed to present a myriad of color patterns, *e.g.*, pastel colors of the favorite color palette of the person in remembrance. (“A pastel of smoothly and continuously changing color patterns. The light display may start out with a deep blue color that gradually becomes bluish-purple, then a lavender pink color that gradually becomes a red-orange color. The red-orange color gradually becomes a deep red-pink color that gradually becomes a light purple color that gradually becomes a blue color, and then back to a deep blue color, whereupon the cycle will repeat.”) (Lau, Ex. 1107, Col. 3:36-44.) The “eternal flame” is just a symbolic gesture of remembrance, so one would know it need not be confined to a specific color or colors or pattern(s). As a symbolic flame, there should be no limitations (except for the bandwidth of the electronics) on the colors realized or patterns one could program the circuitry to achieve. Therefore, it would have been

obvious to modify the program control in Chliwnyj to produce repeating continuous color changing cycles in order to satisfy Lau's objective.

171. Chliwnyj teaches a solar powered light and AC powered light; and Lau teaches an AC powered light. The circuits disclosed in each have a microprocessor or microcontroller and electronics to drive the LEDs either through a pulse width modulator and LED drivers or just simply from a microprocessor with a built in pulse width modulator. Although, Lau is not a solar device, one of ordinary skill in the art would have known that the circuitry used by Lau to achieve the color changing to be performed on either solar battery power or AC power. Chliwnyj teaches that the circuitry in Lau (plus additional circuitry) can run on solar battery power. Therefore, one of skill in the art would have been motivated to use the teachings in Lau to combine with Chliwnyj at the time of the invention.

172. As solar lighting products, such as those taught in these references, are easily manufactured into hundreds or thousands of designs having characteristics easily interchangeable as a matter of design choice, for this reason and the reasons set forth above, plugging together the different known features of the lighting products taught in these references to obtain the claimed invention would have been obvious to one of ordinary skill in the art at the time of the invention

173. In my opinion each of the limitations of the challenged claims is

expressly taught in the prior art references. As solar lighting products, such as those taught in these references, are easily manufactured into hundreds or thousands of designs having characteristics easily interchangeable as a matter of design choice, and the reasons set forth above, in my opinion plugging together the different known features of the available lighting products taught in these references to obtain the claimed invention would have been obvious to one of ordinary skill in the art at the time of the invention.

VII. CONCLUSION

174. In my opinion, all the elements of the challenged claims are unpatentable in view of the references discussed above. Presented above, the applied references support Ground1 in the Petition for *inter partes* review.

175. I reserve the right to supplement my opinions to address any information obtained, or positions taken, based on any new information that comes to light throughout this proceeding.

176. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for

cross-examination within the United States during the time allotted for cross-examination.

177. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made knowing that willful false statements so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Respectfully submitted,

Peter W. Schaefer

Executed on: 1/16/2015

APPENDICES TO DECLARATION OF DR. PETER W. SHACKLE

Appendix A: Curriculum Vitae

Appendix B: Materials considered

Appendix A: CV of Dr. Peter W. Shackle

**PETER WILLIAM SHACKLE
112 ASPEN WAY
ROLLING HILLS ESTATES, CA 90274**

Education

9/62-5/65 Bachelor's degree in Physics from University of Birmingham, UK. Recipient of simultaneous state scholarship and University open entrance scholarship. Graduated top student in University class.

9/65- 5/69 Ph.D. in Physics from Trinity College, Cambridge, UK. Researched at the Royal Society Mond Laboratory, an élite subsection of the Cavendish Physics laboratory including Nobel Prize winner Brian Josephson. Thesis described a new technique for measuring the Hall effect in liquid metals.

1982 Passed the Master of Business Administration exam for the University of Florida after studying an MBA course in conjunction with Harris Corporation.

Work Experience

1/2012 – present President and Founder of Photolume, a consulting company in the field of lighting electronics products, particularly LED drive circuits and electronic ballast circuits.

1/2011-12/2011 Director of Power Supply Products, Light Based Technologies. Operated a three person laboratory in Torrance, CA developing LED drive application circuits for the LBT microprocessor chip.

1/2008 – 12/2010 Chief Technologist at Lightech Electronics North America, Inc., Torrance, CA. Responsible for operating a three person laboratory in Torrance, CA developing advanced LED drives for this international company. During this time developed phase control dimming LED drives capable of dimming to 0.1% using TRIAC dimmers. Put eight such products through UL and into Chinese manufacturing, and three more European products through ENEC approval and into Chinese manufacturing. Developed a dramatically new technology for dimmable constant current LED drives with efficiency of 90%, capable of working

at either 120V or 277V. Side responsibilities involved managing the patent portfolio of Lichtechnology internationally. Two patent applications filed during this time.

8/2004-12/2007 V. P. Advanced Technology at Fulham Co., Inc., Hawthorne, CA. Responsible for the technology direction of this fast growing company. Responsibilities included creation of new technologies and development of new products involving innovative technology. Achievements at Fulham included the creation of the Racehorse family of high performance products that are the subject of a Fulham patent application, and the creation of a new charge pump technology for cost effective instant start T8 ballasts, subject of an issued patent. Nine products transferred to Chinese manufacture during this time. Managed design of a 4 channel LED driver which was transferred to China for manufacture

5/2002-8/2004 Director of Engineering and later V.P. of Advanced Technology at Universal Lighting Technologies, Inc., Huntsville, AL. Worked on the latest analog and digital technology for electronic ballasts. Product focus was on low cost IC based products and on sophisticated microprocessor based products for more complex applications such as dimming and instant start T5. Ran an operation of 30 people and directly organized a group of nine, including 3 Ph.D. level staff. Achievements in this position included a line of microprocessor based instant start T5 ballasts. Five patents resulted.

10/2000 – 5/2002 V.P. Engineering at Robertson Worldwide, Blue Island, IL. Managed both electronic and magnetic ballast new product development. Invented a new low cost electronic ballast architecture that still has all the specified features, marketed as the "World Series" ballasts. Trained engineering staff for modern electronic ballast development and assembled state of the art ballast characterization facilities.

4/93-10/2000 Engineering Manager and Chief Technologist at Energy Savings, Inc. Schaumburg, IL. Worked on fundamental issues making possible the development of low cost, low profile electronic ballasts. Personally designed and put into manufacture 60 ballasts in first five years. Later managed team of designers and technicians producing ballast designs while personally prototyping the more difficult designs. ESI ballasts combined high performance with low cost & small size with capability for extremely fast product development. Authored multiple inventions involving microprocessor controlled digital ballasts.

Responsibilities in this company included all fundamental technology issues and patent related activities. Developed new low cost dimming technology. Personally designed the logical flow charts for microprocessor ballast software. Shipments rate increased to \$40M/yr. from zero in 7 years.

8/91-4/93 Manager of Ballast integrated Circuit Design at Motorola Lighting Inc., Buffalo Grove, IL. Worked on novel ballast circuits suitable for integration in silicon. Put three conventional ballast circuits into production.

4/87-8/91 Research Department head at Philips Research, Briarcliff, NY. Worked on the application of Power IC technology to all products in the Philips family of companies. Worked on analysis of customer needs and specification of Power IC products to meet those needs. Ran a department of 20 producing power IC designs, including chips for Fluorescent Lighting ballasts.

11/83-4/87 V.P. of Engineering for Telmos, Inc. in Sunnyvale, CA. Developed the first 500V CMOS technology and put numerous high voltage IC chips into production. 1986 Chaired the Electrochemical society symposium on high voltage and Smart Power Devices, which has since morphed into the conference series now known as ISPSD. These developments were the subject of a cover page article in Powertechnics magazine.

6/80-11/83 Manager of high voltage integrated circuit products at Harris Semiconductor in Melbourne, Florida developing high voltage ac line powered integrated circuits. This work was the subject of a cover page article in Electronics Design magazine.

6/70 – 6/80 Member of technical staff at ATT Bell Laboratories, Murray Hill, NJ doing research on solid state devices in general and high voltage integrated circuits in particular. Invented the first 500V IC, for which work a prize was awarded at the 1981 International Solid State Circuits Conference. Became group supervisor in 1979.

5/69 – 6/70 Member of technical staff at the GET Hurst Research Center in Wimble, UK, doing research on circuits and structures for microwave avalanche diodes.

Issued Patents and Pending Patent Applications

1. F. A. D'Altroy, A. R. Hartman, R. M. Jacobs, R. L. Pritchett, P. W. Shackle, "Integrated circuit switching network using low substrate leakage current thyristor construction," U.S. Patent No. 4,130,827, issued on December 19, 1978.
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Three additional U.S. patent applications pending.

Publications

Eight publications in refereed journals, plus ten other publications

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17. P. W. Shackle and I. Wacyk, "An ASIC approach to PICs," *Proc. of the 2nd Semiconductor Devices and ICs*, 7-12 (1990) (invited keynote address).
18. P. W. Shackle, "Selecting or Specifying a Driver for Your LED Array," *LEDs Mag.*, white paper, June 2013.

Litigation Related Experience

- 2014 - authored an expert declaration in support of *Inter Partes* Review of US patent No. 6,786,625.
- 2013 - provided 7 hours of deposition as a witness in Robertson Transformer Co. d/b/a Robertson Worldwide v. General Electric Company *et al.*

Honors and Achievements

- Received a prize from the International Solid State Circuits Conference in February 1980 for paper describing the first 500V solid state crosspoint
- 1987 Chairman of First Symposium on High Voltage and Smart Power devices, which subsequently became the ISPSD conference series
- Elected a Senior Life Member of IEEE in 2010.

- Published the science fiction novel *A Disruptive Invention* in 2010, available electronically through multiple on-line channels.

Appendix B: Materials considered

1. U.S. Patent No. 7,429,827
2. File History of U.S. Patent No. 7,429,827
3. AU Patent Application No. 2003271383
4. U.S. Patent No. 5,924,784
5. U.S. Patent Pub. No. US 2003/0201874 A1
6. Chinese Patent Publication No. CN 2522722Y
7. U.S. Patent No. 5,062,028
8. Chinese Patent Publication No. CN 2541713Y
9. AU Patent Application No. 2002100505 A4
10. U.S. Patent No. 6,120,165
11. U.S. Patent No. 4,841,416
12. U.S. Patent No. 5,055,984
13. PCT Application No. WO 02/101285
14. U.S. Patent No. 6,431,719
15. U.S. Patent No. 5,211,470
16. Chinese Patent No. CN 2145314Y
17. U.S. Patent No. 6,241,362
18. U.S. Patent No. 6,150,774
19. U.S. Patent No. 8,201,713
20. U.S. Patent No. 6,459,919
21. U.S. Patent No. 4,845,481

- 22.U.S. Patent No. 6,06,038
- 23.U.S. Patent No. 4,810,937
- 24.U.S. Patent No. 7,064,498
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- 32.[Cycle, http://dictionary.reference.com/browse/cycle?s=t.](http://dictionary.reference.com/browse/cycle?s=t)
- 33.Cycle, IPR2014-00938, Ex. 3002.
- 34.Cycle, IPR2014-00938, Ex. 3005.
- 35.IPR2014-00877, paper 10.