

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Hisense USA Corporation
Petitioner

v.

Brightplus Ventures LLC
Patent Owner

Patent No. 8,941,331

Filing Date: May 17, 2013

Issue Date: January 27, 2015

Title: SOLID-STATE LIGHTING PANELS WITH VARIABLE VOLTAGE
BOOST CURRENT SOURCES

Ex. 1003 – Declaration of Rafael Betancourt

Table of Contents

	<u>Page</u>
I. Introduction.....	4
II. Qualifications.....	5
III. Summary of Legal Issues	7
A. Obviousness.....	8
B. Claim Construction	11
C. Level of Skill in the Art.....	11
IV. The '331 Patent.....	11
A. Person of Ordinary Skill in the Art of the '331 Patent.....	12
B. Construction of Claim Terms of the '331 Patent	12
V. Materials Considered	13
VI. State of the Art as of November 18, 2005.	14
A. Lys	16
B. Mueller	18
C. Grootes	20
D. Xu	21
E. Blum	22
VII. The Prior Art Renders Every Element of Claims 17-18 and 20-25 Obvious.	22
A. Backlighting Systems for LED Displays Were Known in the Art.	22
B. Lighting Panels Using Multiple Strings of LEDs Were Known in the Art.....	23
C. Current Supply Circuits that Provide Strings of LEDs with On-State Drive Currents Were Known in the Art.	27
D. PWM Controllers to Generate Control Signals for Current Supply Circuits for LEDs Were Known in the Art.	31
E. Variable Voltage Boost, Constant Current Power Supply Circuits Configured to Operate in Continuous Current Mode were Known in the Art.....	36

F.	Current Supply Circuits Using a Sense Resistors to Provide Feedback Signals for Closed Loop Control Were Known in the Art.....	38
G.	Current Supply Circuits Using Filters Coupled to Sense Resistors to Filter Feedback Input Were Known in the Art.....	40
H.	Temperature Sensors Used to Provide Input to PWM Controllers Were Known in the Art.	41
I.	Wavelength Conversion Phosphors and Combinations of Blue, Yellow, and Right LEDs Were Known in the Art.	43
VIII.	Lys and Grootes in View of the Knowledge of a Person of Ordinary Skill in the Art Renders Obvious Claim 17 of the '331 Patent.....	45
IX.	Lys, Grootes, and Xu in View of the Knowledge of a Person of Ordinary Skill in the Art Renders Obvious Claims 18-20 and 22-25 of the '331 Patent.	52
X.	Lys, Grootes, Xu, and Blum in View of the Knowledge of a Person of Ordinary Skill in the Art Renders Obvious Claim 21 of the '331 Patent.	62
XI.	Mueller and Grootes in View of the Knowledge of a Person of Ordinary Skill in the Art Renders Obvious Claim 17 of the '331 Patent.	65
XII.	Mueller, Grootes, and Xu in View of the Knowledge of a Person of Ordinary Skill in the Art Renders Obvious Claims 18 and 20 of the '331 Patent.....	72
XIII.	Mueller, Grootes, Xu, and Blum in View of the Knowledge of a Person of Ordinary Skill in the Art Renders Obvious Claim 21 of the '331 Patent.	77

I, Rafael J. Betancourt, declare as follows:

I. Introduction

1. I am an independent consultant. I am over eighteen years of age, and I would otherwise be competent to testify as to the matters set forth herein if I am called upon to do so.

2. I have prepared this Declaration for consideration by the Patent Trial and Appeal Board in the *Inter Partes* Reviews of U.S. Patent No. 8,941,331 (“the ’331 Patent”).

3. I provide this Declaration at the request of and have been retained by Kilpatrick Townsend & Stockton, LLP, which represents Hisense USA Corporation (“Hisense”) in connection with the above-captioned *Inter Partes* Review. I have been informed and understand that Hisense contends that claims 17-18 and 20-25 of the ’331 Patent are invalid.

4. I am being compensated at an hourly rate of \$750 per hour. My compensation is not dependent on the outcome of or any issue in relation to the above-captioned *Inter Partes* Review, and I have no interest in either party.

5. In forming my opinions, I relied on my knowledge, education, experience, and training in the field and on documents and information referenced in this Declaration.

II. Qualifications

6. My curriculum vitae (“CV”) is attached hereto as Ex. 1004 and provides an accurate identification of my background and experience.

7. I hold the title of President of Betasoft Consulting, Inc., where I specialize in Analog Mixed-signal (“AMS”) architecture, debugging, modeling, and verification. Since 2019, I have worked with many major clients, including Applied Materials Inc., Palo Alto Electron, Inc., Scientific Analog Inc., Vidatronic, Inc., and zGlue Inc., to provide them with R&D engineering services and tools for AMS architecture, design, and verification of silicon integrated circuits.

8. I received a B.S. (1987) in Electrical Engineering from the University of Puerto Rico; an M.S. (1989) in Electrical Engineering from the University of Southern California; and an Engineers Degree in Electrical Engineering (2005) from Stanford University.

9. From 2002 to 2018, I worked at Synaptics, Inc., a leading manufacturer of human interface sensing devices. From 2014 to 2018, I held the title of Director of Analog Mixed-Signal Systems and Verification at Synaptics, Inc., where I was responsible for a global team that performs AMS verification of complex capacitive touch controllers, as well as integrated touch and LCD display controllers (TDDI) for mobile and automotive applications. While at Synaptics, Inc., I also worked as a technical lead for touchscreen CMOS controllers for

mobile, tablet, and notebook PCs and as a technical lead for various touch controller ASICs.

10. From 1998 to 2001, I worked as a Senior Mixed-Signal IC Design Engineer at Innovative Semiconductors, Inc. During that time, I designed a 480Mb/s analog transceiver for USB 2.0 in TSMC's 0.25um and 0.18um CMOS processes. I also wrote specifications for a 480MHz PLL clock synthesizer and interfaced with a PLL design contractor for post-layout verification and performance characterization. I also performed analog verification of a 400Mb/s serial transceiver 1394 PHY chip in TSMC's 0.35um CMOS, bench-tested, troubleshot, and characterized 1394 PHY, and assisted with porting of IEEE-1394 PHY to UMC's 0.18um CMOS.

11. I am currently an IEEE Senior Member and a member of IEEE Solid-State Circuits and Circuits & Systems societies, and I have held the following professional memberships and affiliations:

- IEEE Silicon Valley Chapter of the Technology and Engineering Management Society ("TEMS"): 2020-21 Chair; 2018-19 Vice-Chair; 2022-23/2017 Secretary; Reviewer for 2019 TEMSCON.
- IEEE Santa Clara Valley Section: 2020 Vice-Chair.
- Volunteer at IEEE Global Humanitarian Technology Conference 2018
- Volunteer Judge at International Science & Engineering Fair (ISEF), 7 times

12. I have authored over six (6) publications including:

- 1-GHz and 2.8-GHz CMOS Injection-locked Ring Oscillator Prescalers, *Symposium on VLSI Circuits, June 14-16, 2001, Kyoto, Japan.*
- CMOS VCOs for Frequency Synthesis in Wireless Biotelemetry, *International Symposium on Low Power Electronics and Design, August 10-12, 1998, Monterey, California.*
- Low Phase Noise CMOS Ring Oscillator VCOs for Frequency Synthesis, *2nd International Workshop on Design of Mixed-Mode Integrated Circuits, July 27-29, 1998, Guanajuato, Mexico.*
- A Low Power Frequency Synthesizer for Wireless Biotelemetry, *33rd. International Telemetering Conference, October 27-30, 1997, Las Vegas, Nevada.*
- A 1.5mW, 200MHz CMOS VCO for Wireless Biotelemetry, *First International Workshop on Design of Mixed-Mode Integrated Circuits and Applications, July 28-30, 1997, Cancun, Mexico.*
- A High-speed GaAs Transversal Filter Circuit for Clutter Rejection Systems, *SPIE's Tech. Symp. Optical Eng. & Photonics in Aerospace Sensing, April 1990.*

13. I am a named inventor on several issued patents: U.S. Pat. No.

9,778,804; U.S. Pat. No. 9,740,351; and U.S. Pat. No. 8,058,884. I have previously testified in multiple cases, including those concerning capacitive touch sensors, and circuits used in capacitive touch and display controllers as well as LCD touch screens. My CV (attached as Exhibit 1004) contains a list of cases in which I have testified in the last five years.

III. Summary of Legal Issues

14. I am not a lawyer. Thus, in expressing my opinions and considering the subject matter of the claims of the '331 Patent, I am relying upon certain legal principles that counsel has explained to me.

A. Obviousness

15. First, 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 that is used to evaluate whether an invention is new and not obvious is generally referred to as “prior art” and generally includes patents and printed publications (e.g., books, articles, product manuals, company publications, etc.).

17. I understand that in this proceeding Hisense has the burden of proving that the claims of the patents-at-issue are obvious in view of the prior art by a preponderance of the evidence. I understand that “a preponderance of the evidence” is evidence sufficient to show that a fact is more likely true than it is not true.

18. I understand that in this proceeding, the information that may be evaluated is limited to patents and printed publications. My analysis below compares the claims to patents and printed publications that I understand are prior art to the patents-at-issue.

19. I have been informed and understand that a claim is obvious in light of the prior art if the difference or differences between the claimed subject matter and the prior art are such that the subject matter as a whole would have been

obvious, at the time the invention was made, to a person having ordinary skill in the art. I have been informed and understand that the Supreme Court provided an outline for analyzing obviousness in which it rejected an earlier test in favor of an “expansive and flexible approach” using “common sense.” I have also been informed and understand that the Supreme Court explained that under the correct analysis, any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed. I have also been informed and understand that the Supreme Court explained that “[t]he combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.” I further have been informed and understand that the Court pointed to other factors that may show obviousness. These factors included the following principles:

- a. combination that unites old elements with no change in their respective functions is unpatentable. As a result, the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results,
- b. a predictable variation of a work in the same or a different field of endeavor is likely obvious if a person of ordinary skill would be able to implement the variation,

- c. an invention is obvious if it is the use of a known technique to improve a similar device in the same way, unless the actual application of the technique would have been beyond the skill of the person of ordinary skill in the art. In this case, a key inquiry is whether the improvement is more than the predictable use of prior art elements according to their established functions,
- d. an invention is obvious if there existed at the time of invention a known problem for which there was an obvious solution encompassed by the patent's claims,
- e. inventions that were “obvious to try” — chosen from a finite number of identified, predictable solutions, with a reasonable expectation of success — are likely obvious,
- f. known work in one field of endeavor may prompt variations of it 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, and
- g. an explicit teaching, suggestion, or motivation in the art to combine references, while not a requirement for a finding of obviousness, remains “a helpful insight” in determining upon which a finding of obviousness may be based.

B. Claim Construction

20. I have been informed and understand that in an *inter partes* review claim terms are construed according to their ordinary and customary meaning as understood by one of ordinary skill in the art in view of the specification and the prosecution history of the patent.

C. Level of Skill in the Art

21. I am informed and understand that a person of ordinary skill in the art is a hypothetical person who is presumed to have known the relevant art at the time of the alleged invention. I am informed and understand that factors that may be considered in determining the level of ordinary skill in the art may include: (A) the type of problems encountered in the art; (B) prior art solutions to those problems; (C) the rapidity with which innovations are made; (D) the sophistication of the technology; and (E) the educational level of active workers in the field.

IV. The '331 Patent

22. The '331 Patent is entitled "Solid State Lighting Panels with Variable Voltage Boost Current Sources" and was filed on May 17, 2013. I am informed that the earliest claimed priority date of the '331 Patent is November 18, 2005. Each of the prior art references I address herein was available prior to November 18, 2005, thus I have not analyzed whether each claim of the '331 Patent is entitled to that priority date.

A. Person of Ordinary Skill in the Art of the '331 Patent

23. The '331 Patent relates to solid state lighting (e.g., LEDs) and “adjustable sold state lighting panels and systems and methods for generating high voltages for illuminating solid state lighting panels.” '331 Patent, 1:28-31.

24. Upon consideration of this and the factors outlined in Section III.C above, in my opinion a person of ordinary skill in the art as of November 18, 2005, the earliest claimed priority date of the '331 Patent, would have had at least a graduate degree in mechanical engineering, physics, materials science, electrical engineering, or a related discipline, coupled with at least four years' experience in designing backlighting systems for displays; the level of ordinary skill in the art is approximate and additional education could make up for a lack of experience or vice-versa.

25. As I explain above, I have the relevant educational background and I have worked in the technical area of the '331 Patent for many years. As of November 18, 2005, which I understand to be the time of the alleged invention, I possessed at least such experience and knowledge of a person of ordinary skill in the art.

B. Construction of Claim Terms of the '331 Patent

26. As explained in further detail below, under any reasonable construction, the claims are obvious in view of the prior art I address herein. Thus,

I do not separately offer an opinion with respect to the proper construction of the terms of the claims of the '331 Patent.

V. Materials Considered

27. In forming my opinions, in addition to my knowledge and experience, I have considered the following documents and things that I have obtained, or that have been provided to me:

Exhibit	Description
1001	U.S. Patent No. 8,941,331 (“the '331 Patent”)
1002	Prosecution History of U.S. Patent No. 8,941,331
1005	WO 2005/089293 to Lys (“Lys”)
1006	US 2007/0046485 to Grootes (“Grootes”)
1007	CN 1588523 to Xu (“Xu”)
1008	Certified Translation of Xu
1009	U.S. 2005/0047134 A1 to Mueller (“Mueller”)
1010	U.S. 5,663,667 to Blum (“Blum”)
1016	Supertex Inc., HV9910 – Universal High Brightness LED Driver
1017	Supertex Inc., Press Release Announcing HV9910 (May 17, 2004)

28. In addition to the documents above, in forming the opinions expressed below, I have also considered my own knowledge and experience based upon my education and work in the field, as described above and in my *curriculum vitae* (Ex. 1004).

VI. State of the Art as of November 18, 2005.

29. As of November 18, 2005, there were many different available driving circuits for LEDs. A few examples of well-known circuits that a Person of Ordinary Skill in the Art would have recognized at the time are:

30. **Linear Constant Current Drivers:** These were the most common type of constant current driver at the time. They work by providing a constant current to the LED, regardless of the voltage drop across it. This type of driver is relatively simple to design and manufacture, but it is not very efficient.

31. **Switching Constant Current Drivers:** These work by switching the output current on and off very rapidly, which allows them to achieve higher efficiency than linear drivers.

32. **Digitally Programmable Pulse-Width Modulation (PWM) Power Control:** Modulating the output current of the driver with a square wave of programmable duty cycle allows for very precise control of LED brightness. Digital control of the duty cycle allows for easy control of the LED's brightness, as well as other features such as dimming and color temperature control.

33. **Discontinuous Current Mode (DCM):** Is a mode of operation in which the inductor current falls to zero at some point during the switching cycle. In DCM, the inductor current is only nonzero for a portion of the switching cycle. This means that the output voltage of the converter is also discontinuous, as it is

proportional to the inductor current. However, the output voltage can still be regulated by using a feedback loop to control the duty cycle of the switching transistor. This mode of operation is typically used when the load is light, as it allows the converter to operate with a smaller inductor and lower switching frequency.

34. **Continuous Current Mode (CCM)**: Is a mode of operation “in which current flows continuously through the charging inductor” (’331 Patent, 14:60-61). “In the continuous conduction mode (CCM), the inductor current has peaks. However, the peak currents may be lower than in DCM, and the inductor current may not return to Zero between the peaks” (’331 Patent, 15:2-5).

35. The main difference between continuous current mode (CCM) and discontinuous current mode (DCM) is that in CCM, the inductor current never falls to zero, while in DCM, the inductor current does fall to zero at some point during the switching cycle.

36. DCM has some advantages over continuous current mode (CCM). First, it allows the converter to operate with a smaller inductor, which can save space and cost. Second, it allows the converter to operate with a lower switching frequency, which can reduce EMI emissions.

37. DCM also has some disadvantages. First, it can make the converter more sensitive to load variations. Second, it can make the converter more difficult

to design, as the designer needs to ensure that the inductor current does not fall to zero for too long.

38. The best mode of operation for a particular switching regulator will depend on the specific application. For example, CCM is often used in applications where the load is constant (e.g., LED drivers), while DCM is often used in applications where the load is variable (e.g., microprocessors, motors, etc.).

39. Multiple types of constant current LED drivers were available prior to November 18, 2005. An example from Supertex is the HV9910 (Ex. 1016). Released in May 2004, this switching constant current driver is designed for high-brightness LED applications (275mA max., input voltage range = 8-450V). It features a programmable current accuracy of +/-3%, which makes it ideal for applications where precise LED brightness control is required. This is just one example of the many constant current LED drivers that were available circa 2005. The best driver for a particular application will depend on the specific requirements of that application.

A. Lys

40. Lys is a publication of an International Application, and I am informed that Lys is prior art to the '331 Patent. Lys relates to "high output linear lighting systems for various environments," and the linear lighting systems may

include “power systems for driving light sources in high-voltage environments.”

Lys, Abstract.

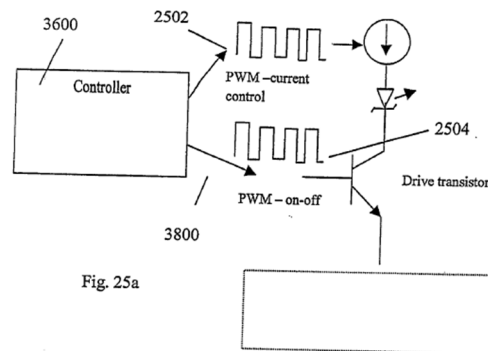
41. Lys describes “a lighting unit 102 is controlled by a control facility 3500,” which “controls the intensity, color, saturation, color temperature, on-off state, brightness, or other feature of light that is produced by the lighting unit 102.”

Lys, p. 32:6-9. The lighting unit 102 can include “a light source 300, which in embodiments is a solid-state light source, such as a semiconductor-based light source, such as light emitting diode, or LED.” Lys, p. 32:10-12.

42. The lighting unit 102 or the light source 300 may “include and/or be coupled to a power facility 1800,” which may be “AC power sources, DC power sources, batteries, solar-based power sources, thermoelectric or mechanical-based power sources and the like” in various embodiments. Lys, p. 60:13-17. In one aspect, the power facility 1800 may include or be associated with one or more power conversion devices that convert power received by an external power source to a form suitable for operation of the lighting unit 102. Lys, p. 60:17-19.

43. Control facilities may include more complex drive facilities 3800, including various forms of drive hardware 3802, such as switches, current sinks, voltage regulators, and complex circuits, as well as various methods of driving 4300, including “modulation techniques such as pulse-width-modulation, pulse-amplitude-modulation, combined modulation techniques, table-based modulation

techniques, analog modulation techniques, and constant current techniques.” Lys, p. 34:23-35:2. In one embodiment, the control facility 3500 can switch between a current-control mode 2502 (which itself could be controlled by a PWM stream) and a separate PWM mode 2504, and such a system can include simultaneous current control via PWM for wavelength and PWM control balanced to produce desired output intensity and color. Lys, p. 85:17-20. As shown in Figure 25a, “two control signals” are created from a controller, such as a microprocessor “to control one or more LEDs in a string.” Lys, p. 85:20-22.



Lys, Fig. 25a.

B. Mueller

44. Mueller is a publication of a U.S. Application, and I am informed that Mueller is prior art to the '331 Patent. Mueller discloses “methods and systems for providing controlled lighting.” Mueller, [0037]. The lighting unit 100 shown in Figure 1 may be used alone or together with other similar lighting units in a system of lighting units, and the lighting unit 100 may be employed in a variety of

applications including, among other applications, illumination of displays and/or merchandise. Mueller, [0153].

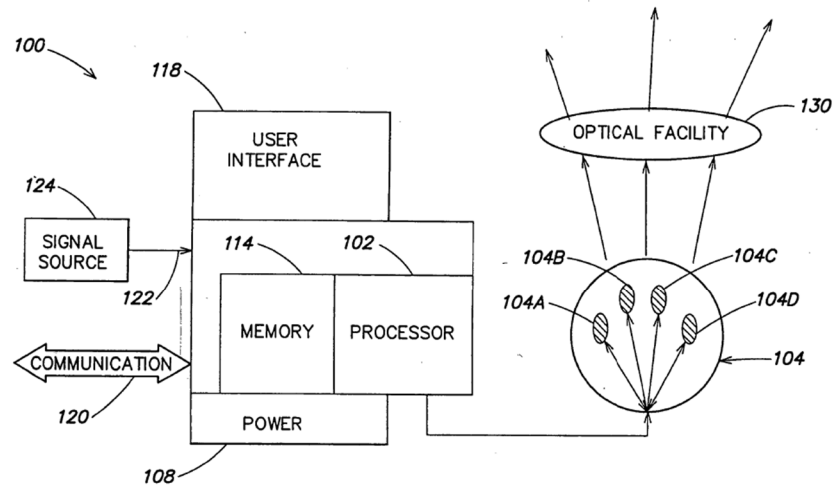


FIG. 1

Mueller, Fig. 1.

45. As shown Mueller's Figure 2, a number of lighting units 100, similar to those discussed above in connection with Figure 1, are coupled together to form the networked lighting system. Lighting unit controllers (LUCs) 208A, 208B, 208C, and 208D may be configured to be "intelligent" in that the central controller 202 may be configured to communicate higher level commands to the LUCs that need to be interpreted by the LUCs before lighting control information can be forwarded to the lighting units 100. Mueller, [0192]. When a given LUC receives such a command, it may then interpret the command so as to generate the appropriate lighting control signals which it then communicates using a DMX

protocol via any of a variety of signaling techniques (e.g., PWM) to one or more lighting units that it controls. Mueller, [0192].

C. Grootes

46. Grootes is a publication of a U.S. Application, and I am informed that Grootes is prior art to the '331 Patent. Grootes discloses an “LED backlight structure” and techniques for “setting the voltages and currents for the LEDs.” Grootes, Abstract. Grootes describes that “[s]eries strings of red LEDs 32, green LEDs 33, and blue LEDs 34” and current sources 40, 41, and 42 are mounted on a single printed circuit board (PCB) 30, and the cathode of each string is “connected to its own current source 40, 41, 42.” Grootes, [0035]-[0037].

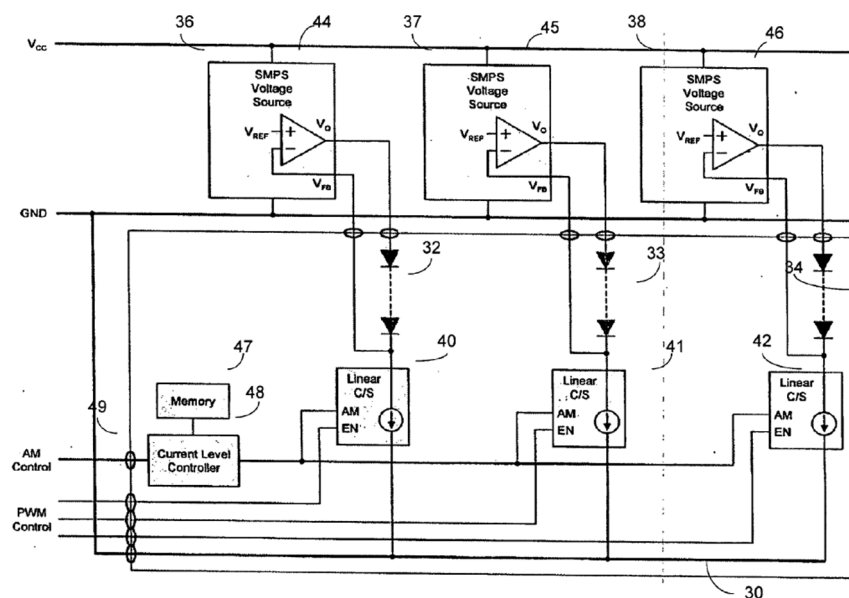


Fig. 4

Grootes, Fig. 4.

D. Xu

47. Xu is a Chinese Patent Application, and I am informed that Xu is prior art to the '331 Patent. Xu discloses “a driving device for a light-emitting diode series for a back light module.” Xu, p. 5:5-6. Xu describes that the direct current-direct current converter 208 in three examples may also be replaced by other buck converter, boost converter, boost-buck converter, flyback converter or full-bridge converter. Xu, p. 11:17-20. Xu further states that the feed circuit 206 comprises a current-voltage converter 214, and the current-voltage converter 214 is, for example, a resistor R_s . Xu, p. 8:8-11.

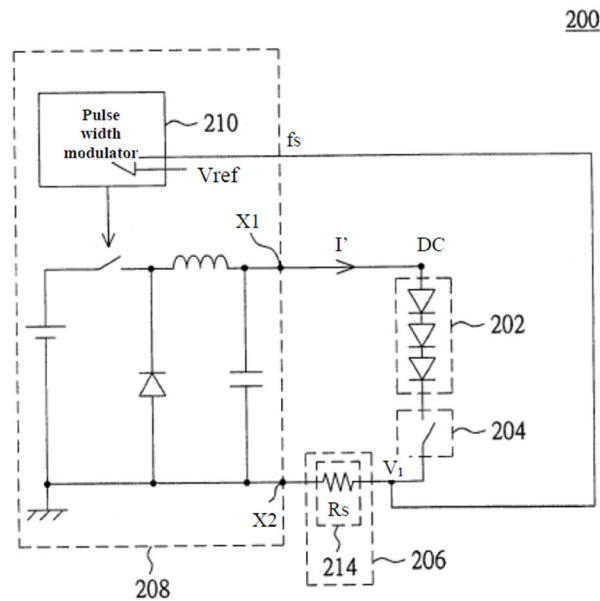


Figure 2

Xu, Fig. 2.

E. Blum

48. Blum is a publication of a U.S. Application, and I am informed that Blum is prior art to the '331 Patent. Blum is directed to “a circuit that reduces leading edge current spikes in a current sense signal that may occur during switching.” Blum, col. 1:11-13. Blum discloses monitoring the amount of current flowing in a switching device such as a transistor by adding a current sense element, such as a resistor connected in series with the switching device. Blum, col. 1:14-18. Blum confirms that “plac[ing] a low pass RC filter between the current sense element and the current sense input of the PWM controller” is a well-known method in the art for eliminating the leading-edge current spike. Blum, col. 1:45-48. One example of such a low pass RC filter is a filter formed from passive components that have an attenuation effect over the entire signal that is greater over certain frequency levels than others. Blum, col. 1:48-53.

VII. The Prior Art Renders Every Element of Claims 17-18 and 20-25 Obvious.

A. Backlighting Systems for LED Displays Were Known in the Art.

49. Backlighting systems using solid state light sources, such as LEDs to provide backlights for displays were well known in the art. As one example, Lys discloses “a lighting system” and that “The lighting unit 102 can include a light source 300, -which in embodiments is a solid-state light source, such as a semiconductor-based light source, such as light emitting diode, or LED.” Lys, p.

32:6-12. Lys makes clear that “[t]he lighting system may include a lighting system for a largescale display.” Lys, p. 28:8-9.

50. Similarly, Mueller describes “the lighting unit 100 shown in FIG. 1 may be used alone or together with other similar lighting units in a system of lighting units (e.g., as discussed further below in connection with FIG. 2).” Mueller, [0153]. Mueller further explains that “[u]sed alone or in combination with other lighting units, the lighting unit 100 may be employed in a variety of applications including, but not limited to ...illumination of displays and/or merchandise (e.g. for advertising and/or in retail/consumer environments)....” Mueller, [0153].

B. Lighting Panels Using Multiple Strings of LEDs Were Known in the Art.

51. Further, it was well-known in the art to use strings of multiple LEDs in lighting systems. In particular, Lys describes, “the sources 300 can be point sources or can be arranged in many different configurations 302, such as ... a circular configuration 308, an oval configuration 304 ... or any other geometric configuration, including two-dimensional and three-dimensional configurations.” Lys, 36:30-37:2. With respect to panels, one example Lys gives is that “ housings 800 may include panels 804 that consist of a support platform on which light sources 300 are disposed in an array.” Lys, 51:15-16. Further, “the lighting unit 102 [in Figure 3] may be any kind of lighting unit 102 that is capable of

responding to control, but in embodiments the lighting unit 102 includes a light source 300 that is a solid-state light source, such as a semiconductor-based light source, such as a light emitting diode, or LED. Lighting units 102 can include LEDs that produce a single color or wavelength of light, or LEDs that produce different colors or wavelengths, including red, green, blue, white, orange, amber, ultraviolet, infrared, purple or any other wavelength of light.” Lys, p. 36:16-23. Lys further describes, “one or more LEDs in a string” and that “[m]ultiple such strings can be used to create a light fixture that can vary in color (HSB) and spectrum based on the current and on-off control.” Lys, p. 85:17-30. Each of these strings of LEDs would be controlled to emit light, i.e., a first light and a second light. See, e.g., Lys, p. 37:3-8 (“The sources 300 can also be mixed, including sources 300 of varying wavelength, intensity, power, quality, light output, efficiency, efficacy or other characteristics. In embodiments sources 300 for different lighting units 102 are consistently mixed to provide consistent light output for different lighting units 102. In embodiments the sources are mixed 300 to allow light of different colors or color temperatures, including color temperatures of white.”).

52. As another example, Mueller that its lighting unit 100 may include one or more light sources including multiple LEDs. Mueller, [0155] (“the lighting unit 100 shown in FIG. 1 may include one or more light sources 104A, 104B,

104C, and 104D (collectively 104) wherein one or more of the light sources may be an LED-based light source that includes one or more light emitting diodes (LEDs).”).

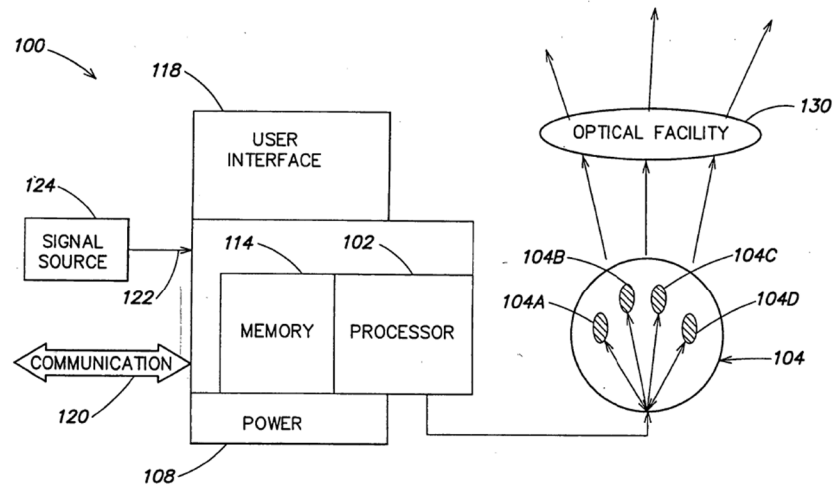
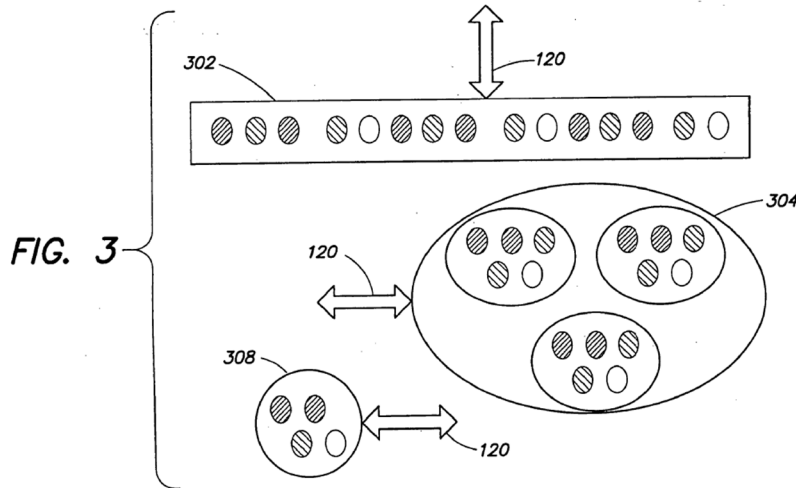


FIG. 1

Mueller, Fig. 1.

53. Mueller further describes that these LEDs may include serial connections of LEDs, which demonstrates that the LEDs are in strings . Mueller, [0160] (“the lighting unit 100, one or more of the light sources 104A, 104B, 104C and 104D shown in FIG. 1 may include a group of multiple LEDs or other types of light sources (e.g., various parallel and/or serial connections of LEDs or other types of light sources) that are controlled together by the processor 102.”).



Mueller, Fig. 3. With respect to “a lighting panel,” Mueller describes multiple configurations that disclose a lighting panel. Mueller describes that “various configurations can be provided for lighting units 100.... Configurations include a linear configuration 302 (which may be curvilinear in embodiments), a circular configuration 308, an oval configuration 304, or a collection of various configurations 302, 304, 308.” Mueller, [0194]. As one example of such a configuration, Mueller describes that “lighting units can be used on the interior ceiling 2714 or along the floor 2712, such as being used as directional lights 2704. The lights can be used to light the seating environment 2710.... The lighting units 100 can thus be used to provide aesthetic lighting, alarm lighting, safety lighting, lighting entertainment, indication of conditions or data, or many other purposes.” *Id.*, [0248]; [0249] (“Lighting units 100 can be disposed along the ceiling 2802, above seats 2808, or along the aisle 2804, to provide a variety of illumination effects,”); [0255] (“Referring to FIG. 33, a medical environment is depicted in which

a health care provider 3300 provides health care services to a patient 3302 under a lighting system 3308 that includes a plurality of lighting units 100.”)

C. Current Supply Circuits that Provide Strings of LEDs with On-State Drive Currents Were Known in the Art.

54. A person of ordinary skill in the art would have further recognized that controlling multiple strings of LEDs with on-state drive currents to each of the individual strings was well-known in the art.

55. Lys describes power supply circuits that provide current to the strings of LEDs. *See, e.g.*, Lys, p. 60:14-19 (“In various aspects, examples of power facilities 1800 include, but are not limited to, AC power sources, DC power sources Additionally, in one aspect, the power facility 1800 may include or be associated with one or more power conversion devices that convert power received by an external power source to a form suitable for operation of the lighting unit 102.”). Lys further describes that Pulse width modulation (PWM) involves supplying a substantially constant current to the LEDs for particular periods of time.” Lys, 79:9-10. Thus, Lys describes multiple color LEDs driven by PWM and that the power supply may supply “a substantially constant current.”

56. Lys further describes that “[p]ower supplies may be separate from lighting units 102 or may be incorporated on-board the lighting units 102 in power-on-board configurations. Power supplies may power multiple lighting units 102 or a single lighting unit 102. In embodiments power supplies may provide low-

voltage output or high-voltage output.” Lys, p. 60:22-27. With respect to Figure 17, Lys describes that the power factor correction facility 1804 and DC to DC converter 1812 are integrated into a single stage power factor correction/DC to DC converter facility 1908. This converter “is integrated with the lighting unit 102, rather than being contained in a separate power supply.” Lys, p. 62:18-21. In other words, each of the LED lights 102 has its own single stage power factor correction/DC to DC converter facility 1908. A person of ordinary skill in the art would recognize that a DC to DC converter is a current supply circuit, and as shown below, there is a current supply circuit 1908 for each string of microprocessor controlled LED lights 102.

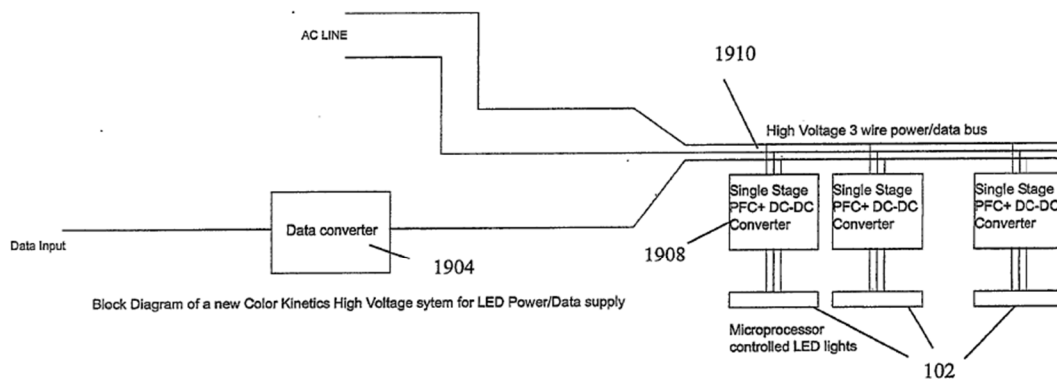


Fig. 17

Lys, Fig. 17.

57. In my opinion, a person of ordinary skill in the art would view this disclosure as teaching the use of a single power supply circuit for each string of LEDs.

58. Mueller also describes using power sources 108 to supply power to the strings of LEDs. Mueller, [0184]. As shown in FIG. 2, the lighting system 200 may include one or more lighting unit controllers (hereinafter “LUCs”) 208A, 208B, 208C and 208D.

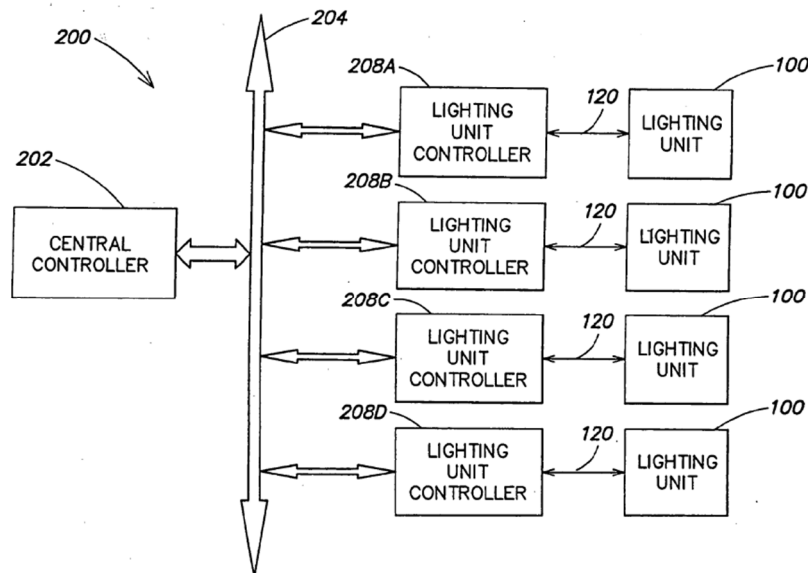


FIG. 2

Mueller, Fig. 1. “Each LUC is responsible for communicating with and generally controlling one or more lighting units 100 coupled to it.” Mueller, [0189]. These “LUCs 208A, 208B, 208C and 208D shown in FIG. 2 may be configured to be ‘intelligent’ in that the central controller 202 may be configured to communicate higher level commands to the LUCs that need to be interpreted by the LUCs before

lighting control information can be forwarded to the lighting units 100.” Mueller, [0192].

59. In view of this disclosure a person of ordinary skill in the art would recognize that Mueller discloses or at least suggests that each lighting unit includes its own power supply.

60. However, to the extent either Lys or Mueller fail to disclose the use of a single supply circuit for each string of LEDs, Grootes expressly describes that “[s]eries strings of red LEDs 32, green LEDs 33, and blue LEDs 34” and current sources 40, 41, and 42 are mounted on a single printed circuit board (PCB) 30, and the cathode of each string is “connected to its own current source 40, 41, 42.” Grootes, [0035]-[0037]. Each current source 40-42 is controllable to control the brightness of its associated LEDs to achieve the desired white point. Grootes, [0041].

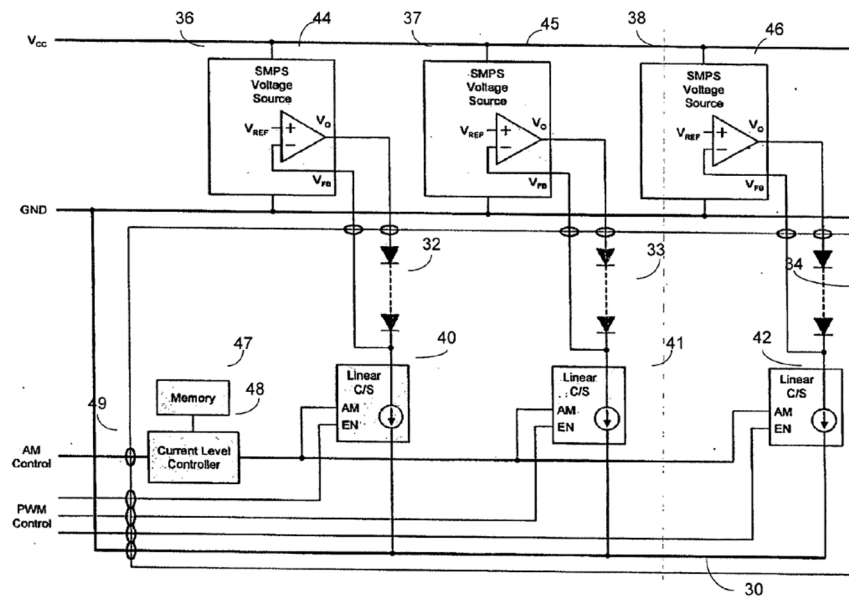


Fig. 4

Grootes, Fig. 4.

61. As discussed below, a person of ordinary skill in the art would be motivated to combine Grootes to either of Lys or Mueller to achieve the desired white point and it would have been trivial to do so as, according to Grootes, it would allow for the individual control of current sources. The combination of Lys in view of Grootes discloses this claim element.

D. PWM Controllers to Generate Control Signals for Current Supply Circuits for LEDs Were Known in the Art.

62. PWM controllers to control strings of LEDs were well-known in the art. As one example, Lys expressly describes that its “[c]ontrol facilities may include more complex drive facilities 3800, including various forms of drive hardware 3802” and that these control facilities may include “various methods of driving 4300, including modulation techniques such as pulse-width-

modulation....” Lys, p. 34:23-29. Lys further states: “In particular, the color (or color temperature) of the mixed colored light may be varied by varying one or more of the respective intensities of the light sources or the apparent intensities, such as using a duty cycle in a pulse width modulation technique.” Lys, p. 37:16-24; *see also* 79:14-16 (“The PWM technique is considered one of the preferred techniques for driving LEDs, although the present invention is not limited to such control techniques.”).

63. Thus, Lys describes that “control signals [e.g., PWM control signals] from a control facility 3500 ... are used by a processor 3600 that controls the drive hardware 3800, causing current to be delivered to the light sources 300 in the desired intensities and durations, often in very rapid pulses of current, such as in pulse width modulation” Lys, p. 73:7-12. *See also* 76:11-15 (“In embodiments the switch turns on and off in rapid pulses, such as in pulse width modulation of the current to the LEDs, which results in changes in the apparent intensity of the LED, based on the percentage of the duty cycle of the pulse width modulation technique during which the switch is turned 15 on.”); Lys, p. 85:8-11 (“a single fixture can have narrow bandwidth light sources for multicolor light applications and then can change to a current and PWM control mode to get broad spectra to make good white light or non-white light with broader spectrum color characteristics”); Lys, p. 85:17-20 (“The control facility 3500 can switch between a

current-control mode 2502 (which itself could be controlled by a PWM stream) and a separate PWM mode 2504. Such a system can include simultaneous current control via PWM for wavelength and PWM control balanced to produce desired output intensity and color.”).

Lys, Fig. 24.

“[s]eries strings of red LEDs 32, green LEDs 33, and blue LEDs 34” and current sources 40, 41, and 42 are mounted on a single printed circuit board (PCB) 30, and the cathode of each string is “connected to its own current source 40, 41, 42.” Grootes, [0035]-[0037].

65. Similarly, Mueller discloses lighting unit controllers that are configured to be “intelligent.” Mueller, [0192]. Mueller further describes controlling the lighting units with PWM signals, describing that “examples of control signals that may be generated by the processor to control the light sources include ... pulse width modulated signals (PWM)” Mueller, [0156]. Mueller further states: “Pulse width modulation (PWM) involves supplying a substantially constant current to the LEDs for particular periods of time. The shorter the time, or pulse-width, the less brightness an observer will observe in the resulting light. The human eye integrates the light it receives over a period of time and, even though the current through the LED may generate the same light level regardless of pulse duration, the eye will perceive short pulses as “dimmer” than longer pulses. The PWM technique is considered one of the preferred techniques for driving LEDs” Mueller, [0158]. A PWM controller is further shown in Mueller Figure 69.

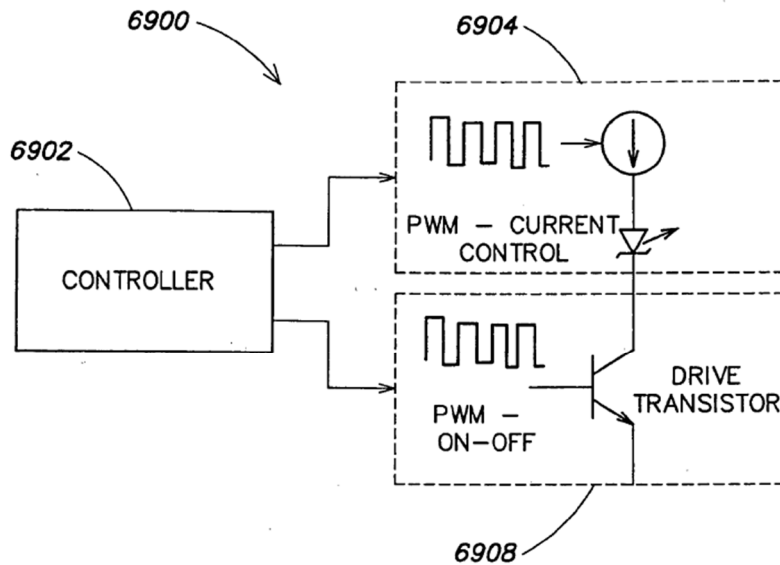


FIG. 69

Mueller, Fig. 69. Mueller describes with respect “to FIG. 69, a control system 6900 embodiment can use a variety of well-known methods. Thus, the control facility 6902 can switch between a current control mode 6904 (which itself could be controlled by a PWM stream) and a separate PWM mode 6908. Such a system can include simultaneous current control via PWM for wavelength and PWM control balanced to produce desired output intensity and color. FIG. 69 shows a schematic diagram 6900 with one possible embodiment for creating the two control signals from a controller, such as a microprocessor to control one or more LEDs in a string. Multiple such strings can be used to create a light fixture that can vary in color (HSB) and spectrum based on the current and on-off control.” Mueller, [0315]. In my opinion this discloses controlling one or more LEDs in a string with PWM control.

66. As discussed above, Mueller describes using power sources 108 to supply power to strings of LEDs and because each lighting unit 100 shown in Figure 2 has its own light unit controller. Further, as noted with respect to Lys, Grootes expressly describes that “[s]eries strings of red LEDs 32, green LEDs 33, and blue LEDs 34” and current sources 40, 41, and 42 are mounted on a single printed circuit board (PCB) 30, and the cathode of each string is “connected to its own current source 40, 41, 42.” Grootes, [0035]-[0037].

E. Variable Voltage Boost, Constant Current Power Supply Circuits Configured to Operate in Continuous Current Mode were Known in the Art.

67. Variable voltage boost, constant current power supply circuit configured to operate in continuous current mode were well-known in the art. As discussed above, both the Lys-Grootes and Mueller-Grootes combination describe using PWM control signals.

68. In a similar field, Xu further describes a constant current supply circuit configured to operate in continuous current mode. For example, Xu describes that, “[w]hen [a control] switch 204 is turned on, a fixed turn-on current flows through the light-emitting diode series 202, and the light-emitting diode series is rapidly lit to a predetermined brightness; and when the switch 204 is turned off, the current flowing through the light-emitting diode series 202 stops immediately, and the light-emitting diode series 202 is quickly extinguished.” Xu,

7:27-29. Xu further describes a pulse width modulator 210, which is shown in Figure 2:

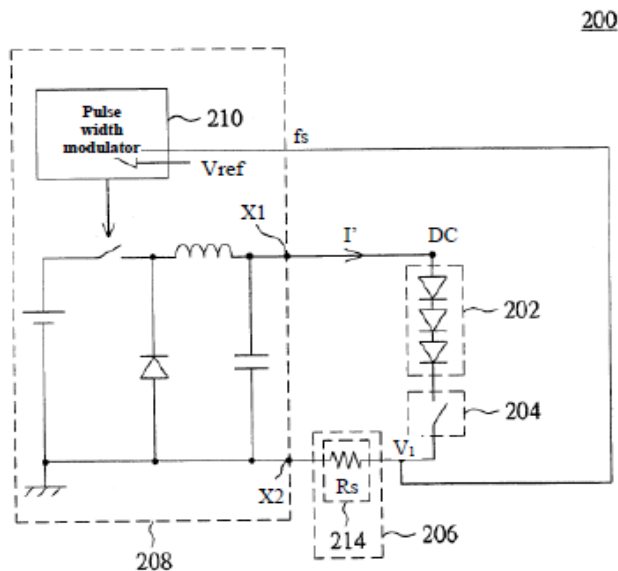


Figure 2

Xu, Fig. 2.

69. Xu further describes various conversion circuits that can be used to provide power to the string of LEDs. In particular, that “the direct current-direct current converter 208 in these three examples may also be replaced by other buck converter, boost converter, boost-buck converter, flyback converter or full-bridge converter, similarly allowing the light-emitting diode series 202 to be quickly extinguished and lit.” Xu, 11:16-19.

70. As discussed below, a person of ordinary skill in the art would be motivated to modify either the Lys-Grootes or the Mueller-Grootes combination

based on Xu in order to provide greater control of the overall light output, especially the constant color temperature.

F. Current Supply Circuits Using a Sense Resistors to Provide Feedback Signals for Closed Loop Control Were Known in the Art.

71. A person of ordinary skill in the art would recognize that a sense resistor that is coupled to an output terminal of the respective one of the first and second current supply circuits and that is coupled to a feedback input to provide the feedback signal to provide closed loop control.

72. Lys describes the use of feedback control circuits, describing that “[c]urrent control can be provided with various embodiments, including feedback loops, such as using a light sensor as a signal source 8400....” Lys, p. 85:1-4.

73. Mueller similarly describes the use of a feedback sensor, “the sensor can be a light sensor, and the sensor can provide control of a lighting signal based on a feedback loop, in which an algorithm at the step 6008 modifies the lighting control signal based on the lighting conditions measured by the sensor. In embodiments, a closed-loop feedback system can read spectral properties and adjust color rendering index, color temperature, color, intensity, or other lighting characteristics based on user inputs or feedback based on additional ambient light sources to correct or change light output.” Mueller, [0291].

74. Mueller further states: “A feedback system, whether closed loop or open loop, can be of particular use in rendering white light. Some LEDs, such as those containing amber, can have significant variation in wavelength and intensity over operating regimes. Some LEDs also deteriorate quickly over time. To compensate for the temperature change, a feedback system can use a sensor to measure the forward voltage of the LEDs, which gives a good indication of the temperature at which the LEDs are running. In embodiments the system could measure forward voltage over a string of LEDs rather than the whole fixture and assume an average value. This could be used to predict running temperature of the LED to within a few percent. Lifetime variation would be taken care of through a predictive curve based on experimental data on performance of the lights.” Mueller, [0292].

75. Xu further describes a feedback circuit that uses a resistor as a current-voltage converter. In Xu, “the feedback circuit 206 comprises a current-voltage converter 214.... The current-voltage converter 214 is, for example, a resistor R_s . When the switch 204 is turned on, the direct-current current I' flows into the current-voltage converter 214, causing the current-voltage converter 214 to generate a first reference voltage V_I as the feedback signal f_s according to the direct-current current I' . Therefore, the direct current-direct current converter 208 controls the magnitude of the direct-current current I' according to the feedback

signal f_s , so as to achieve a constant color temperature of the backlight module.”

Xu, p. 8:7-15.

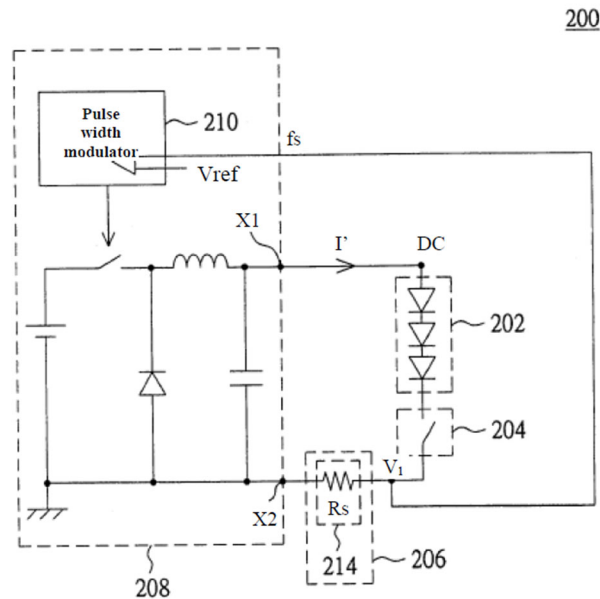


Figure 2

Xu, Fig. 2.

76. As discussed below, a person of ordinary skill in the art would be motivated to modify either the Lys-Grootes or the Mueller-Grootes combination based on Xu in order to provide greater control of the overall light output, especially the constant color temperature.

G. Current Supply Circuits Using Filters Coupled to Sense Resistors to Filter Feedback Input Were Known in the Art.

77. Filters were well-known in the art, including filters coupled to a sense-resistor of the type described above.

78. Blum discloses monitoring the amount of current flowing in a switching device such as a transistor by adding a current sense element, such as a resistor connected in series with the switching device. Blum, col. 1:14-18. Blum admits that “plac[ing] a low pass RC filter between the current sense element and the current sense input of the PWM controller” is a well-known method in the art for eliminating the leading-edge current spike. Blum, col. 1:45-48. One example of such a low pass RC filter is a filter formed from passive components that have an attenuation effect over the entire signal that is greater over certain frequency levels than other. Blum, col. 1:48-53.

79. As discussed below, a person of ordinary skill in the art would be motivated to combine Blum to the Lys-Grootes-Xu combination or the Mueller-Grootes-Xu combination in order to provide greater control of the overall light output by way of, for example, avoiding the leading-edge current spike in the feedback signal.

H. Temperature Sensors Used to Provide Input to PWM Controllers Were Known in the Art.

80. Temperature sensors were well-known in the art before November 2005, and a person of ordinary skill in the art would have recognized that a temperature sensor could be used in PWM controllers for LED lighting. As one example, Lys describes that its current supply circuit uses a temperatures sensor configured to generate a sensor output signal that the PWM controller uses to

sensor, “which gives a good indication of the temperature at which the LEDs are running,” enables precise prediction (“within a few percent”) of the running temperature of the LED, while taking lifetime variation or degradation into account. Lys, p. 136:24-137:3. Thus, Lys discloses a temperature sensor that is configured to generate a sensor output signal that the PWM controller (the processor 3600) uses to generate PWM signals.

I. Wavelength Conversion Phosphors and Combinations of Blue, Yellow, and Right LEDs Were Known in the Art.

82. It was well-known in the art to include before November 2005, to include wavelength conversion phosphors in LEDs to change the color output of the LED and to combine multiple different colors of LEDs to blend light output to create specific types of light, e.g., warmer or cooler light. Lys describes controlling multiple LED strings “to create a light fixture that can vary in color (HSB) and spectrum based on the current and on-off control.” Lys, p. 85:23-28. Sources of varying wavelengths, intensity, etc. can be mixed. Lys, p. 41:5-14.

83. Lys expressly discloses the use of “a wavelength conversion phosphor” because it describes “a phosphor for shifting a wavelength of light emitted from one or more of the plurality of LEDs.” Lys, p. 5:15-16; 40:8-9 (“an LED may be associated with a phosphor that is considered as an integral part of the LED (e.g., some types of white LEDs).”). Lys discloses the wavelength-conversion nature of a

phosphor, stating that the phosphor material “converts luminescence having a first spectrum to a different second spectrum.” Lys, p. 39:28-30.

84. Lys similarly describes combining light for multiple LEDs including dominant wavelengths such as blue and yellow. Lys describes “that LEDs may be configured to generate radiation having various bandwidths for a given spectrum....” (Lys, p. 39:21-23), and explicitly discloses dominant wavelengths corresponding to both a blue and a yellow color, describing that “examples of LEDs include ... red LEDs, blue LEDs ... yellow LEDs.” Lys, p. 39:18-21; Lys, 8:16-17 (“[t]he plurality of LED light sources may include one or more *blue LEDs that include a phosphor*.”). Lys further expressly describes that “white source[s] can be mixed with, for example, an amber or *red* source to provide a warm white light or with *a blue source* to produce a cool white light.” Lys, 35:12-14.

85. Lys goes on to describe that “red LEDs produce light in a red region 2618 and blue LEDs produce light in a blue region 2620. Mixing these colors produces mixed light output, such as in the overlapping areas between the regions, including those for orange, purple and other mixed light colors.” Lys, p. 86:30-87:3. Lys also expressly teaches that “that a given spectrum may be the result of a mixing of two or more other spectrums (e.g., mixing radiation respectively emitted from multiple light sources).” Lys, p. 41:12-14. Similarly, Lys expressly describes that the LEDs may be light sources, “which [may be] configured to

produce substantially white light and may include without limitation red, green, blue, and white LEDs.” Lys, p. 20:7-9. In other words, using red, green, blue, and white LEDs to generate mixed lighting. Further Lys expressly states: “[t]he plurality of LEDs may include *at least one* red LED, at least one green LED, at least one blue LED, and at least one white LED.” Lys, p. 21:11-14. Lys further describes that “three colors of LEDs [may be] presented (e.g., red, green and blue) and each of the colors is driven with PWM to vary its apparent intensity.” Lys, p. 79:9-22. Thus, Lys describes driving strings with PWM to vary the intensity of each string. This would have taught a person of ordinary skill in the art that multiple strings of different color lights could be individually controlled.

86. Thus, Lys expressly discloses a broad range of LED color variations and mixing those colors to create a desired light output. In my opinion it would have been obvious to a person of ordinary skill in the art reviewing Lys to utilize the combination of blue LEDs and a wavelength conversion phosphor to emit a first light that includes blue, red, and yellow components in order to produce specific type of lighting.

VIII. Lys and Grootes in View of the Knowledge of a Person of Ordinary Skill in the Art Renders Obvious Claim 17 of the '331 Patent.

87. A person of ordinary skill in the art would have been motivated to modify the linear lighting systems described in Lys to connect each string of lights to its own current source described in Grootes.

88. Lys and Grootes are in the same field of endeavor, i.e., setting the voltages and currents for LED strings. Consequently, a person of ordinary skill in the art would have had a reasonable expectation of success in combining their various disclosures to produce a lighting system having a mechanism for setting the voltages and currents for LED strings. Furthermore, it was well within the technical ability of a person of ordinary skill in the art at the time to incorporate the improvements to the lighting systems described in Grootes into the lighting systems disclosed by Lys.

89. A primary motivation of one of ordinary skill in the art would have been to provide a pulse current with a constant level to achieve color and brightness uniformity. Modifying Lys to include a current source for each string of LEDs, as disclosed by Grootes would meet this goal. For example, Grootes states that the current sources 40, 41, and 42, which are connected to red LEDs 32, green LEDs 33, and blue LEDs 34, respectively, are independently “controllable to control the brightness of its associated LEDs to achieve the desired white point.” Grootes, [0041]. In other words, including a separate current source for each string of LEDs can achieve a better “balance (white point) between the three colors.” Grootes, [0041].

90. Lys recognizes certain major challenges with lighting systems. For example, Lys states: “A need exists for improved components for such lighting

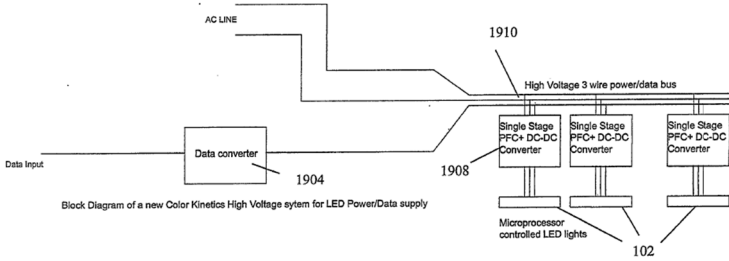
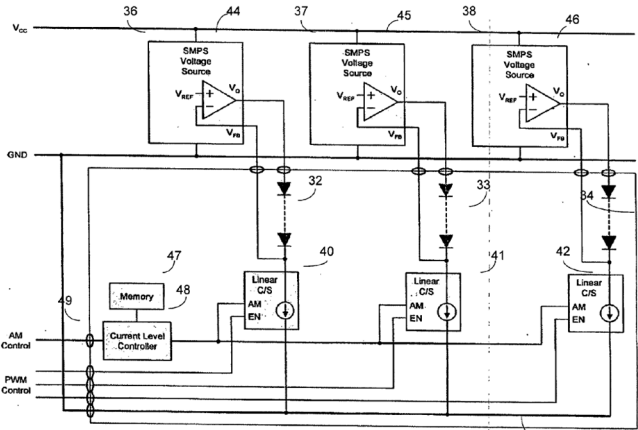
systems and for improved methods and systems for powering, making, addressing, cooling, and controlling such lighting systems. A need also exists for improved systems that take advantage of LED lighting systems.” Lys, p. 3:5-8. Those same challenges are recognized in Grootes as well. Grootes, [0008] and [0009]. Grootes stresses that the techniques disclosed therein “can store optimal current settings for strings of LEDs, such that color and brightness uniformity in the backlight application is ensured.” Grootes, [0010]. Grootes further states: “Storing the optimal current settings for a particular light source board on the board results in all light source boards having uniform light output characteristics.” Grootes, [0010].

91. Each of Lys and Grootes describe known methods for improving the color and brightness uniformity of the lighting system. A person of ordinary skill in the art would have been motivated to use the improvements described within Grootes to improve the color and brightness uniformity of the lighting system described in Lys. A person of ordinary skill in the art would recognize that the combination would have provided better color and brightness uniformity, and this would have provided motivation to combine known elements from the prior art in a similar field. Thus, combining these two references—Lys and Grootes—that both use the same components to achieve the same goal would have been obvious to a person of ordinary skill in the art.

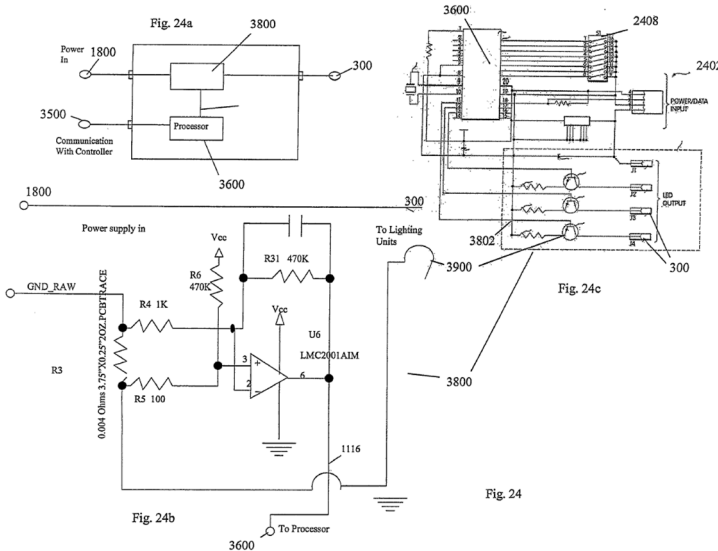
92. In my opinion, a person of ordinary skill in the art would have recognized that each element of claim 17 was obvious in view of the combination of Lys and Grootes. This is further demonstrated by the claim chart below.

Claims of the '331 Patent	Prior Art
[’331 Claim 17 Preamble] A lighting system, comprising:	Lys discloses “a lighting system” and that “The lighting unit 102 can include a light source 300, - which in embodiments is a solid-state light source, such as a semiconductor-based light source, such as light emitting diode, or LED.” Lys, p. 32:6-12. Lys, p. 28:8-9 (“The lighting system may include a lighting system for a largescale display.”).
[’331 Claim 17A] a lighting panel including at least first and second strings of solid state lighting devices that are respectively configured to emit at least a first light and a second light, respectively;	Lys, p. 36:16-23 (“Referring to FIG. 3, the lighting unit 102 may be any kind of lighting unit 102 that is capable of responding to control, but in embodiments the lighting unit 102 includes a light source 300 that is a solid-state light source, such as a semiconductor-based light source, such as a light emitting diode, or LED. Lighting units 102 can include LEDs that produce a single color or wavelength of light, or LEDs that produce different colors or wavelengths, including red, green, blue, white, orange, amber, ultraviolet, infrared, purple or any other wavelength of light.”). “[O]ne or more LEDs in a string” and that “[m]ultiple such strings can be used to create a light fixture that can vary in color (HSB) and spectrum based on the current and on-off control.” Lys, p. 85:17-30. Lys, p. 37:3-8 (“The sources 300 can also be mixed, including sources 300 of varying wavelength, intensity, power, quality, light output, efficiency, efficacy or other characteristics. In

Claims of the '331 Patent	Prior Art
	embodiments sources 300 for different lighting units 102 are consistently mixed to provide consistent light output for different lighting units 102. In embodiments the sources are mixed 300 to allow light of different colors or color temperatures, including color temperatures of white.”).
[’331 Claim 17B] at least first and second current supply circuits coupled to the at least first and second strings of solid state lighting devices, respectively, and configured to supply an on-state drive current to a respective one of the first and second strings of solid state lighting devices; and	Lys, p. 60:14-19 (“In various aspects, examples of power facilities 1800 include, but are not limited to, AC power sources, DC power sources Additionally, in one aspect, the power facility 1800 may include or be associated with one or more power conversion devices that convert power received by an external power source to a form suitable for operation of the lighting unit 102.”). Lys, p. 60:22-27 (“[p]ower supplies may be separate from lighting units 102 or may be incorporated on-board the lighting units 102 in power-on-board configurations. Power supplies may power multiple lighting units 102 or a single lighting unit 102. In embodiments power supplies may provide low-voltage output or high-voltage output.”). Lys, p. 62:18-21 (“Fig. 17 shows an embodiment where the power factor correction facility 1804 and DC to DC converter 1812 are integrated into a single stage power factor 20 correction/DC to DC converter facility 1908 that is integrated with the lighting unit 102, rather than being contained in a separate power supply.”).

Claims of the '331 Patent	Prior Art
	 Fig. 17 Lys, Fig. 17. Grootes, [0037] (“The anode of each string is connected to its own voltage regulator 36, 37, 38, and the cathode of each string is connected to its own current source 40, 41, 42.”).  Fig. 4 Grootes, Fig. 4.
[’331 Claim 17C] a pulse width modulation (PWM) controller that is coupled to the first current supply circuit and the second current supply circuit and that is configured to generate, for each of the first current supply circuit and	Lys, p. 34:23-29 (“[c]ontrol facilities may include more complex drive facilities 3800, including various forms of drive hardware 3802” and that these control facilities may include “various methods of driving 4300, including modulation techniques such as <i>pulse-width-modulation</i>....”). Lys, p. 37:16-24 (“In particular, the color (or color temperature) of the mixed colored light may

Claims of the '331 Patent	Prior Art
the second current supply circuit, a first PWM control signal and a second PWM control signal that are supplied to the each of the at least first and second strings.	be varied by varying one or more of the respective intensities of the light sources or the apparent intensities, such as using a duty cycle in <i>a pulse width modulation</i> technique.”). Lys, p. 79:14-16 (“The PWM technique is considered one of the preferred techniques for driving LEDs, although the present invention is not limited to such control techniques.”). Lys, p. 73:7-12 (“control signals [e.g., PWM control signals] from a control facility 3500 ... are used by a processor 3600 that controls the drive hardware 3800, causing current to be delivered to the light sources 300 in the desired intensities and durations, often in very rapid pulses of current, such as in pulse width modulation”). Lys, p. 76:11-15 (“In embodiments the switch turns on and off in rapid pulses, such as in pulse width modulation of the current to the LEDs, which results in changes in the apparent intensity of the LED, based on the percentage of the duty cycle of the pulse width modulation technique during which the switch is turned 15 on.”). Lys, p 85:8-11 (“a single fixture can have narrow bandwidth light sources for multicolor light applications and then can change to a current and PWM control mode to get broad spectra to make good white light or non-white light with broader spectrum color characteristics”). Lys, p. 85:17-20 (“The control facility 3500 can switch between a current-control mode 2502 (which itself could be controlled by a PWM stream) and a separate PWM mode 2504. Such a system can include simultaneous current control via PWM for wavelength and PWM control

Claims of the '331 Patent	Prior Art
	balanced to produce desired output intensity and color.”).  <i>Lys</i>, Fig. 24. Grootes, [0037] (“The anode of each string is connected to its own voltage regulator 36, 37, 38, and the cathode of each string is connected to its own current source 40, 41, 42.”).

IX. Lys, Grootes, and Xu in View of the Knowledge of a Person of Ordinary Skill in the Art Renders Obvious Claims 18-20 and 22-25 of the '331 Patent.

93. A person of ordinary skill in the art would be motivated to combine Xu to the Lys-Grootes combination such that (1) each of the first and second current supply circuits comprises a variable voltage boost, constant current power supply circuit configured to operate in continuous current mode described in Xu; and (2) to couple a sense resistor to an output terminal of the current supply

circuits to provide a feedback signal to allow for the closed loop control described in Xu.

94. Xu is in the same field of endeavor as each of Lys and Grootes, i.e., setting the voltages and currents for LED strings. Consequently, a person of ordinary skill in the art would have had a reasonable expectation of success in combining their various disclosures to produce a lighting system having a mechanism for setting the voltages and currents for LED strings. Furthermore, it was well within the technical ability of a person of ordinary skill in the art at the time to incorporate Xu's improvements to an LED driving circuit into the lighting systems disclosed by Lys and Grootes as all of the references employ or use well known electrical techniques in electronic circuitry.

95. A primary motivation of one of ordinary skill in the art would have been to provide a turn-on current with a constant level and achieve a constant color temperature. Modifying the Lys-Grootes combination to include the constant on current and the current-voltage converter (e.g., a sense resistor), as disclosed by Xu would meet this goal. For example, Xu states that "[w]hen [a control] switch 204 is turned on, a fixed turn-on current flows through the light-emitting diode series 202, and the light-emitting diode series is rapidly lit to a predetermined brightness; and when the switch 204 is turned off, the current flowing through the light-emitting diode series 202 stops immediately, and the light-emitting diode series 202 is

quickly extinguished.” Xu, p. 7:27-29. Xu further states that the current-voltage converter 214, which is a sense resistor, generates a feedback signal, based on which “the constant color temperature” of the lighting system can be realized. Xu, p. 8:7-15.

96. Lys recognizes certain major challenges with lighting systems. For example, Lys states: “A need exists for improved components for such lighting systems and for improved methods and systems for powering ... cooling, and controlling such lighting systems. A need also exists for improved systems that take advantage of LED lighting systems.” Lys, p. 3:5-8. Those same challenges are recognized in Xu as well. For example, Xu admits that there is a phenomenon of slow capacitor charging and discharging, and thus the LED series cannot be quickly turned on or off. Xu, p. 5:22-26. A primary motivation of one of ordinary skill in the art would have been to provide a pulse current with a constant level to achieve color and brightness uniformity. The modifications described in Xu would achieve this improved color and brightness uniformity in the Lys-Grootes combination.

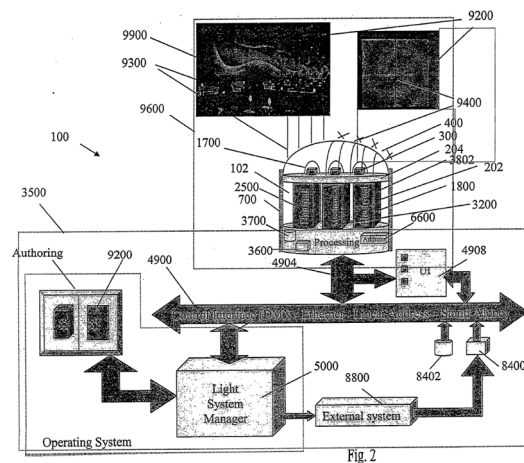
97. A person of ordinary skill in the art would recognize that each of Lys, Grootes, and Xu describe known methods for improving the color and brightness uniformity of the lighting system. A person of ordinary skill in the art would have been motivated to use the improvements described in Xu to improve the color and

brightness uniformity of the lighting system described in Lys, and that this combination would have provided better color and brightness uniformity. This would have provided motivation to make the combination, which is nothing more than the combination of known elements from the prior art. Thus, combining these three references—Lys, Grootes, and Xu—that all use the same components to achieve the same goal would have been obvious to a person of ordinary skill in the art.

98. In my opinion, a person of ordinary skill in the art would have recognized that each element of claims 18 and 20 was obvious in view of the combination of Lys, Grootes, and Xu. This is further demonstrated by the claim chart below.

Claims of the '331 Patent	Prior Art
[’331 Claim 18] The lighting system according to claim 17, wherein each of the first and second current supply circuits comprises a variable voltage boost, constant current power supply circuit configured to operate in continuous current mode.	Lys, p. 79:9-22 (“three colors of LEDs [may be] presented (e.g., red, green and blue) and each of the colors is driven with PWM to vary its apparent intensity.”). Xu, 7:27-29 (“When [a control] switch 204 is turned on, a fixed turn-on current flows through the light-emitting diode series 202, and the light-emitting diode series is rapidly lit to a predetermined brightness; and when the switch 204 is turned off, the current flowing through the light-emitting diode series 202 stops immediately, and the light-emitting diode series 202 is quickly extinguished.”).

	Xu, p. 11:16-19 (“the direct current-direct current converter 208 in these three examples may also be replaced by other buck converter, boost converter, boost-buck converter, flyback converter or full-bridge converter, similarly allowing the light-emitting diode series 202 to be quickly extinguished and lit.”).
[’331 Claim 19A] The lighting system according to claim 18, wherein each of the first and second current supply circuits comprises: a temperature sensor that is configured to generate a sensor output signal that the PWM controller uses to generate the first PWM signal or the second PWM signal, and	Lys, p. 135:4-12 (“Some examples of a signal source 8400 that may be employed in, or used in connection with, the lighting unit 102 of Fig. 2 include any of a variety of sensors 8402 or transducers that generate one or more signals in response to some stimulus. Examples of such sensors include, but are not limited to, various types of environmental condition sensors, such as thermally sensitive (e.g., temperature, infrared) sensors....”) Lys, p. 134:24-28 (“Examples of the signal(s) that may be received and processed by the processor 3600 include, but are not limited to, one or more ... signals representing some detectable/sensed condition, signals from lighting units, signals consisting of modulated light, etc.”) Lys, p. 134:16-22 (“Fig. 2 also illustrates that the lighting unit 102 may be configured to receive one or more signals 122 from one or more other signal sources 8400. · In one implementation, the processor 3600 of the lighting unit may use the signal(s), either alone or in combination with other control signals (e.g., signals generated by executing a lighting 20 program, one or more outputs from a user interface, etc.), so as to control one or more of the light sources 300 in a manner similar to that discussed above in connection with the user interface 4908.”).



Lys, Fig. 2.

Lys, p. 136:24-27(“A feedback system, whether closed loop or open loop, can be of particular use in rendering white light. Some LEDs, such as those containing amber, can have significant variation in wavelength and intensity over operating regimes. Some LEDs also deteriorate quickly over time. To compensate for the temperature change, a feedback system can use a sensor to measure the forward voltage of the LEDs, which gives a good indication of the temperature at which the LEDs are running.... This could be used to predict running temperature of the LED to within a few percent. Lifetime variation would be taken care of through a predictive curve based on experimental data on performance of the lights. Degradation can be addressed through an LED that produces amber or red through another mechanism such as phosphor conversion”).

[’331 Claim 19B] a sense resistor that is coupled to an output terminal of the current supply circuit and that is configured to provide a

Lys, p. 85:1-4 (“[c]urrent control can be provided with various embodiments, including feedback loops, such as using a light sensor as a signal source 8400....”).

feedback signal to the PWM controller.

Xu, p. 8:7-15 (“the feedback circuit 206 comprises a current-voltage converter 214.... The current-voltage converter 214 is, for example, a resistor R_s . When the switch 204 is turned on, the direct-current current I' flows into the current-voltage converter 214, causing the current-voltage converter 214 to generate a first reference voltage V_i as the feedback signal f_s according to the direct-current current I' . Therefore, the direct current-direct current converter 208 controls the magnitude of the direct-current current I' according to the feedback signal f_s , so as to achieve a constant color temperature of the backlight module.”).

200

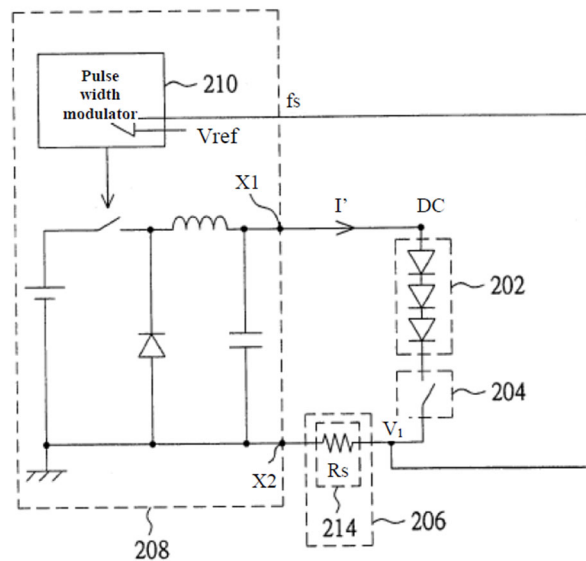


Figure 2

Xu, Fig. 2.

[’331 Claim 20] The lighting system according to claim 17, wherein each of the first and second current supply circuits comprises a sense resistor that

See Claim 19[B].

is coupled to an output terminal of the respective one of the first and second current supply circuits and that is coupled to a feedback input to provide the feedback signal to provide closed loop control.	
[’331 Claim 22] The lighting system according to claim 17, wherein the first string of solid state lighting devices are coated with a wavelength conversion phosphor and are configured to emit the first light that includes a combined light including a dominant wavelength corresponding to a blue color and a dominant wavelength corresponding to a yellow color, and wherein the second string of solid state lighting devices are configured to emit the second light that includes a dominant wavelength corresponding to a red color.	Lys, p. 85:23-28 (“Multiple such strings can be used to create a light fixture that can vary in color (HSB) and spectrum based on the current and on-off control. The PWM signal can also be a 25 PWM Digital-to-analog converter (DAC) such as those from Maxim and others. Note that the functions that correspond to particular values of output can be calibrated ahead of time by determining nominal values for the PWM signals and the resultant variations in the LED output.”) Lys, p. 41:5-14 (“The term "spectrum" should be understood to refer to any one or more frequencies (or wavelengths) of radiation produced by one or more light sources. Accordingly, the term "spectrum" refers to frequencies (or wavelengths) not only in the visible range, but also frequencies (or wavelengths) in the infrared, ultraviolet, and other areas of the overall electromagnetic spectrum. Also, a given spectrum may have a relatively narrow bandwidth (essentially few frequency or wavelength components) or a relatively wide bandwidth (several frequency or wavelength components having various relative strengths). It should also be appreciated that a given spectrum may be the result of a mixing of two or more other spectrums (e.g., mixing radiation respectively emitted from multiple light sources).”)

	Lys, p. 5:15-16; 40:8-9 (“an LED may be associated with a phosphor that is considered as an integral part of the LED (e.g., some types of white LEDs).”). Lys, p. 39:28-30 (“In another implementation, a white light LED may be associated with a phosphor material that converts luminescence having a first spectrum to a different second spectrum.”). Lys, p. 39:18-23 (“Some examples of LEDs include, but are not limited to, various types of infrared LEDs, ultraviolet LEDs, 20 red LEDs, blue LEDs, green LEDs, yellow LEDs, amber LEDs, orange LEDs, and white LEDs (discussed further below). It also should be appreciated that LEDs may be configured to generate radiation having various bandwidths for a given spectrum (e.g., narrow bandwidth, broad bandwidth).”) Lys, 8:16-17 (“[t]he plurality of LED light sources may include one or more blue LEDs that include a phosphor.”). Lys, 35:12-14 (“white source[s] can be mixed with, for example, an amber or red source to provide a warm white light or with a blue source to produce a cool white light.”) Lys, p. 86:30-87:3 (“red LEDs produce light in a red region 2618 and blue LEDs produce light in a blue region 2620. Mixing these colors produces mixed light output, such as in the overlapping areas between the regions, including those for orange, purple and other mixed light colors.”)
--	--

	Lys, p. 41:12-14 (“a given spectrum may be the result of a mixing of two or more other spectrums (e.g., mixing radiation respectively emitted from multiple light sources).”).
[’331 Claim 23] The lighting system according to claim 22, wherein the first current supply circuit provides current control of the first string of solid state lighting devices that is independent of current control of the second string of solid state lighting devices provided by the second current supply circuit.	See Claim 17[B]. Lys, p. 62:18-21 (“Fig. 17 shows an embodiment where the power factor correction facility 1804 and DC to DC converter 1812 are integrated into a single stage power factor 20 correction/DC to DC converter facility 1908 that is integrated with the lighting unit 102, rather than being contained in a separate power supply.”). Grootes, [0041] (“Each current source 40-42 is controllable to control the brightness of its associated LEDs to achieve the desired white point.”)
[’331 Claim 24] The lighting system according to claim 22, further comprising a third string of solid state lighting devices that are configured to emit a third light that includes a dominant wavelength corresponding to a red color.	Lys, p. 20:7-9 (light sources may be “configured to produce substantially white light and may include without limitation red, green, blue, and white LEDs.”) Lys, p. 21:11-14 (“[t]he plurality of LEDs may include <i>at least one</i> red LED, at least one green LED, at least one blue LED, and at least one white LED.”)
[’331 Claim 25] The lighting system according to claim 24, further comprising a third current supply circuit that is configured to supply an on-state drive current to the third string of solid state lighting devices, and wherein the first current supply circuit provides	Lys, p. 62:18-21 (“the power factor correction facility 1804 and DC to DC converter 1812 are integrated into a single stage power factor 20 correction/DC to DC converter facility 1908 that is integrated with the lighting unit 102, rather than being contained in a separate power supply.”)

current control of the first string of solid state lighting devices that is independent of current control of the second string of solid state lighting devices provided by the second current supply circuit and that is independent of current control of the third string of solid state lighting devices provided by the third current supply circuit.	Lys, p. 79:18-22 (“In an embodiment, three colors of LEDs are presented (e.g., red, green and blue) and each of 20 the colors is driven with PWM to vary its apparent intensity. This system allows for the generation of millions of colors (e.g., 16.7 million colors when 8-bit control is used on each of the PWM channels).”) Grootes, [0041] (“Each current source 40-42 is controllable to control the brightness of its associated LEDs to achieve the desired white point.”)
--	---

X. Lys, Grootes, Xu, and Blum in View of the Knowledge of a Person of Ordinary Skill in the Art Renders Obvious Claim 21 of the '331 Patent.

99. A person of ordinary skill in the art would be motivated to combine Blum to the Lys-Grootes-Xu combination to include features such as a low pass RC filter between the sense resistor and the current sense input of the PWM controller described in Blum.

100. Blum is in the same field of endeavor as each of Lys, Grootes, and Xu, i.e., setting the voltages and currents for LED strings. Consequently, a person of ordinary skill in the art would have had a reasonable expectation of success in combining their various disclosures to produce a lighting system having a mechanism for setting the voltages and currents for LED strings. Furthermore, it was well within the technical ability of a person of ordinary skill in the art at the time to incorporate the improvements to the filtering circuit that reduces current

spikes in a feedback signal described in Blum into the lighting systems disclosed by Lys, Grootes, and Xu.

101. A primary motivation of one of ordinary skill in the art would have been to eliminate current spike in the feedback signal to provide enhanced light quality and longer circuit life. Modifying the Lys-Grootes-Xu combination to include the low pass RC filter between the sense resistor and the current sense input of the PWM controller, as disclosed by Blum would meet this goal. For example, Blum discloses monitoring the amount of current flowing in a switching device such as a transistor by adding a current sense element, such as a resistor connected in series with the switching device. Blum, col. 1:14-18. Blum describes that “plac[ing] a low pass RC filter between the current sense element and the current sense input of the PWM controller” is a well-known method in the art for eliminating the leading-edge current spike. Blum, col. 1:45-48.

102. Lys recognizes certain major challenges with lighting systems. For example, Lys states: “A need exists for improved components for such lighting systems and for improved methods and systems for powering, making, addressing, cooling, and controlling such lighting systems. A need also exists for improved systems that take advantage of LED lighting systems.” Lys, p. 3:5-8. Those same challenges are recognized in Blum as well. For example, Blum admits that avoiding “the problems of a leading-edge spike in a current sense signal” is

desired. Blum, col. 1:40-63. A primary motivation of one of ordinary skill in the art would have been to provide a low pass RC filter to avoid the leading-edge spike in the feedback signal and thereby improve the overall quality of light output and increase longevity of the lighting circuit.

103. A person of ordinary skill in the art would recognize that each of Lys, Grootes, Xu, and Blum describe known methods for improving the color and brightness uniformity of the lighting system. A person of ordinary skill in the art would have been motivated to use the improvements described within Blum to improve the color and brightness uniformity of the lighting system described in Lys, with mitigated leading-edge spike in the feedback signal. A person of ordinary skill in the art would recognize that the combination would have provided better color and brightness uniformity, and this would have provided motivation to make the combination. This combination is nothing more than the combination of known elements from the prior art. Thus, combining these four references—Lys, Grootes, Xu, and Blum—that all use the same components to achieve the same goal would have been obvious to a person of ordinary skill in the art

104. In my opinion, a person of ordinary skill in the art would have recognized that each element of claim 21 was obvious in view of the combination of Lys, Grootes, Xu, and Blum. This is further demonstrated by the claim chart below.

Claims of the '331 Patent	Prior Art
[’331 Claim 21] The lighting system according to claim 20, further comprising a filter coupled to the sense resistor, the filter configured to filter the feedback input.	Blum, col. 1:14-18 (“Switching regulator controllers operate by monitoring the amount of current flowing in a switching device such as a transistor driving a transformer. The current is typically monitored by adding a current sense element, such as a resistor or transformer, in series with the switching device.”). Blum, col. 1:45-53 (“One existing method for eliminating the leading edge current spike is to place a low pass RC filter between the current sense element and the current sense input of the PWM controller. A filter is formed from passive components that have an attenuation effect over the entire signal that is greater over certain frequency levels than others. As such a filter can insert some distortion into the entire signal, though its primary effect is directed at spike reduction. FIG. 1 shows a sense or current sense signal. A with a leading edge spike.”).

XI. Mueller and Grootes in View of the Knowledge of a Person of Ordinary Skill in the Art Renders Obvious Claim 17 of the ’331 Patent.

105. In my opinion, a person of ordinary skill in the art would have been motivated to modify the systems for providing controlled lighting described in Mueller such that each string is connected to its own current source as described in Grootes.

106. Each of Mueller and Grootes are in the same field of endeavor, namely setting the voltages and currents for LED strings. Consequently, a person of ordinary skill in the art would have had a reasonable expectation of success in combining their various disclosures to produce a lighting system having a

mechanism for setting the voltages and currents for LED strings. Furthermore, it was well within the technical ability of a person of ordinary skill in the art at the time to incorporate the improvements to the lighting systems described in Grootes into the systems for providing controlled lighting disclosed by Mueller.

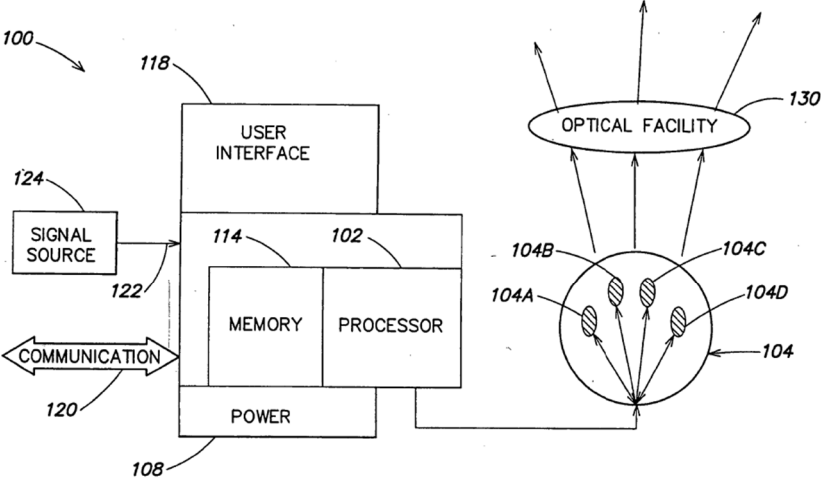
107. A primary motivation of one of ordinary skill in the art would have been to provide a pulse current with a constant level to achieve color and brightness uniformity. Modifying Mueller to include a current source for each string of LEDs, as disclosed by Grootes would meet this goal. For example, Grootes states that the current sources 40, 41, and 42, which are connected to red LEDs 32, green LEDs 33, and blue LEDs 34, respectively, are independently “controllable to control the brightness of its associated LEDs to achieve the desired white point.” Grootes, [0041]. In other words, including a separate current source for each string of LEDs can achieve a better “balance (white point) between the three colors.” Grootes, [0041].

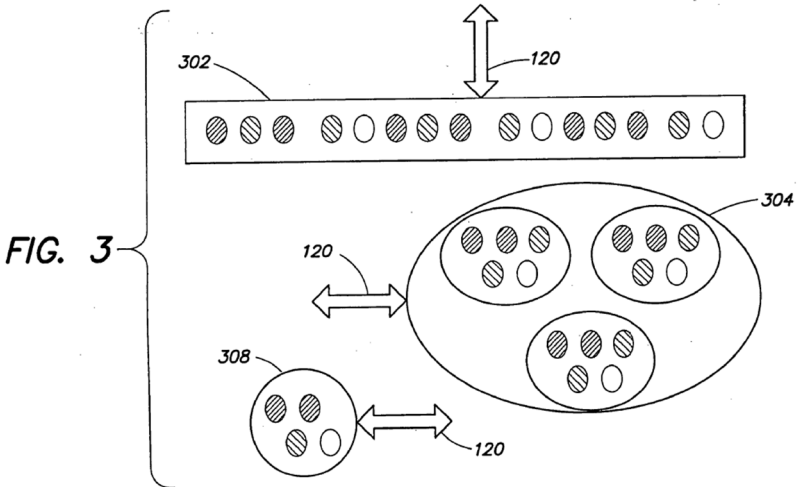
108. Mueller recognizes certain major challenges with lighting systems. For example, Mueller states: “In conventional LED-based light systems, constant current control is often preferred because of lifetime issues. Too much current can destroy an LED or curtail useful life. Too little current produces little light and is an inefficient or ineffective use of the LED.” Mueller, [0297]. The lighting systems disclosed by Mueller can “operate LEDs in an efficient manner.” Mueller, [0157].

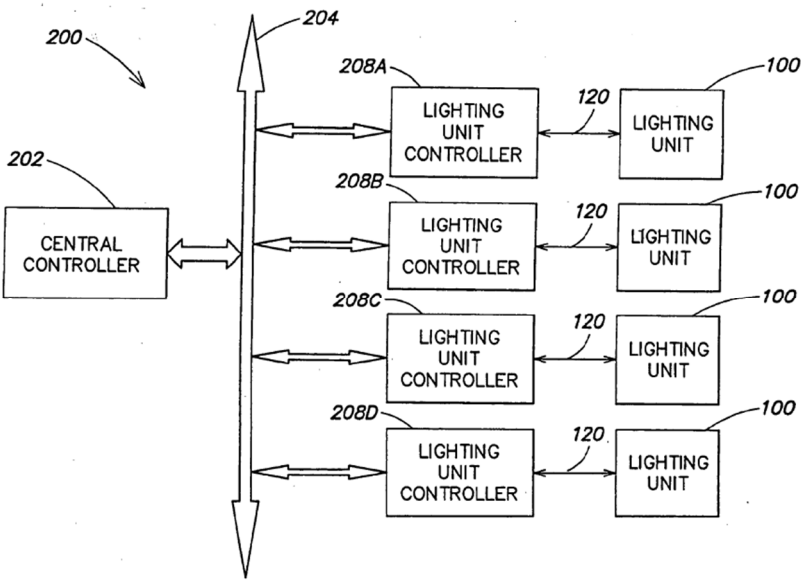
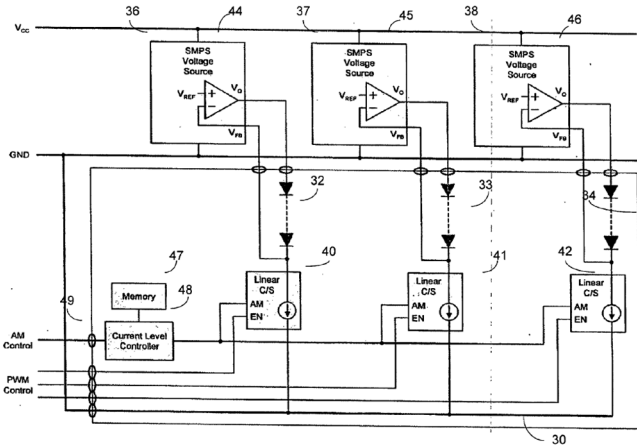
Those same challenges are recognized in Grootes as well. Grootes, [0008] and [0009]. Grootes stresses that the techniques disclosed therein “can store optimal current settings for strings of LEDs, such that color and brightness uniformity in the backlight application is ensured.” Grootes, [0010]. Grootes further states: “Storing the optimal current settings for a particular light source board on the board results in all light source boards having uniform light output characteristics.” Grootes, [0010].

109. A person of ordinary skill in the art would recognize that each of Mueller and Grootes describe known methods for improving the color and brightness uniformity of the lighting system. A person of ordinary skill in the art would have been motivated to use the improvements described within Grootes to improve the color and brightness uniformity of the lighting system described in Mueller. A person of ordinary skill in the art would recognize that the combination would have provided better color and brightness uniformity, and this would have provided motivation to make the combination. This combination is nothing more than the combination of known elements from the prior art. Thus, combining two references—Mueller and Grootes—that both use the same components to achieve the same goal would have been obvious to a person of ordinary skill in the art.

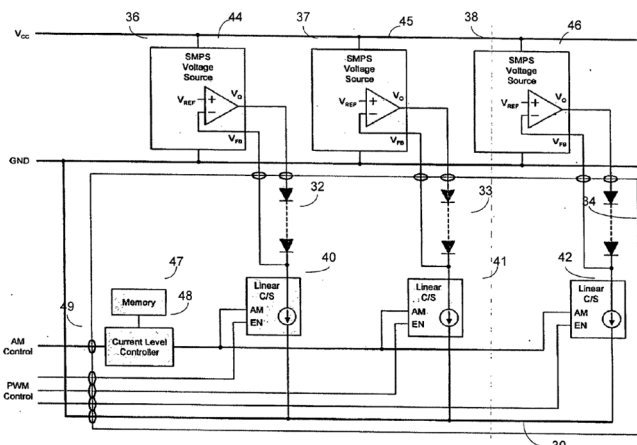
110. In my opinion, a person of ordinary skill in the art would have recognized that each element of claim 17 was obvious in view of the combination of Mueller and Grootes. This is further demonstrated by the claim chart below.

Claims of the '331 Patent	Prior Art
['331 Claim 17 Preamble] A lighting system, comprising:	Mueller, [0153] (“the lighting unit 100 shown in FIG. 1 may be used alone or together with other similar lighting units in a system of lighting units (e.g., as discussed further below in connection with FIG. 2).”)
['331 Claim 17A] a lighting panel including at least first and second strings of solid state lighting devices that are respectively configured to emit at least a first light and a second light, respectively;	Mueller, [0155] (“the lighting unit 100 shown in FIG. 1 may include one or more light sources 104A, 104B, 104C, and 104D (collectively 104) wherein one or more of the light sources may be an LED-based light source that includes one or more light emitting diodes (LEDs).”). Mueller, [0160] (“the lighting unit 100, one or more of the light sources 104A, 104B, 104C and 104D shown in FIG. 1 may include a group of multiple LEDs or other types of light sources (e.g., various parallel and/or serial connections of LEDs or other types of light sources) that are controlled together by the processor 102.”).  FIG. 1 Mueller, Fig. 1.

Claims of the '331 Patent	Prior Art
	 Mueller, Fig. 3.
['331 Claim 17B] at least first and second current supply circuits coupled to the at least first and second strings of solid state lighting devices, respectively, and configured to supply an on-state drive current to a respective one of the first and second strings of solid state lighting devices; and	Mueller, [0184] (“In one embodiment, the lighting unit 100 of FIG. 1 may include and/or be coupled to one or more power sources 108. In various aspects, examples of power source(s) 108 include, but are not limited to, AC power sources, DC power sources, batteries, solar-based power sources, thermoelectric or mechanical-based power sources and the like. Additionally, in one aspect, the power source(s) 108 may include or be associated with one or more power conversion devices that convert power received by an external power source to a form suitable for operation of the lighting unit 100.”). Mueller, [0189]. “Each LUC is responsible for communicating with and generally controlling one or more lighting units 100 coupled to it.”). Mueller, [0192] (“LUCs 208A, 208B, 208C and 208D shown in FIG. 2 may be configured to be ‘intelligent’ in that the central controller 202 may be configured to communicate higher level commands to the LUCs that need to be interpreted by the LUCs before lighting control information can be forwarded to the lighting units 100.”).

Claims of the '331 Patent	Prior Art
	 FIG. 2 Mueller, Fig. 1. Grootes, [0037] (“The anode of each string is connected to its own voltage regulator 36, 37, 38, and the cathode of each string is connected to its own current source 40, 41, 42.”).  Fig. 4 Grootes, Fig. 4.
[’331 Claim 17C] a pulse width modulation	Mueller, [0192] (“LUCs 208A, 208B, 208C and 208D shown in FIG. 2 may be configured to be ‘intelligent’ in that the central controller 202 may be configured to communicate higher level commands to the LUCs that need to be

Claims of the '331 Patent	Prior Art
(PWM) controller that is coupled to the first current supply circuit and the second current supply circuit and that is configured to generate, for each of the first current supply circuit and the second current supply circuit, a first PWM control signal and a second PWM control signal that are supplied to the each of the at least first and second strings.	interpreted by the LUCs before lighting control information can be forwarded to the lighting units 100.”). Mueller, [0156] (“examples of control signals that may be generated by the processor to control the light sources include ... pulse width modulated signals (PWM)”). Mueller, [0158] (“Pulse width modulation (PWM) involves supplying a substantially constant current to the LEDs for particular periods of time. The shorter the time, or pulse-width, the less brightness an observer will observe in the resulting light. The human eye integrates the light it receives over a period of time and, even though the current through the LED may generate the same light level regardless of pulse duration, the eye will perceive short pulses as “dimmer” than longer pulses. The PWM technique is considered one of the preferred techniques for driving LEDs”). The diagram, labeled FIG. 69, shows a system for driving LEDs. A central block labeled 'CONTROLLER' (6902) is connected to two dashed boxes. The top dashed box (6904) is labeled 'PWM - CURRENT CONTROL' and contains a square wave pulse and a circle with a downward arrow. The bottom dashed box (6908) is labeled 'PWM - ON-OFF' and contains a square wave pulse and a transistor symbol labeled 'DRIVE TRANSISTOR'. The output of the 'PWM - CURRENT CONTROL' block is connected to the 'DRIVE TRANSISTOR' block. A label '6900' with an arrow points to the overall system. FIG. 69 Mueller, Fig. 69.

Claims of the '331 Patent	Prior Art
	Grootes, [0037] (“The anode of each string is connected to its own voltage regulator 36, 37, 38, and the cathode of each string is connected to its own current source 40, 41, 42.”).  Fig. 4 Grootes, Fig. 4.

XII. Mueller, Grootes, and Xu in View of the Knowledge of a Person of Ordinary Skill in the Art Renders Obvious Claims 18 and 20 of the '331 Patent.

111. In my opinion a person of ordinary skill in the art would be motivated to combine Xu to the Mueller-Grootes combination to include such that (1) each of the first and second current supply circuits comprises a variable voltage boost, constant current power supply circuit configured to operate in continuous current mode described in Xu; and (2) to couple a sense resistor to an output terminal of the current supply circuits to provide a feedback signal to allow for the closed loop control described in Xu.

112. Xu is in the same field of endeavor as each of Mueller and Grootes, namely setting the voltages and currents for LED strings. Consequently, a person of ordinary skill in the art would have had a reasonable expectation of success in combining their various disclosures to produce a lighting system having a mechanism for setting the voltages and currents for LED strings. Furthermore, it was well within the technical ability of a person of ordinary skill in the art at the time to incorporate the improvements to the driving device for a LED string described in Xu into the lighting systems disclosed by Mueller and Grootes.

113. A primary motivation of one of ordinary skill in the art would have been to provide a turn-on current with a constant level and achieve a constant color temperature. Modifying the Mueller-Grootes combination to include the constant on current and the current-voltage converter (e.g., a sense resistor), as disclosed by Xu would meet this goal. For example, Xu states that “[w]hen [a control] switch 204 is turned on, a fixed turn-on current flows through the light-emitting diode series 202, and the light-emitting diode series is rapidly lit to a predetermined brightness; and when the switch 204 is turned off, the current flowing through the light-emitting diode series 202 stops immediately, and the light-emitting diode series 202 is quickly extinguished.” Xu, p. 7:27-29. Xu further states that the current-voltage converter 214, which is a sense resistor, generates a feedback

signal, based on which “the constant color temperature” of the lighting system can be realized. Xu, p. 8:7-15.

114. Mueller recognizes certain major challenges with lighting systems. For example, Mueller states: “In conventional LED-based light systems, constant current control is often preferred because of lifetime issues. Too much current can destroy an LED or curtail useful life. Too little current produces little light and is an inefficient or ineffective use of the LED.” Mueller, [0297]. The lighting systems disclosed by Mueller can “operate LEDs in an efficient manner.” Mueller, [0157]. Those same challenges are recognized in Xu as well. For example, Xu admits that there is a phenomenon of slow capacitor charging and discharging, and thus the LED series cannot be quickly turned on or off. Xu, p. 1:22-26. A primary motivation of one of ordinary skill in the art would have been to provide a pulse current with a constant level to achieve operation efficiency. The modifications described in Xu would achieve this improved color and brightness uniformity in the Mueller-Grootes combination.

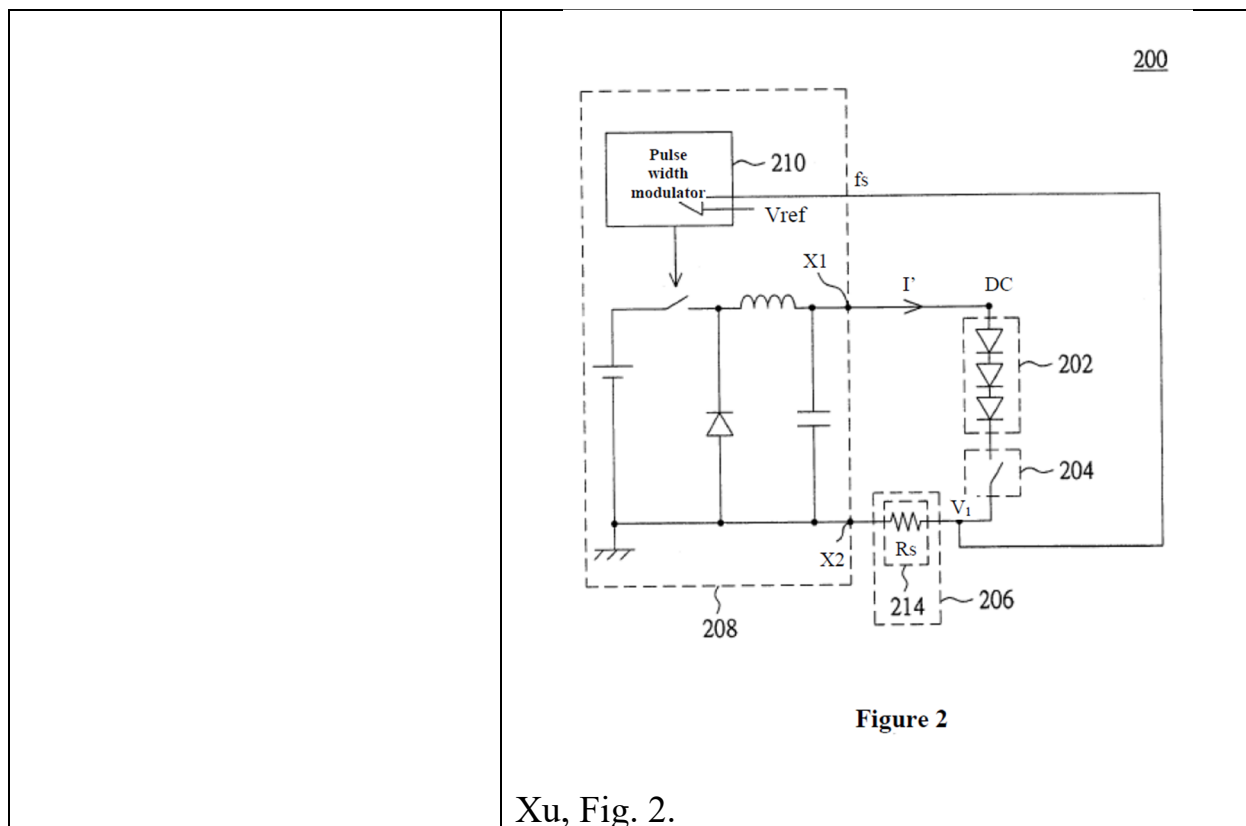
115. A person of ordinary skill in the art would recognize that each of Mueller, Grootes, and Xu describe known methods for improving the color and brightness uniformity of the lighting system. A person of ordinary skill in the art would have been motivated to use the improvements described within Xu to improve the color and brightness uniformity of the lighting system described in

Mueller. A person of ordinary skill in the art would recognize that the combination would have provided better color and brightness uniformity, and this would have provided motivation to make the combination. This combination is nothing more than the combination of known elements from the prior art. Thus, combining these three references—Mueller, Grootes, and Xu—that all use the same components to achieve the same goal would have been obvious to a person of ordinary skill in the art.

116. In my opinion, a person of ordinary skill in the art would have recognized that each element of claims 18 and 20 was obvious in view of the combination of Mueller, Grootes, and Xu. This is further demonstrated by the claim chart below.

Claims of the '331 Patent	Prior Art
['331 Claim 18] The lighting system according to claim 17, wherein each of the first and second current supply circuits comprises a variable voltage boost, constant current power supply circuit configured to operate in continuous current mode.	Xu, 7:27-29 (“When [a control] switch 204 is turned on, a fixed turn-on current flows through the light-emitting diode series 202, and the light-emitting diode series is rapidly lit to a predetermined brightness; and when the switch 204 is turned off, the current flowing through the light-emitting diode series 202 stops immediately, and the light-emitting diode series 202 is quickly extinguished.”). Xu, p. 11:16-19 (“the direct current-direct current converter 208 in these three examples may also be replaced by other buck converter, boost converter, boost-buck converter, flyback converter or full-bridge converter, similarly

	allowing the light-emitting diode series 202 to be quickly extinguished and lit.”).
[’331 Claim 20] The lighting system according to claim 17, wherein each of the first and second current supply circuits comprises a sense resistor that is coupled to an output terminal of the respective one of the first and second current supply circuits and that is coupled to a feedback input to provide the feedback signal to provide closed loop control.	Mueller, [0291] (“the sensor can be a light sensor, and the sensor can provide control of a lighting signal based on a feedback loop, in which an algorithm at the step 6008 modifies the lighting control signal based on the lighting conditions measured by the sensor. In embodiments, a closed-loop feedback system can read spectral properties and adjust color rendering index, color temperature, color, intensity, or other lighting characteristics based on user inputs or feedback based on additional ambient light sources to correct or change light output.”). Xu, p. 8:7-15 (“the feedback circuit 206 comprises a current-voltage converter 214.... The current-voltage converter 214 is, for example, a resistor R_s. When the switch 204 is turned on, the direct-current current I' flows into the current-voltage converter 214, causing the current-voltage converter 214 to generate a first reference voltage V_I as the feedback signal f_s according to the direct-current current I'. Therefore, the direct current-direct current converter 208 controls the magnitude of the direct-current current I' according to the feedback signal f_s, so as to achieve a constant color temperature of the backlight module.”).



XIII. Mueller, Grootes, Xu, and Blum in View of the Knowledge of a Person of Ordinary Skill in the Art Renders Obvious Claim 21 of the '331 Patent.

117. A person of ordinary skill in the art would have been motivated to modify the Mueller-Grootes-Xu combination to include features such as a low pass RC filter between the sense resistor and the current sense input of the PWM controller described in Blum.

118. Blum is in the same field of endeavor as each of Mueller, Grootes, and Xu, i.e., setting the voltages and currents for LED strings. Consequently, a person of ordinary skill in the art would have had a reasonable expectation of success in combining their various disclosures to produce a lighting system having

a mechanism for setting the voltages and currents for LED strings. Furthermore, it was well within the technical ability of a person of ordinary skill in the art at the time to incorporate the improvements to the circuit that reduces current spikes in a feedback signal described in Blum into the lighting systems disclosed by Mueller, Grootes, and Xu.

119. A primary motivation of one of ordinary skill in the art would have been to eliminate current spike in the feedback signal to provide enhanced light quality and longer circuit life. Modifying the Mueller-Grootes-Xu combination to include the low pass RC filter between the sense resistor and the current sense input of the PWM controller, as disclosed by Blum would meet this goal. For example, Blum discloses monitoring the amount of current flowing in a switching device such as a transistor by adding a current sense element, such as a resistor connected in series with the switching device. Blum, col. 1:14-18. Blum admits that “plac[ing] a low pass RC filter between the current sense element and the current sense input of the PWM controller” is a well-known method in the art for eliminating the leading-edge current spike. Blum, col. 1:45-48.

120. Mueller recognizes certain major challenges with lighting systems. For example, Mueller states: “In conventional LED-based light systems, constant current control is often preferred because of lifetime issues. Too much current can destroy an LED or curtail useful life. Too little current produces little light and is

an inefficient or ineffective use of the LED.” Mueller, [0297]. The lighting systems disclosed by Mueller can “operate LEDs in an efficient manner.” Mueller, [0157]. Those same challenges are recognized in Blum as well. For example, Blum admits that avoiding “the problems of a leading-edge spike in a current sense signal” is desired. Blum, col. 1:40-63. A primary motivation of one of ordinary skill in the art would have been to provide a low pass RC filter to avoid the leading-edge spike in the feedback signal and thereby improve the overall quality of light output and increase longevity of the lighting circuit.

121. A person of ordinary skill in the art would recognize that each of Mueller, Grootes, Xu, and Blum describe known methods for improving the color and brightness uniformity of the lighting system. A person of ordinary skill in the art would have been motivated to use the improvements described within Blum to improve the color and brightness uniformity of the lighting system described in Mueller, with mitigated leading-edge spike in the feedback signal. A person of ordinary skill in the art would recognize that the combination would have provided better color and brightness uniformity, and this would have provided motivation to make the combination. This combination is nothing more than the combination of known elements from the prior art. Thus, combining these four references—Mueller, Grootes, Xu, and Blum—that all use the same components to achieve the same goal would have been obvious to a person of ordinary skill in the art.

122. In my opinion, a person of ordinary skill in the art would have recognized that each element of claim 21 was obvious in view of the combination of Mueller, Grootes, Xu, and Blum. This is further demonstrated by the claim chart below.

Claims of the '331 Patent	Prior Art
[’331 Claim 21] The lighting system according to claim 20, further comprising a filter coupled to the sense resistor, the filter configured to filter the feedback input.	Blum, col. 1:14-18 (“Switching regulator controllers operate by monitoring the amount of current flowing in a switching device such as a transistor driving a transformer. The current is typically monitored by adding a current sense element, such as a resistor or transformer, in series with the switching device.”). Blum, col. 1:45-53 (“One existing method for eliminating the leading edge current spike is to place a low pass RC filter between the current sense element and the current sense input of the PWM controller. A filter is formed from passive components that have an attenuation effect over the entire signal that is greater over certain frequency levels than others. As such a filter can insert some distortion into the entire signal, though its primary effect is directed at spike reduction. FIG. 1 shows a sense or current sense signal. A with a leading edge spike.”).

I hereby declare that statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true. Should further information become available to me as this matter proceeds, I may revise my opinions accordingly as necessary. I declare under penalty of perjury that the foregoing Declaration is true and correct.

09/09/2023

Date

Rafael Betancourt

Rafael J. Betancourt