UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT TRIAL AND APPEAL BOARD

BOE TECHNOLOGY GROUP CO., LTD.

Petitioner

v.

BISHOP DISPLAY TECH LLC

Patent Owner

Case No. IPR2025-01331
Patent No. 8,093,830

PETITION FOR *INTER PARTES* REVIEW

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EXHIBIT LIST

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1002	File History of U.S. Patent No. 8,093,830 ("'830FH")
1003	Declaration of Dr. Alex Kattamis in Support of Petition for *Inter Partes* Review of U.S. Patent No. 8,093,830 ("Kattamis")
1004	U.S. Patent No. 6,285,139 ("Ghanem")
1005	U.S. Patent No. 7,332,699 ("Nishimura")
1006	U.S. Patent No. 7,262,559 ("Tripathi")
1007	U.S. Patent Pub. No. 2003/0173910 ("Suzuki")
1008	Docket Control Order, *Bishop Display Tech LLC v. BOE Technology Group Co., LTD.*, No. 2:25-CV-00310-JRG (E.D. Tex.)
1009	Paul Horowitz et al., THE ART OF ELECTRONICS, 2nd ed. (Cambridge University Press: 1989), ISBN: 0-521-37095-7 ("Horowitz Handbook")
1010	Kevin Warwick, AN INTRODUCTION TO CONTROL SYSTEMS, 2 ed., Vol. 8 in ADVANCED SERIES IN ELECTRICAL AND COMPUTER ENGINEERING (WORLD SCIENTIFIC PUBLISHING CO. PTC LTD: 1989), ISBN: 981-02-1563-0 ("Warwick Text")
1011	Steve Winder, POWER SUPPLIES FOR LED DRIVING, 1st ed. (Newnes: 2008), ISBN: 0-750683-41-4 ("Winder Text")
1012	U.S. Patent Pub. No. 2007/0091995 ("Ibragimov")
1013	U.S. Patent No. 8,090,198 ("Yoshii")
1014	Sergio Franco, DESIGN WITH OPERATIONAL AMPLIFIERS AND ANALOG INTEGRATED CIRCUITS, 3rd ed. (McGraw-Hill: 2002), ISBN: 0-07-232084-2 ("Franco Text")

Other than the prosecution history, Ex. 1002, all citations to exhibits reference original page numbers found in the underlying document. Unless noted, all emphases are added.

LIST OF CHALLENGED CLAIMS

Claim Element	Claim Language from '830 Patent
l(pre)	1. A semiconductor light source driving apparatus comprising:
l(a)	a semiconductor light source that is driven by a current;
l(b)	a voltage source that drives the semiconductor light source;
l(c)	an output voltage controlling section that controls a drive current value for driving the semiconductor light source by controlling an output voltage of the voltage source;
l(d)	an output current detecting section that detects an output current of the semiconductor light source;
l(e)	a current command section that specifies a reference value of a drive current which is applied to the semiconductor light source;
l(t)	a current comparing section that compares the output current detected by the output current detecting section and the reference value specified by the current command section; and
l(g)	an impedance detecting section that detects an impedance of the semiconductor light source,
l(h)	wherein the output voltage controlling section controls the output voltage of the voltage source based on an output of the current comparing section and an output of the impedance detecting section.
2	2. The semiconductor light source driving apparatus according to claim 1, wherein the impedance detecting section comprises a divider that divides the output voltage of the voltage source by the output current detected by the output current detecting section, and acquires a value corresponding to the impedance of the semiconductor light source from an output of the divider.

3	3. The semiconductor light source driving apparatus according to claim 1, wherein: the output voltage controlling section comprises a gain circuit that sets a gain; and the gain circuit multiplies the impedance of the semiconductor light source detected by the impedance detecting section and the output of the current comparing section to prevent a gain of a control loop from changing even when the impedance of the semiconductor light source changes.
4	4. The semiconductor light source driving apparatus according to claim 1, wherein the output voltage controlling section comprises: a multiplier that multiplies the impedance of the semiconductor light source detected by the impedance detecting section and the output of the current comparing section; and a compensator that performs predetermined processing with respect to an output of the multiplier to compensate for control characteristics.
5(pre)	5. A semiconductor light source driving method in a semiconductor light source driving apparatus that comprises:
5(a)	a semiconductor light source that is driven by a current;
5(b)	a voltage source that drives the semiconductor light source; and
5(c)	an output voltage controlling section that controls a drive current value for driving the semiconductor light source by controlling an output voltage of the voltage source,
5(d)	the semiconductor light source driving method comprising: detecting an output current of the semiconductor light source;
5(e)	comparing the detected output current of the semiconductor light source and a specified reference value;
5(t)	detecting an impedance of the semiconductor light source; and

5(g)	controlling the output voltage of the voltage source based on a result of the comparison and the impedance of the semiconductor light source.

Pursuant to §§311-319 and §42.1,[1] BOE Technology Group Co., Ltd. ("Petitioner") petitions for *inter partes review* ("IPR") of claims 1-5 ("Claims") of U.S. Patent No. 8,093,830 (Ex. 1001, "'830"), assigned to Bishop Display Tech LLC ("PO"). There is a reasonable likelihood—and it is highly likely—that at least one challenged claim is unpatentable as explained herein. Petitioner requests review of the Claims and judgment finding them unpatentable under §103.

I. INTRODUCTION

The '830 is generally directed to a semiconductor light source driving apparatus that uses an output voltage controlling section to control a voltage source's output voltage applied to a light source based on both a detected current draw and impedance of the light source. '830, cl. 1. Kattamis, ¶¶33, 41. The Claims were allowed without rejection, and the Examiner noted that the "best prior art of record" did not teach "**an impedance detecting section** that detects an impedance of the semiconductor light source" and "the output voltage controlling section control[ling] the output voltage of the voltage source based on…an output of the **impedance**

[1] Section cites reference 35 U.S.C. (pre-AIA) or 37 C.F.R. as context indicates. All emphasis/annotations added unless noted. Figure annotations herein generally quote the Claims for reference. Citations herein are exemplary and not meant to be limiting.

detecting section." '830 File History ("'830FH, Ex. 1002), 155; Kattamis, ¶¶43-44.

But these concepts were not new. **Nishimura** discloses a "**current sensor** to measure an operating current," a "**voltage sensor** to measure a voltage," and "**control circuitry 506**" that "set[s] an operating current (I) of…LED[s]" based on "a dynamic impedance of the LED[s]" estimated using "acquired readings from [the] current and voltage sensors," such as by dividing voltage by current. Nishimura, 2:64-3:5, 4:48-58, Claims 18, 24. As such, the current sensor 502, voltage sensor 504, and control circuitry 506 jointly disclose an impedance detecting section. Kattamis, ¶¶83-84.

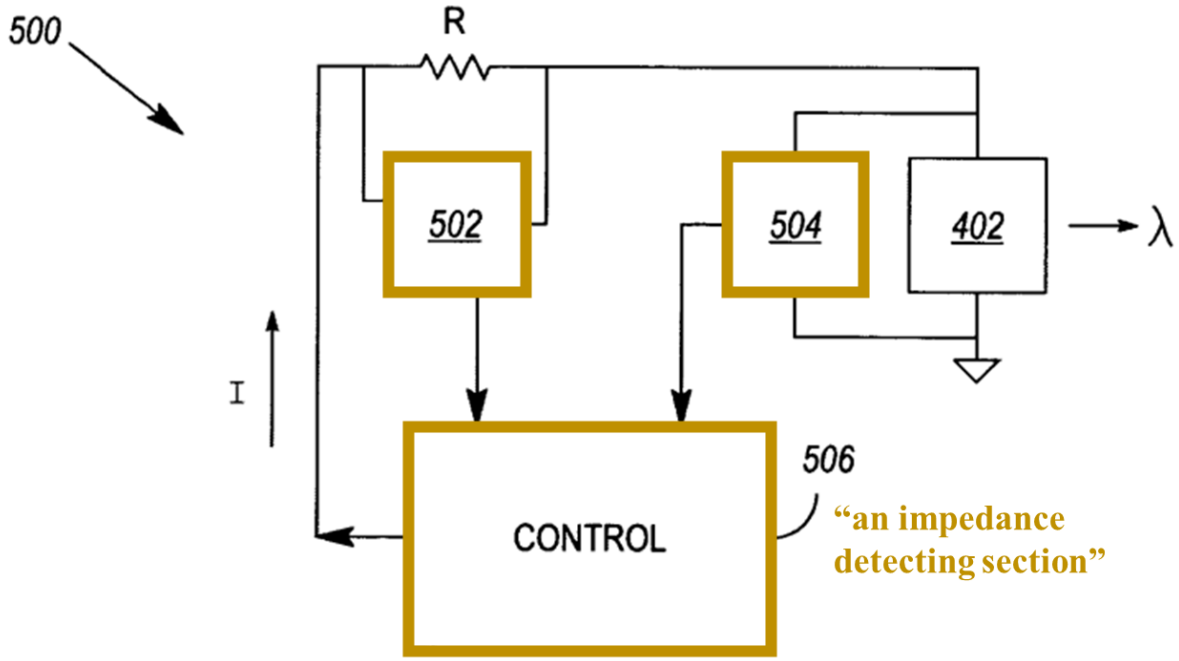

FIG. 5

Nishimura, Fig. 5.

Ghanem and **Tripathi** each disclose the remaining limitations. Indeed, the '830 confirms that these concepts were well-known in the art. '830, 1:25-2:18, Fig. 1. Thus, **Ghanem** in view of **Nishimura** and **Tripathi** in view of **Nishimura** each render the Challenge Claims obvious. Kattamis, ¶¶79-238.

Accordingly, Petitioner requests that the Board institute trial and find the Claims unpatentable.

II. MANDATORY NOTICES

A. Real Party-In-Interest

Petitioner BOE Technology Group Co., Ltd. is the real party-in-interest. No other parties had access to or control over the present Petition, and no other party funded or participated in preparation of the present Petition.

B. Related Matters

The '830 is the subject of the following co-pending civil action: *Bishop Display Tech LLC v. BOE Tech. Grp. Co., Ltd.*, No. 2:25-cv-00310-JRG (E.D. Tex.) ("Texas Litigation").

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Petitioner consents to electronic service of documents to the email addresses identified above.

III. PAYMENT OF FEES

The undersigned authorizes the Office to charge the fee required by §42.15(a) and any additional fees that might be due to Deposit Account No. 18-1945, under Order No. 120330-0001-652.

IV. REQUIREMENTS FOR *INTER PARTES* REVIEW

A. Grounds for Standing

Pursuant to §42.104(a), Petitioner certifies that the '830 is available for IPR. Petitioner and any real parties-in-interest are not barred or estopped from requesting IPR challenging the Claims on the Grounds identified herein.

B. Identification of Challenge

Pursuant to §§42.104(b)-(b)(1), Petitioner requests IPR of Claims 1-5, and that the Board cancel the same as unpatentable.

1. Specific Art on Which the Challenge is Based

Petitioner relies on the following prior art (Kattamis, ¶¶79-238):

Name	Ex.	Publication/ Title	Filed	Published/Issued	Prior art under at least
Ghanem	1004	US6285139	12/23/1999	9/4/2001	§102(b)
Nishimura	1005	US7332699	7/23/2004	2/19/2008	§102(b)
Tripathi	1006	US7262559	12/11/2003	8/28/2007	§102(b)

Each of **Ghanem**, **Nishimura** and **Tripathi** was published at least one year before the earliest possible claimed priority date of the '830 of 7/1/2009 (US filing date), and therefore qualifies as prior art under §102(b).

2. Statutory Grounds on Which the Challenge Is Based[2]

Ground	Claims	Basis	References
1	1-5	§103	Ghanem in view of Nishimura
2	1-2 and 5		Tripathi in view of Nishimura

[2] *See* Kattamis, ¶¶16, 79-238.

V. ’830 PATENT AND PROSECUTION HISTORY

A. ’830

The “object” of the ’830 Patent “is to provide a semiconductor light source driving apparatus…that can achieve constant control performance regardless of whether the drive current value is great or small when a drive current value is increased and decreased while light is adjusted.” ’830, 4:65-5:3. The ’830 admits that it was known that “[t]he brightness of light emitted by a semiconductor light source depends on the magnitude of the drive current,” and “constant-current control makes it possible to control the current applied to semiconductor light sources to be constant against various changes during the control.” *Id.*, 1:25-34. Further, in the context of Figure 1, the ’830 describes “a ***conventional*** semiconductor light source driving apparatus that is generally used to perform a constant-current control of a semiconductor light source.” ’830, 1:35-38; Kattamis, ¶33.

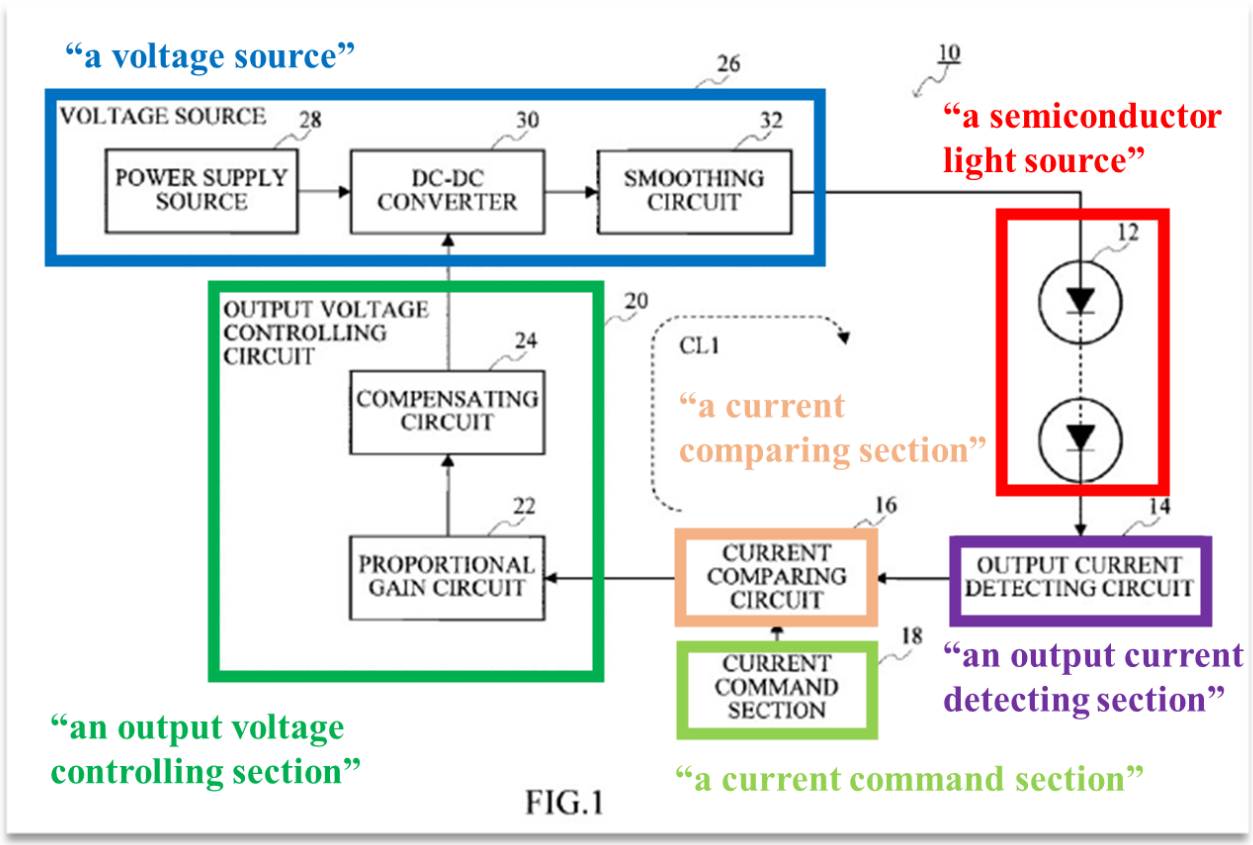


FIG.1

'830, Fig. 1.

As illustrated in Figure 1 above, "a conventional semiconductor light source driving apparatus" includes a "**semiconductor light source 12**" coupled to a "**voltage source 26**." '830, 1:39-65. The apparatus also includes an "**output current detecting circuit 14**" that "detects the current applied to this **semiconductor light source 12**" and provides the result to a "**current comparing circuit 16**," which "compare[s] [it] with a current command value from **current command section 18**." '830, 1:39-65. The comparison result is provided to the "**output voltage controlling circuit 20**" to perform a "pulse width control in **voltage source 26** according to the

comparison result." '830, 1:39-65. This conventional apparatus allowed "negative feedback closed loop current control" to be performed, "thereby creating a stable state in **semiconductor light source 12**." '830, 1:62-65, 2:13-18; Kattamis, ¶¶34-35.

To "adjust light of semiconductor light source stably," the '830 proposes an "**[i]mpedance detecting circuit 150**" that "detects the impedance of semiconductor light source 110," and an "output voltage controlling circuit 160" that compensates for the dynamic impedance of the semiconductor light source by multiplying the "impedance characteristics and the gain characteristics (FIG. 3C) of semiconductor light source 110." '830, 3:51-53, 7:32-42, 8:62-9:19. Figure 5 of the '830 Patent is described as "an embodiment of the present invention." *Id.*, 6:1-3; Kattamis, ¶36.

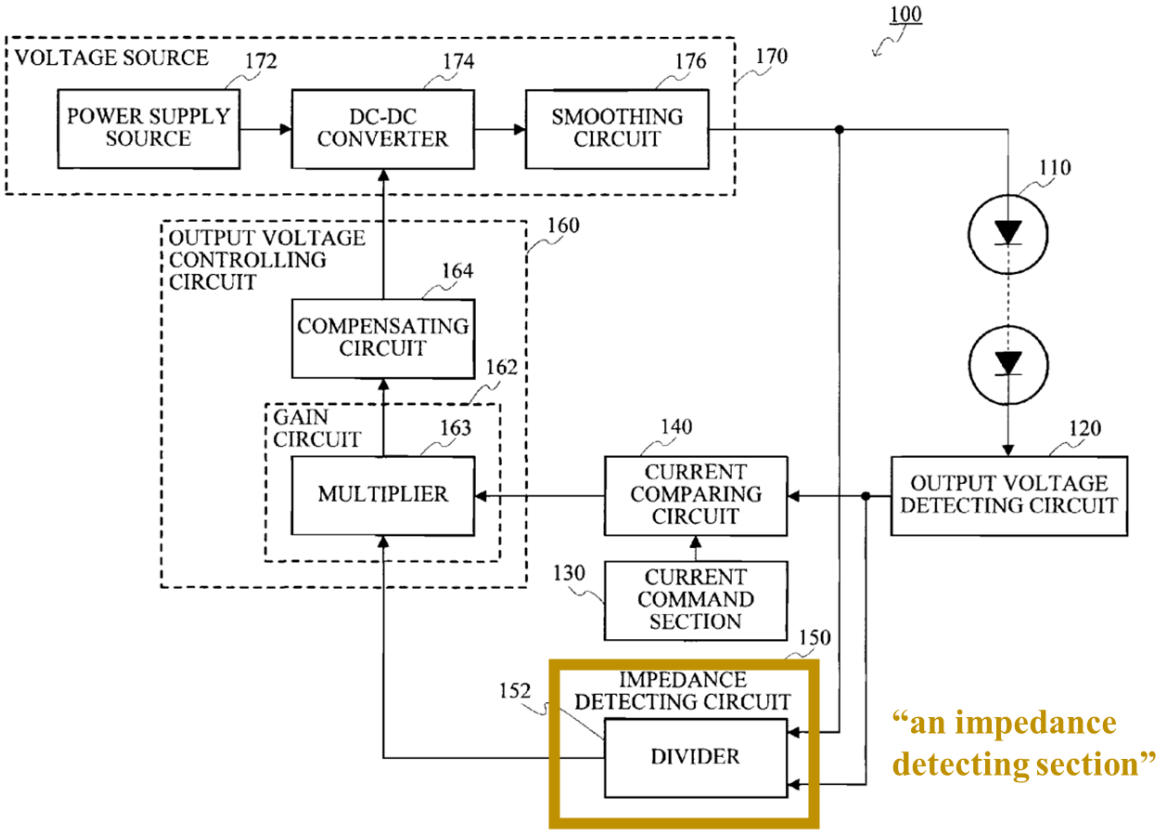


FIG.5

'830, Fig. 5.

In view of Figure 1 and the accompanying disclosure, '830 admits that all but the following limitations of claims 1 and 5 were "conventional" and therefore known in the prior art:

- **Claim 1:** "an impedance detecting section that detects an impedance of the semiconductor light source" and "wherein the output voltage controlling section controls the output voltage of the voltage source based on … an output of the impedance detecting section"
- **Claim 5:** "detecting an impedance of the semiconductor light source" and "controlling the output voltage of the voltage source based on…the impedance of the semiconductor light source"

Kattamis, ¶37.

Likewise, the ’830 also admits that “gain circuit[s]” (recited in dependent claim 3) and “compensating circuit[s]” (recited in dependent claim 4) were “conventional.” ’830, 1:35-37, 1:63-65, 8:5-11. Kattamis, ¶¶38-40.

B. Prosecution History

The ’830 was filed on July 1, 2009 as Application No. 12/496,472. The USPTO examiner did not issue any office actions during prosecution. Ex. 1002, 152; Kattamis, ¶43.

The claims were allowed on Oct. 31, 2011. Ex. 1002, 150. In the Notice of Allowance, the Examiner stated in their reasons for allowance that:

> [T]he best prior art of record, Suzuki, taken alone or in combination of other references, does not teach or fairly suggest a method or a semiconductor light source driving apparatus comprising, among other things, an impedance detecting section that detects an impedance of the semiconductor light source, wherein the output voltage controlling section controls the output voltage of the voltage source based on an output of the current comparing section and an output of the impedance detecting section (claim 1); and detecting an impedance of the semiconductor light source; and controlling the output voltage of the voltage source based on a result of the comparison and the impedance of the semiconductor light source (claim 5), as set forth in the claims.

Ex. 1002, 155; Kattamis, ¶44.

VI. §325(D) AND §314(A) DISCRETION DOES NOT APPLY

A. §325(d)

Under the two-part *Advanced Bionics* framework, the Board should not exercise discretion.

The Grounds raised by this Petition are not the same or substantially the same as the art or arguments raised during '830's prosecution. **Ghanem**, **Nishimura**, and **Tripathi** were not considered during prosecution. These references' disclosures of, e.g., 1(a)-1(h) are not substantially similar to those the Examiner considered. *See* §IX. Indeed, the Examiner noted the "best prior art of record, Suzuki" (US2003/0173910, Ex. 1007) did not disclose or render obvious the claims such that the prior art references analyzed during prosecution are not substantially the same as the references in the Grounds of this Petition. This petition raises the same prior art that was raised in the petition in *Samsung Elecs. Co., Ltd. v. Bishop Display Tech LLC,* IPR2022-00503, that challenged '830 claims 1-2 and 5, but was settled prior to an institution decision. *Samsung Elecs. Co. v. Bishop Display Tech LLC,* IPR2022-00503, Pap. 7 (P.T.A.B. June 1, 2022). Kattamis, ¶¶43-44.

Even if the art or arguments were substantially the same, the Examiner erred in a manner material to the patentability of the Claims. Because the

Examiner "did not expressly consider" **Ghanem**, **Nishimura** and **Tripathi** as prior art, "[i]t is…difficult, if not impossible, to discern exactly why the Examiner allowed the claims of the ['830] patent, or how the Examiner might have considered the arguments presented in the Petition, had they been presented to the Examiner." *Bowtech, Inc. v. MCP IP, LLP*, IPR2019-00379, Pap. 14, *19-20 (declining to exercise §325(d) discretion where Petitioner did not "even attempt[] to explain how the Examiner erred in any way"); *see* §IX.

B. §314(a)

The co-pending Texas Litigation also does not warrant the exercise of discretion under §314(a).

Factor 1 weighs in favor of institution. Petitioner intends to seek a stay of the Texas Litigation pending the outcome of this IPR or in the alternative to bifurcate out this patent from the proceedings and stay that litigation.

Factor 2 weighs in favor of institution, as a trial date is currently scheduled for January 11, 2027, and there will likely be a final written decision rendered around the same time. Ex. 1008, 1.

Factor 3 weighs in favor of institution, as the court and the parties have expended minimal investment in the Texas Litigation. The court has only set a case schedule, and the parties have not exchanged any documents or contentions thus far.

Factor 4 weighs strongly in favor of institution. Upon institution of this IPR proceeding, Petitioner stipulates that it will not pursue in the Texas Litigation the grounds of invalidity asserted in the IPR, or any other ground that was raised or could have reasonably been raised in the IPR with respect to the Challenged Claims.

Factor 5 is neutral or weighs at most only slightly against institution. While Petitioner and PO are the same parties in the Texas Litigation, institution and a public trial record of the important invalidity grounds in the Petition will reduce issues for the public, including all parties besides Petitioner who currently are or may in the future be subject to litigation involving the '830.

Factor 6 weighs strongly in favor of institution. The Petition is strong and presents compelling unpatentability arguments that were overlooked during prosecution. *See* §IX.A-B.

Accordingly, the Board should not exercise its discretion to deny institution. §314(a).

VII. LEVEL OF ORDINARY SKILL IN THE ART

A. Level of Skill in the Art

For purposes of this Petition only, Petitioner assumes the Claims are entitled to the '830's 7/1/2009 filing date. Kattamis, ¶32.

A person of ordinary skill in the art ("POSITA") as of the claimed priority date of the '830 would have had an undergraduate degree in electrical engineering

(or equivalent subject) together with two or three years of experience in designing circuits for driving light-emitting devices including organic light-emitting diodes, or a Ph.D. with experience in the same. Kattamis, ¶¶45-46.

B. Background Knowledge of a POSITA

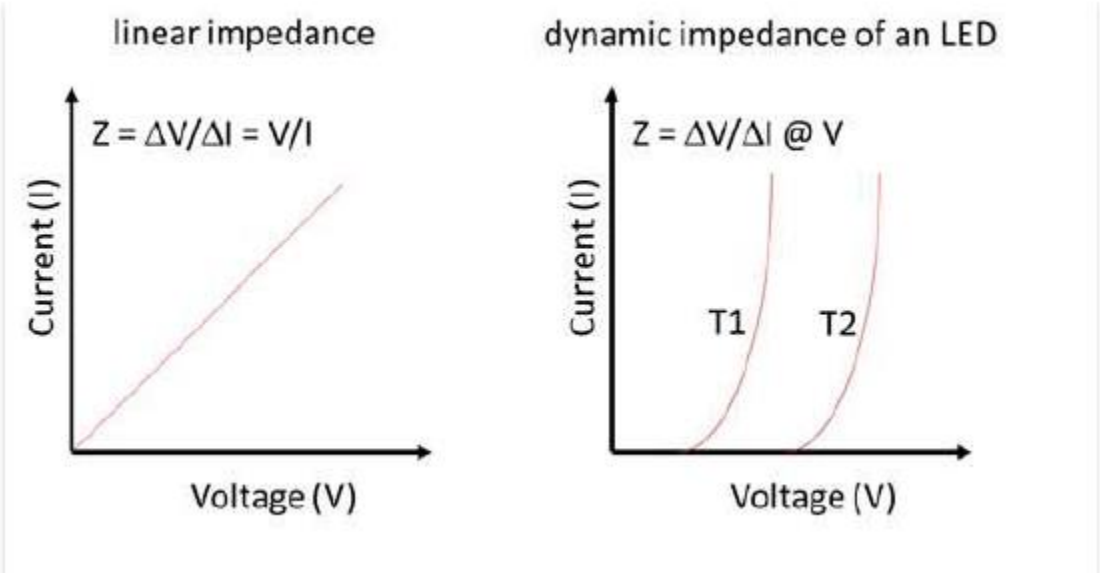
Inquiring into whether "any 'differences' between the invention and the prior art would have rendered the invention obvious … necessarily depends on [a POSITA's] knowledge," including an "assessment of the … background knowledge possessed" by the POSITA. *Koninklijke Philips N.V. v. Google LLC*, 948 F.3d 1330, 1337 (Fed. Cir. 2020). The subjects below were "within the general knowledge" of a POSITA. *See id.* at 1338; *Dish Network L.L.C. v. Broadband iTV, Inc.*, IPR2020-01267, Paper 15 at 10 n.4 (P.T.A.B. Jan. 21, 2021) ("[W]e do not include the general knowledge of a person of ordinary skill in the art in listing the grounds themselves, recognizing that such knowledge is considered in every analysis."). Dr. Kattamis corroborates the general knowledge of a POSITA with engineering references (Exs. 1009-1011, 1014) published before the '830. Kattamis, ¶¶48-78.

1. Current, Voltage, Impedance, and Ohm's Law

Electrical circuits are characterized by three parameters: voltage, current, and impedance. These parameters are interrelated, as described by Ohm's law:

$$V\ (volts) = I\ (amperes)\ x\ Z\ (ohms)$$

Materials such as metal have linear impedance (below, left). For LEDs (below, right), impedance changes depending on many factors, including manufacturing variations, applied voltage, and temperature. Ex. 1011 ("Winder Text"), §2.4, §3.1. The temperature dependent impedance of LEDs is shown in the figure below where temperature T1 is higher than temperature T2.



To ensure constant brightness in the face of changing impedance, power supplies for driving LEDs have included control systems to actively adjust the voltage in order to provide constant (fixed) current. Winder Text, §2.1, §3.1; Kattamis, ¶¶53-58.

2. Feedback Control

Feedback control was known in the art, in which an output signal or parameter is measured and then compared with an input or reference signal. The results of the

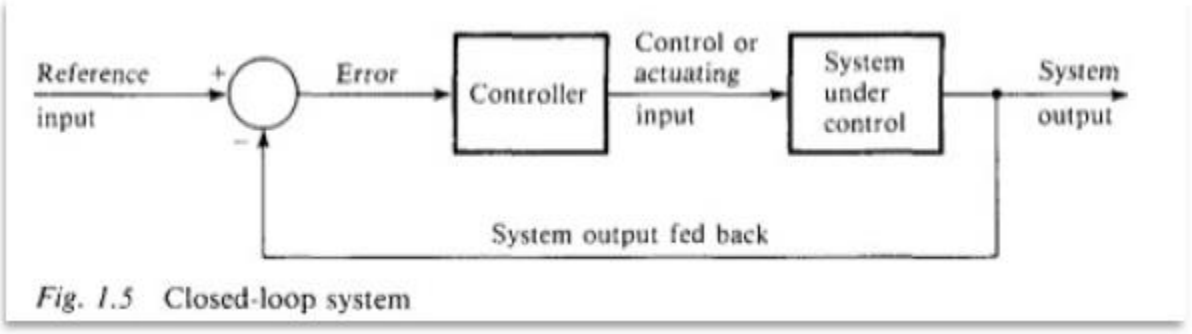
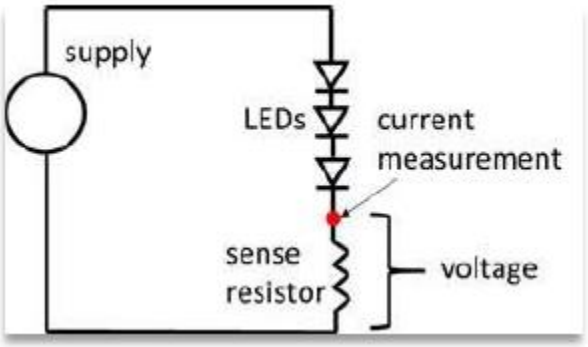


Fig. 1.5 Closed-loop system

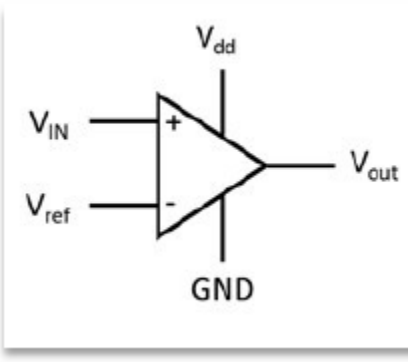
Ex. 1010 ("Warwick Text"), §1.4. It was well-known that in control systems, gain is the proportional value (multiplier) that characterizes the magnitude of the input versus the magnitude of the output. Closed-loop feedback control allows for correction of the output signal by measuring the output, comparing it to an input or reference signal, and then modifying the gain. Warwick Text, §3.4.4; Kattamis, ¶¶59-63.

It was well-known that analog sensors generate outputs (e.g., voltage outputs) that correspond to a physical quantity to be measured, and that these outputs can be used in a feedback control system. For LEDs, it was known that the current flowing is generally measured or sensed via a "current sense" resistor.



In this case, a "sense resistor" is placed in series with the LEDs, and the current flowing through the LEDs and sense resistor establishes a voltage across the sense resistor. Warwick Text, §3.1.2. This measured voltage represents the current flowing through the LEDs, and the voltage signal that is generated can be used in feedback control. Kattamis, ¶¶64-68, 75-78.

Another known component of a feedback control system is a comparator, which compares two values and generates an output based on this comparison. It was well-known that when implemented in an integrated circuit, a binary (high/low) output is generated based on a comparison of two input signals. In this example when V_{in} is less than V_{ref}, a low output (~0V or ground) is generated, and when V_{IN} is greater than V_{ref}, a high output (~V_{dd}) is generated. Ex. 1009 ("Horowitz Handbook"), §4.23; Kattamis, ¶¶69-71.



Condition	Output
$V_{in} < V_{ref}$	V_{out} = GND (logic low)
$V_{in} > V_{ref}$	$V_{out} = V_{dd}$ (logic high)

It was also well-known in the art that multipliers are used to multiply signals, and dividers are used to divide signals. Ex. 1014, 618-619, Figs. 13.10-13.11. Kattamis, ¶¶72-74.

3. LED Driver Circuits

It was well-known that the resistance of an LED is dynamic in that it will change based on the applied voltage and temperature changes. Winder Text, §3.1. It was further well-known that the resistance of an LED is dynamic and changes, yet it was also known that in order to ensure constant brightness, the LEDs need to be driven by a constant current. Thus, based on Ohm's law, it was known that if current must stay constant and impedance changes, then the voltage must be actively changed during operation to keep the current and intensity of the light output constant. Winder Text, §3.5. Kattamis, ¶75.

Therefore, it was known that circuits for driving LEDs drivers are generally designed to actively control the voltage based on feedback. At its most basic, a

measurement of the output current is made and this signal is used to modify the input voltage.

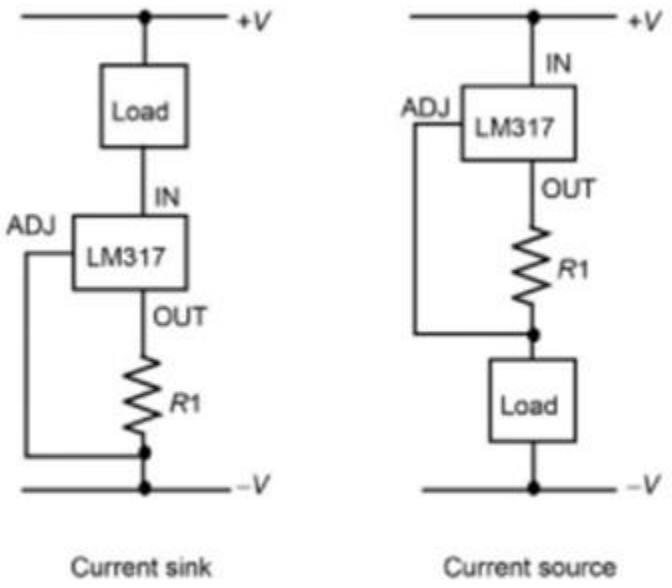
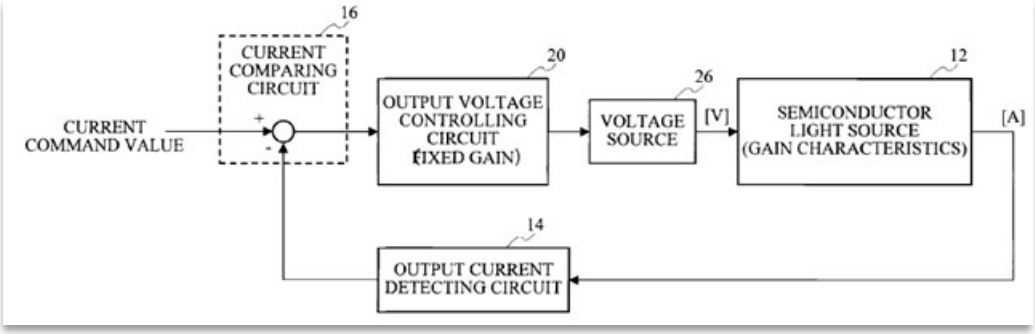


FIGURE 4.3 Constant Current Circuits Using LM317.

Winder Text, Fig. 4.3. In this example, current sense is accomplished via a "current sense" resistor R1. This signal is used in feedback to control a voltage regulator which controls the current applied to the load (LEDs). Kattamis, ¶76.

The '830 discloses the same means of control in the background section. Figure 4 of the '830 shows "a block diagram obtained by modeling" the "conventional semiconductor light source driving apparatus 10 shown in FIGURE 1." '830, 3:61-62. The '830 illustrates a conventional control system used for controlling the current delivered to LEDs based on the output current as a feedback signal as shown below. Kattamis, ¶77.



'830, Fig. 4.

According to the '830, in this conventional circuit, the result of the output current is subtracted from the current command value (input value) to find the difference. The difference is then multiplied by a gain to control the voltage source and thus control the amount of current delivered to the LEDs. Kattamis, ¶78.

> When a voltage is supplied to semiconductor light source 12 from voltage source 26, a drive current that match the characteristics of semiconductor light source 12 is applied to semiconductor light source 12 and so this drive current is used as an output of semiconductor light source 12. This drive current is detected by output current detecting circuit 14. This detection result is outputted to current comparing circuit 16 and is subtracted from the current command value to find the difference. Output voltage controlling circuit 20 multiplies this difference by a certain gain to control voltage source 26. According to such a control

> loop, the output current from semiconductor light source 12 is controlled to match with the current command value.

'830, 3:63-4:8. A person of ordinary skill in the art would have been aware that various output signals could be used in feedback in order to tailor the control of LEDs. Kattamis, ¶78.

VIII. CLAIM CONSTRUCTION

Claim terms subject to IPR are construed using *Phillips v. AWH Corp.*, 415 F.3d 1303, 1313 (Fed. Cir. 2005). 37 C.F.R. §42.100(b). Only terms necessary to resolve the controversy need construction. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor*, 868 F.3d 1013, 1017 (Fed. Cir. 2017). Because the prior art asserted herein discloses embodiments within the Claims' indisputable scope, the Board need not construe the Claims' outer bounds. All claim terms should be construed according to their plain and ordinary meaning. Kattamis, ¶47.

IX. GROUNDS OF UNPATENTABILITY

This Petition is supported by the Declaration of Dr. Alex Z. Kattamis, Ph.D., P.E., which describes the prior art's scope and content at the time of and well before the '830. *See* Ex. 1003 ("Kattamis"). The prior art renders the Claims unpatentable based on the below Grounds. Kattamis, ¶¶79-238.

'830 claims 1 and 5, the two independent claims, are similar to one another, except that claim 1 adds "a current command section that specifies a reference value

of a drive current which is applied to the semiconductor light source." All limitations of claim 5 are already subsumed within claim 1. The following table correlates Claim 5 with Claim 1. Kattamis, ¶42.

Limitation	Text	Cross-Cite to Claim 1
5(pre)	"A semiconductor light source driving method in a semiconductor light source driving apparatus that comprises:"	1(pre)
5(a)	"a semiconductor light source that is driven by a current;"	1(a)
5(b)	"a voltage source that drives the semiconductor light source; and"	1(b)
5(c)	"an output voltage controlling section that controls a drive current value for driving the semiconductor light source by controlling an output voltage of the voltage source,"	1(c)
5(d)	"the semiconductor light source driving method comprising: detecting an output current of the semiconductor light source;"	1(d)
5(e)	"comparing the detected output current of the semiconductor light source and a specified reference value;"	1(e) and 1(f)
5(f)	"detecting an impedance of the semiconductor light source; and"	1(g)
5(g)	"controlling the output voltage of the voltage source based on a result of the comparison and	1(h)

	the impedance of the semiconductor light source."	

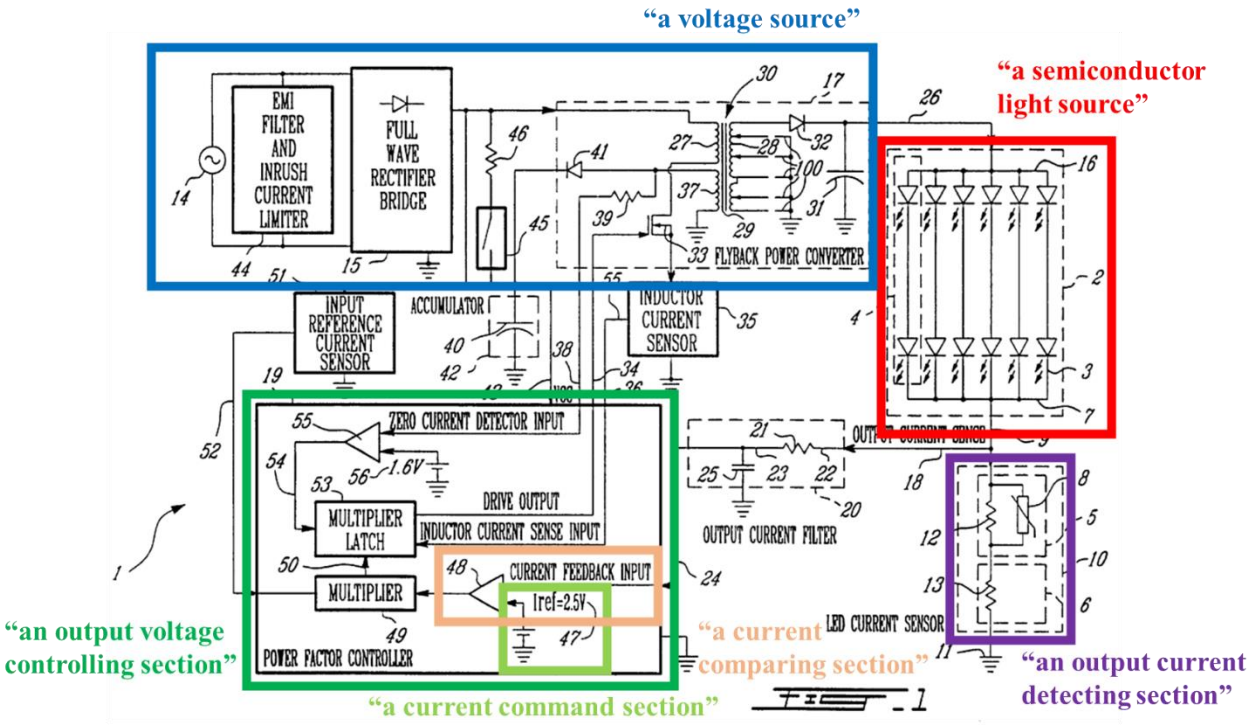
A. GROUND 1: GHANEM IN VIEW OF NISHIMURA

1. Overview of Ghanem

Similar to the '830, **Ghanem** is directed an "electronic circuit" that includes "LEDs" (semiconductor light sources) "driven by a constant current" using a "current sensor circuit and a power supply system" that "adjust[s] the dc voltage and current [supplied to LEDs] to…keep the light intensity produced by the light source substantially constant." Ghanem, 1:39-2:53, 3:36-39, 4:40-44, 5:23-25; Kattamis, ¶¶79-80.

For example, **Ghanem** discloses an "electronic circuit of a light-emitting-diode lamp" that "perform[s] variable current feedback control" for a "**set 2 of light-emitting diodes 3**." Ghanem, 3:36-39, 3:61-67, 4:26-35. The disclosed electronic circuit includes "**a controllable dc voltage and current source**" that power the LEDs. Ghanem, 2:33-39, 3:11-26, 4:30-35. A "**current sensor circuit 10**" detects the "total current flowing through the set 2 of **light-emitting diodes 3**" and provides a "current-representative voltage signal" to a "**comparator 48**," where the "current-representative voltage signal" is compared to a "**fixed reference current I_{ref} (47)**" from a **coupled voltage source**. Ghanem, Abstract, 4:13-21, 5:48-52, 6:34-38. The comparison output of **comparator 48** is provided to a "**power factor controller**

19," which "perform[s] variable current feedback control" to "effectively control[]" the output of the **controllable dc voltage and current source**. Ghanem, 4:25-35, 6:30-7:23. Thus, the circuit "maintains a roughly constant power output from the LEDs" to "keep the light intensity produced by the light source [**light-emitting diodes 3**] substantially constant." Ghanem, 2:47-54, 5:53-56; Kattamis, ¶81.



Ghanem, Fig. 1.

2. Overview of Nishimura

Similar to the '830, **Nishimura** discloses an LED drive circuit that "set[s] the light intensity of…LED[s]" to compensate for "[t]emperature, aging and other factors [that] can lead to a shift in the intensity of light emitted by a light emitting diode." Nishimura, 1:7-23, 1:27-31. **Nishimura** recognizes that "[i]t is known that

the voltage at which an LED starts to conduct appreciable current (i.e., its turn-on voltage), as well as the LED's dynamic impedance, are functions of the LED's junction temperature and aging effects." *Id.*, 2:22-25; Kattamis, ¶¶82-83.

To "control[] the LED's operating current and, as a consequence, the LED's light intensity," **Nishimura** discloses a "**current sensor** to measure an operating current," a "**voltage sensor** to measure a voltage," and "**control circuitry 506**" that "estimate[s] a dynamic impedance of the LED[s]" using "acquired readings from [the] current and voltage sensors," such as by dividing voltage by current. Nishimura, 2:12-15, 2:64-3:5, 4:48-58, Claims 18, 24. Specifically, the "current sensor 502 measures the operating current supplied to the LED 402" and the "voltage sensor 504 measures a voltage of the LED 402." Nishimura, 4:51-54. The estimated impedance is then used by the **control circuitry 506** to "set the desired light intensities of the LEDs." Nishimura, Claims 18, 24. As such, the current sensor 502, voltage sensor 504, and control circuitry 506 jointly disclose an impedance detecting section. Kattamis, ¶84.

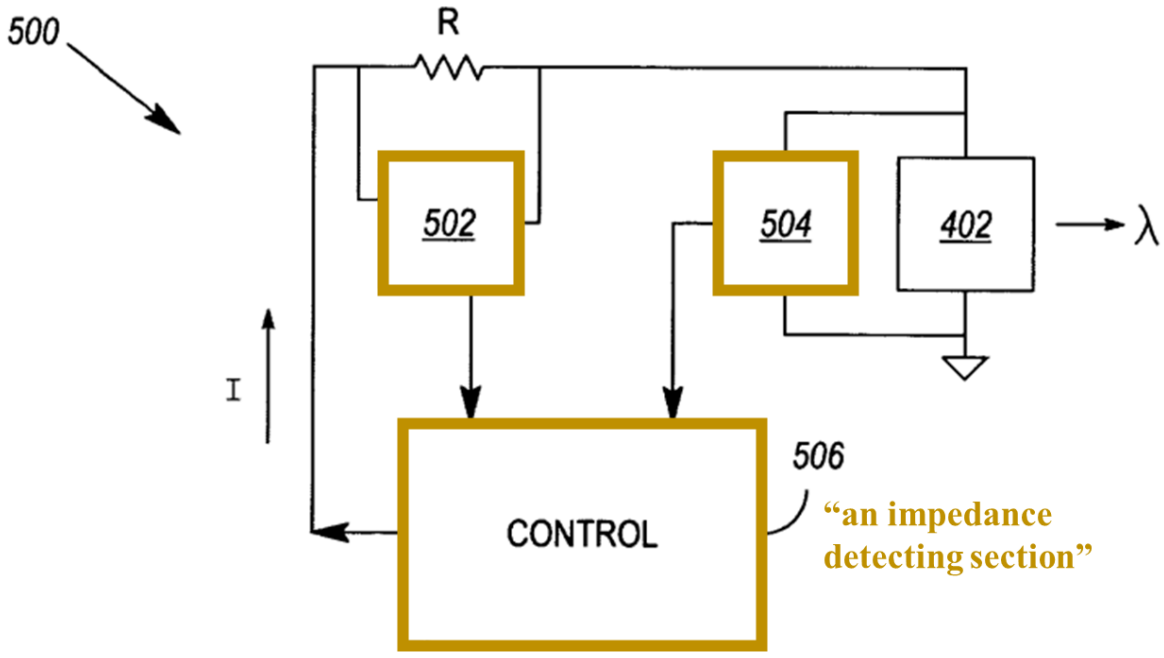


FIG. 5

Nishimura, Fig. 5.

3. Motivation to Apply Nishimura's Teachings to Ghanem

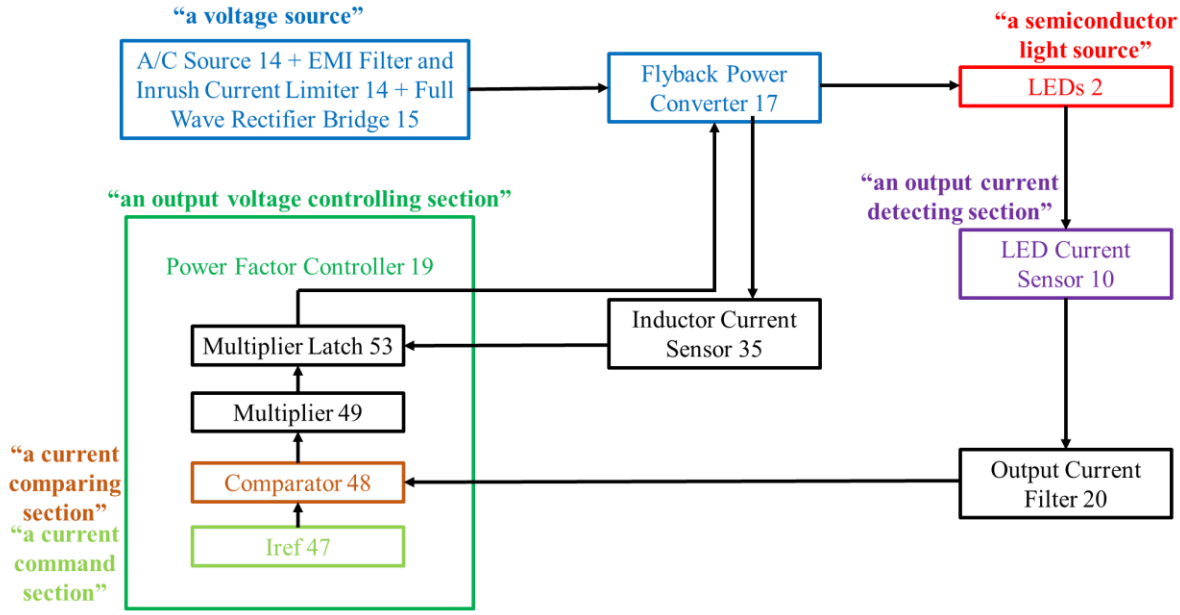
Ghanem and **Nishimura** are in the same field as the '830—which includes LED driving circuits—and are reasonably pertinent to the problems purportedly address by the '830—e.g., controlling LED light intensity. *See, e.g.*, '830, 1:16-18, 3:16-20, 3:47-54, 4:32-5:3, 5:45-50; Ghanem, 1:6-10, 1:55-2:3; Nishimura, 1:7-23, 1:27-31, 2:7-21, 2:22-38; Kattamis, ¶¶85-87.

A POSITA would have been motivated to apply **Nishimura's** impedance detection teachings to **Ghanem's** LED driver circuit to advantageously enhance the reliability of the circuit by "closely predict[ing] the intensity of light emitted by an

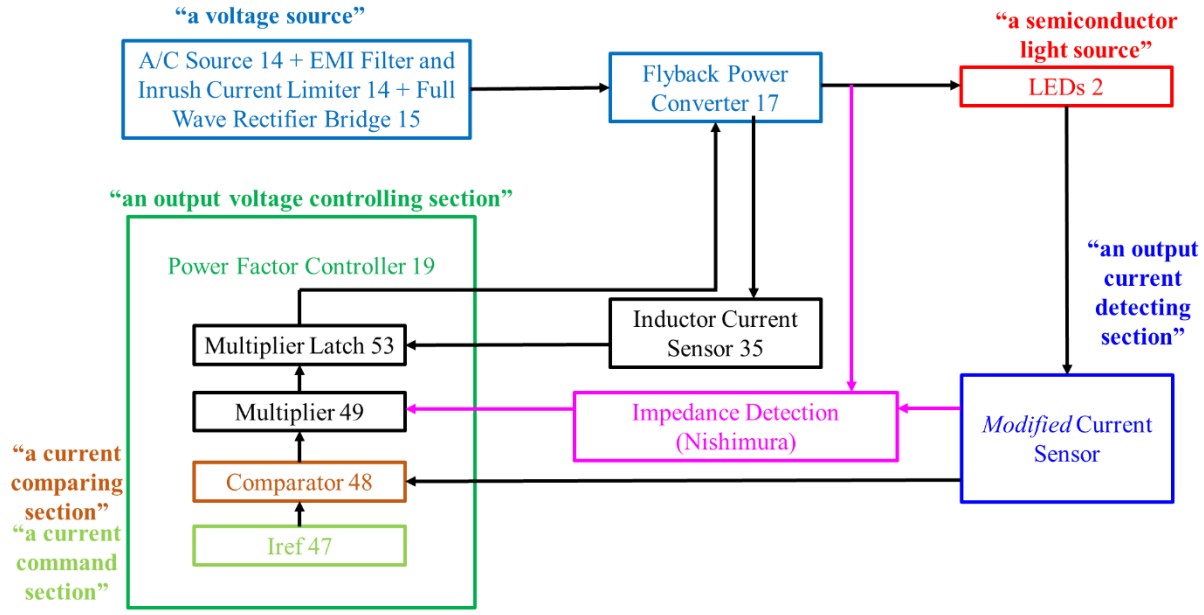
LED as a function of…operating current" that "can then be used to set the light intensity of an LED." Nishimura, 2:22-34. **Nishimura** discloses a direct impedance measurement whereby the dynamic impedance is estimated by measuring the voltage across and the current applied to the LEDs. Nishimura, 4:54-58, Claim 18, 24, Fig. 5. **Ghanem** discloses a thermistor as a "simple-low cost circuit" for "[c]urrent feedback control" of a "non-linear load." Ghanem, 2:25-32. A POSITA would have recognized that the thermistor of **Ghanem** is an indirect analog for the dynamic impedance of the LEDs—being a separate element from the LEDs themselves. As such, a POSITA would have understood that the direct impedance measurement of **Nishimura** would more accurately account for the dynamic impedance of the LEDs, as compared to the indirect impedance compensation of the thermistor of **Ghanem**, as it directly measures the voltage and current characteristics of the LEDs instead of using a separate element to estimate such characteristics. Indeed, **Ghanem** recognizes the need to consider changes in current and impedance when regulating LED brightness. Ghanem, Abstract, 2:54-3:3, 4:13-22. Thus, applying **Nishimura's** impedance detection teachings in implementing **Ghanem's** LED driver circuit would have furthered **Ghanem's** objective of regulating output power to the LEDs to maintain a brightness, and would have done this more accurately. Kattamis, ¶¶88-90.

Further, such an implementation would have advantageously enhanced the reliability of the system by regulating the output power and setting the proper light intensity of the LEDs based on two feedback factors (load current and dynamic impedance), instead of just one factor (load current). Implementing **Ghanem's** LED driver circuit to account for a detected impedance, as taught by **Nishimura**, would be nothing more than applying a known technique of impedance detection to a known device ready for improvement to yield predictable results of accounting for junction temperature and aging effects in addition to load current when setting a light intensity of LEDs. Kattamis, ¶91.

Below is a simplified block diagram that highlights the salient features of Figure 1 of **Ghanem** related to the control of current provided to the LEDs based on a detected current draw. Kattamis, ¶¶92-93.



The figure below shows how a POSITA would have applied **Nishimura's** impedance detection teachings to **Ghanem** to realize the advantages discussed above. Kattamis, ¶94.



To perform this modification, the **LED current sensor 10** and Output Current Filter 20 would be removed and replaced by a single **modified current sensor** that would detect the current through the LEDs, as disclosed by Nishimura. That detected current value would be supplied to comparator 48 (e.g., to be compared to Iref) as well as to the **impedance detection section** (e.g., to be used to calculate the dynamic impedance of the LEDs). The results of both the **comparator 48** and **impedance detection section** would be supplied to multiplier 49 as part of the feedback loop. This **modified current sensor** detects current similar to the method taught by

Nishimura and other known methods discussed in Section VI.B.1 and would have been well within the skills of a POSITA. Kattamis, ¶94.

There are many different ways to implement the block-level diagram shown above, and deriving these circuit-level diagrams based on the disclosures of **Ghanem** and **Nishimura** would have been well within the skill of a POSITA. Indeed, the '830 does not specify a more granular arrangement, describing each of the recited "section[s]" in the abstract and not in terms of their underlying circuitry. Kattamis, ¶95. For example, the '830 describes these recited "section[s]" as shown below in connection with Figure 5:

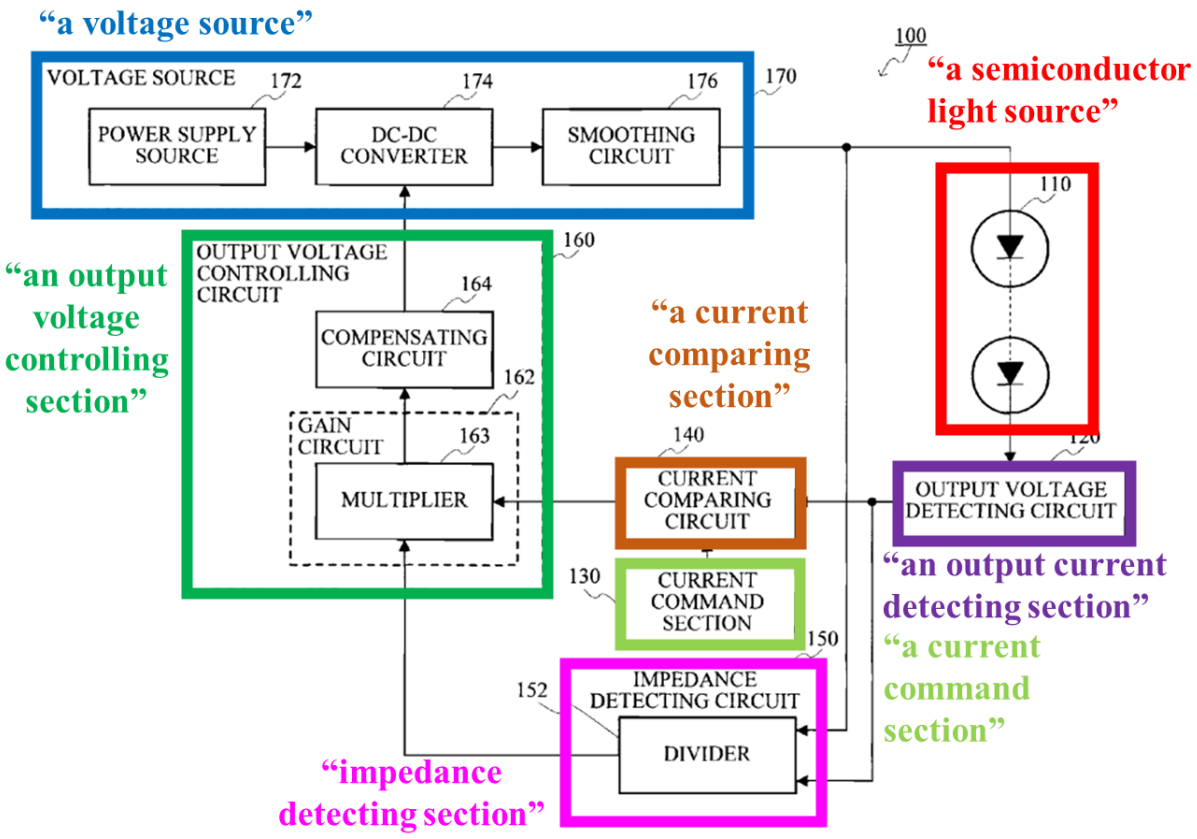


FIG.5

'830, Fig. 5; Kattamis, ¶96.[3]

In implementing **Nishimura's** impedance detection teachings in **Ghanem's** driver circuit, a POSITA would have understood that the impedance detection section would receive a sensed voltage applied to the LEDs (e.g., the output of the flyback converter) and sensed current flowing through the LEDs (e.g., the output from the modified current sensor circuit 10) to calculate the actual impedance of the LEDs by dividing the sensed voltage by the sensed current. Ghanem, 4:13-35, 6:30-61, Fig. 1; Nishimura, 4:54-58, Claims 18, 24, Fig. 5. A POSITA would have been familiar with implementing a divider circuit that performs such division to generate the value corresponding to the LEDs. Kattamis, ¶97.

The calculated impedance value is then fed into a multiplier (e.g., multiplier 49) that "adjust[s] its gain according to its inputs"—e.g., the result from the impedance detection section and the output from comparator 48—and supplies a signal to the multiplier latch (e.g., multiplier latch 53). Ghanem, 4:13-35, 6:30-61, Fig. 1.; Nishimura, 4:54-58, Claims 18, 24, Fig. 5. A POSITA would have been

[3] Figure 5 mislabels component 120 as an "output voltage detecting circuit," but a POSITA would have understood it is an "output current detecting circuit 120," as that is the term used throughout the specification. *E.g.*, '830, 6:32-37, 7:9-22. Kattamis, ¶96.

familiar with implementing a multiplier circuit that performs such multiplication to generate a value corresponding to the impedance of the LEDs multiplied by the LED current. Kattamis, ¶98.

In response, the multiplier latch "produce[s] [a] high or low logic level drive output" to turn a transistor in flyback power converter 17 on and off, thereby regulating the power converter to control the voltage applied to the LEDs according to changes in the detected impedance, thereby adjusting the voltage applied to the LEDs based on changes in the dynamic impedance of the LEDs. Ghanem, 6:56-7:23, Fig. 1; Kattamis, ¶99.

Accordingly, a POSITA would have had a reasonable expectation of success in applying **Nishimura's** impedance detection teaching in implementing **Ghanem's** driver circuit, as it was known in the art to use dynamic impedance measurements to "set an operating current" of LEDs. Nishimura, 4:54-58, Claims 18, 24. A POSITA would have also had a reasonable expectation of success in applying **Nishimura's** impedance detection teachings in implementing **Ghanem**, as both references teach feedback control to maintain voltage supplied to and current drawn from LEDs. Ghanem, Abstract, 4:26-35; Nishimura, Abstract, 4:54-58; Kattamis, ¶100. Further, both **Ghanem** and **Nishimura** disclose using control circuitry to regulate the brightness of the LEDs, specifically based on LED temperature variation, and implementing **Nishimura's** impedance detection teaching in

Ghanem's feedback controller would have required minimal modifications of **Ghanem's** driver circuit, as discussed above. Ghanem, Abstract, 2:20-24, 6:40-42; Nishimura, 1:7-11, 2:7-15, 2:22-38. This would have been a straightforward application of **Nishimura's** impedance detection teachings in a manner that advantageously improves **Ghanem's** driver circuit. Kattamis, ¶100. Thus, a POSITA would have found it straightforward and advantageous to apply **Nishimura's** impedance detection teachings to **Ghanem's** driver circuit, and would have known such a combination (yielding the claimed limitations) would predictably work and provide the expected functionality. Kattamis, ¶100.

4. Claim 1

(a) 1(pre): "1. A semiconductor light source driving apparatus comprising:"

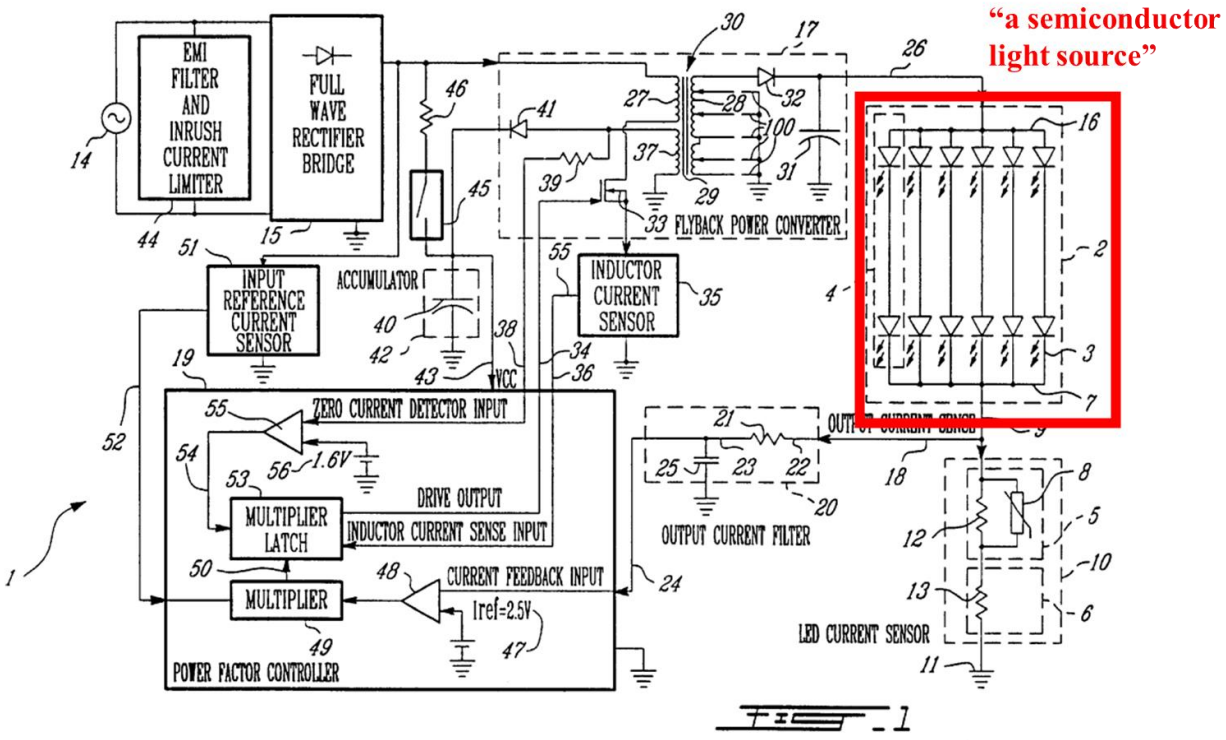
To the extent the preamble is limiting, **Ghanem discloses a semiconductor light source driving apparatus** (*e.g.*, "electronic circuit of a light-emitting-diode lamp"). Ghanem, 2:33-39, 3:36-39, 5:23-25; Kattamis, ¶¶101-104.

For example, **Ghanem** discloses an "electronic circuit of a light-emitting-diode lamp [i]ncorporating the current sensor circuit and a power supply system." Ghanem, 3:36-39. A POSITA would have understood that an LED is a semiconductor light source. *See* '830, 1:24-25 (PO admitting "[s]emiconductor light sources include…light-emitting diodes" in the prior art). **Ghanem** further discloses that the "LEDs are driven by a constant current" using a "controllable dc voltage and

current source for supplying the non-linear light emitting load with dc voltage and current" and "a voltage and current feedback circuit…to thereby adjust the dc voltage and current amplitudes that keep the light intensity produced by the light source substantially constant." *See* Ghanem, 2:33-39, 5:23-25; Kattamis, ¶¶103-104.

(b) 1(a): "a semiconductor light source that is driven by a current;"

Ghanem discloses a semiconductor light source that is driven by a current (*e.g.*, "LEDs…driven by a constant current"). Ghanem, 2:33-39, 3:61-67, 5:23-25, Fig. 1; Kattamis, ¶¶105-108. *See* 1(pre).

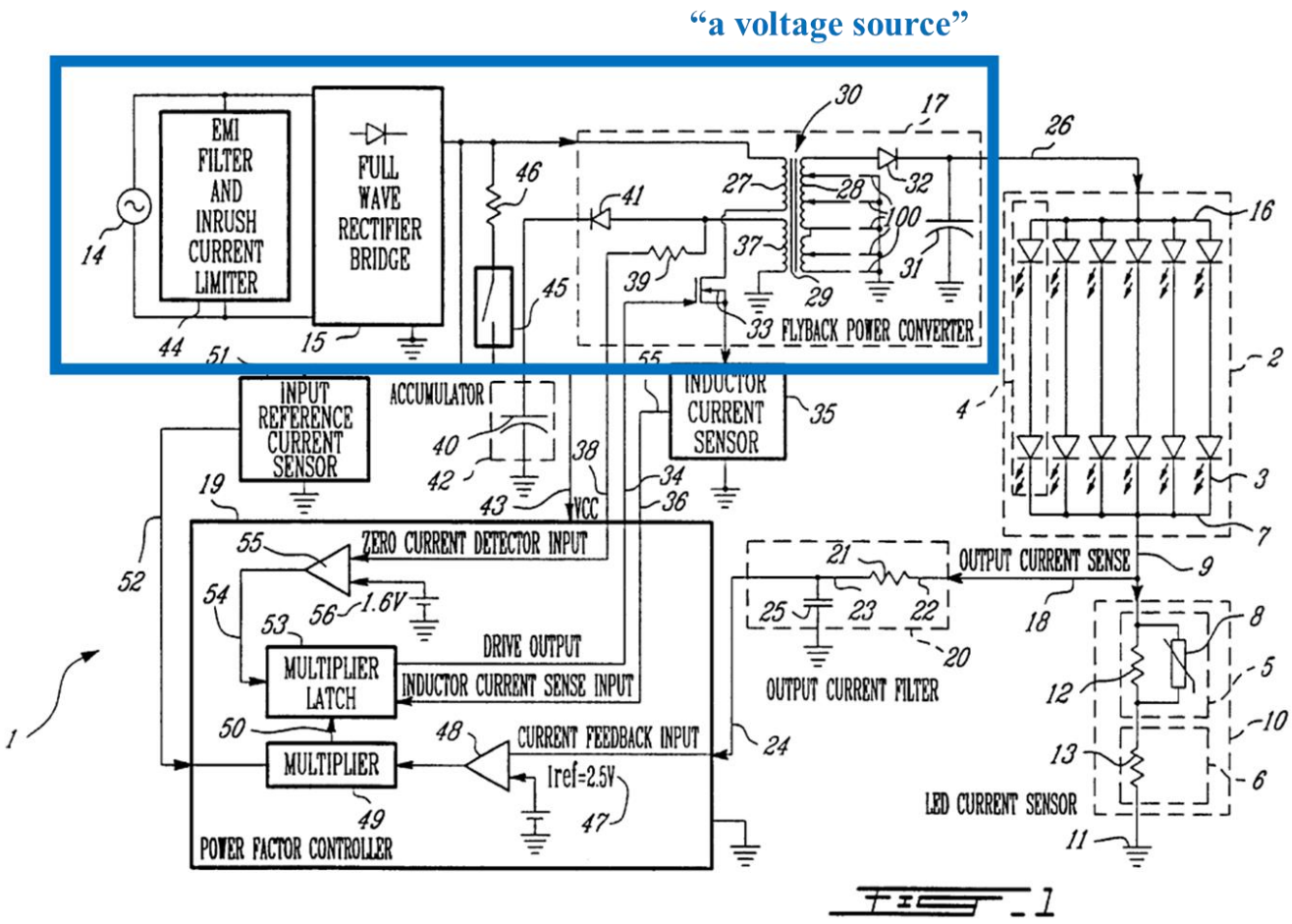


Ghanem, Fig. 1.

For example, **Ghanem** further discloses "a set 2 of…serially interconnected light-emitting diodes 3." Ghanem, 3:61-67. A "controllable dc voltage and current source…suppl[ies] the non-linear light-emitting load with dc voltage and current" such that the "LEDs are driven by a constant current." *Id.*, 2:33-39, 5:23-25; Kattamis, ¶108.

(c) 1(b): "a voltage source that drives the semiconductor light source;"

Ghanem discloses a voltage source that drives the semiconductor light source (*e.g.*, "dc voltage…source" "supplying" LEDs with "dc voltage"). Ghanem, 2:33-39, 3:11-26, 4:5-12, 4:30-35, Fig. 1; Kattamis, ¶¶109-112. *See* 1(a).



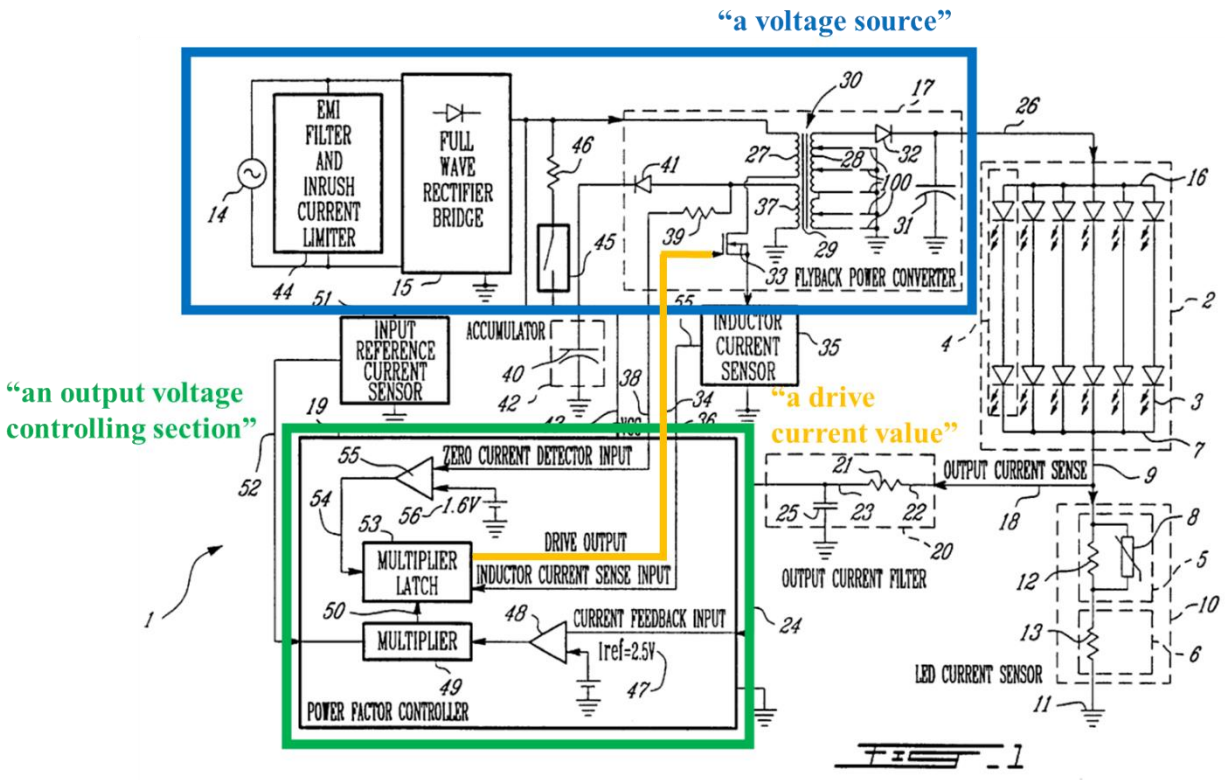
Ghanem, Fig. 1.

For example, **Ghanem** discloses "a controllable dc voltage and current source for supplying the non-linear light-emitting load [*i.e.*, LEDs] with dc voltage and current." Ghanem, 2:33-39. An "ac source 14" is "rectified by a full-wave rectifier bridge 15" and supplied to the LEDs "through a power converter 17." Ghanem, 4:5-12. The "LED supply dc voltage" is "at the output 26 of the power converter 17." *Id.*, 4:30-35. Kattamis, ¶112.

(d) 1(c): "an output voltage controlling section that controls a drive current value for driving the

semiconductor light source by controlling an output voltage of the voltage source;"

Ghanem discloses an output voltage controlling section (*e.g.*, "controller 19") **that controls a drive current value** (*e.g.*, "drive output" to "transistor 33") **for driving the semiconductor light source** (*see* 1(a)) **by controlling an output voltage of the voltage source** (*e.g.*, controls "voltage…transmitted" to LEDs)**.** Ghanem, 4:26-35, 6:30-34, 6:56-7:23, Fig. 1; Kattamis, ¶¶114-116. *See* 1(a)-1(b).



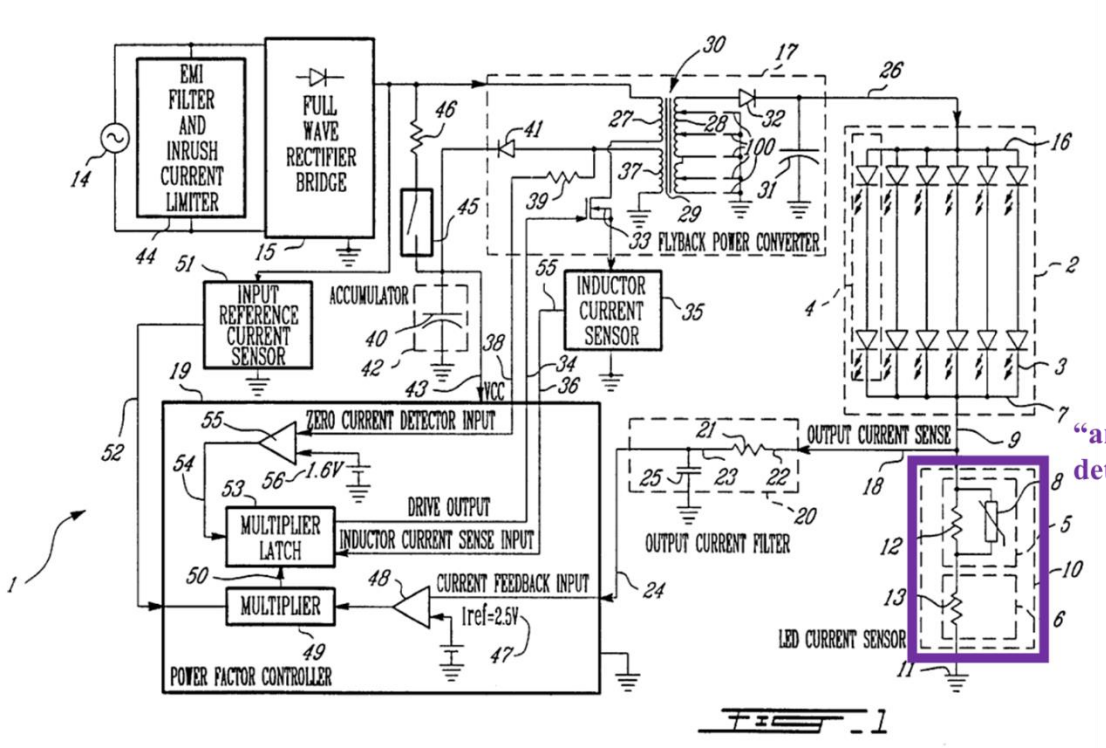
Ghanem, Fig. 1.

For example, **Ghanem** discloses "controller 19 perform[s] variable current feedback control on the set 2 of non-linear light-emitting diodes 3" using "a current-representative voltage feedback signal which varies linearly with the LED supply dc

voltage at the output 26 of the power converter 17." Ghanem, 4:26-35, 6:30-34. Controller 19 sends a "drive output" signal "for controlling MOSFET transistor 33" (within the "voltage source" at the end of the "drive output" line from controller 19) to "effectively control[] output 26 of flyback power converter 17." Ghanem, 6:58-61. Output 34 of "controller 19" is supplied to "transistor 33" to control the "[s]upply of coil 27," which "induce[s] in the coil 28 rectified voltage and current transmitted" to the LEDs. Ghanem, 6:62-7:23; Kattamis, ¶116.

(e) 1(d): "an output current detecting section that detects an output current of the semiconductor light source;"

Ghanem discloses an output current detecting section (*e.g.*, "current sensor circuit 10") **that detects an output current of the semiconductor light source** (*e.g.*, "detects" "the total current flowing through" the LEDs)**.** Ghanem, Abstract, 4:13-22, 4:26-35, 5:18-20, Fig. 1; Kattamis, ¶¶117-120. *See* 1(a)-1(b).

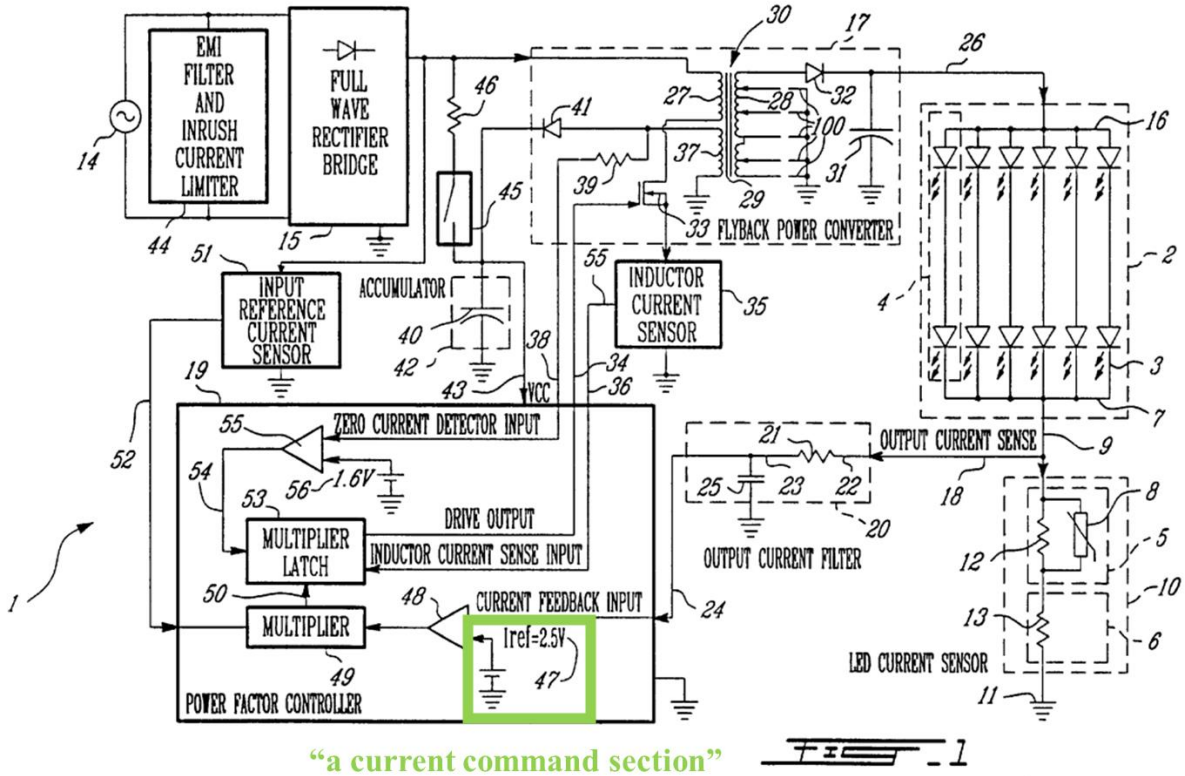


Ghanem, Fig. 1.

For example, **Ghanem** discloses "current sensor circuit 10" that "detects" and "convert[s] the total current flowing through the set 2 of light-emitting diodes 3 to a corresponding current-representative voltage signal present on an output 18" supplied to controller 19. Ghanem, Abstract, 4:13-22, 4:26-35. This is consistent with the '830, which discloses "[t]he output current detecting circuit may employ a method of detecting the voltage generated across a resister." '830, 7:9-13; Kattamis, ¶120.

(f) 1(e): "a current command section that specifies a reference value of a drive current which is applied to the semiconductor light source;"

Ghanem discloses a current command section that specifies a reference value of a drive current (*e.g.*, voltage source that specifies "reference current I_{ref}") **which is applied to the semiconductor light source** (*e.g.*, "I_{ref}…provid[es] a fixed LED current reference")**.** Ghanem, 5:33-52, 6:34-36, Fig. 1; Kattamis, ¶¶121-124. *See* 1(a), 1(c)-1(d).

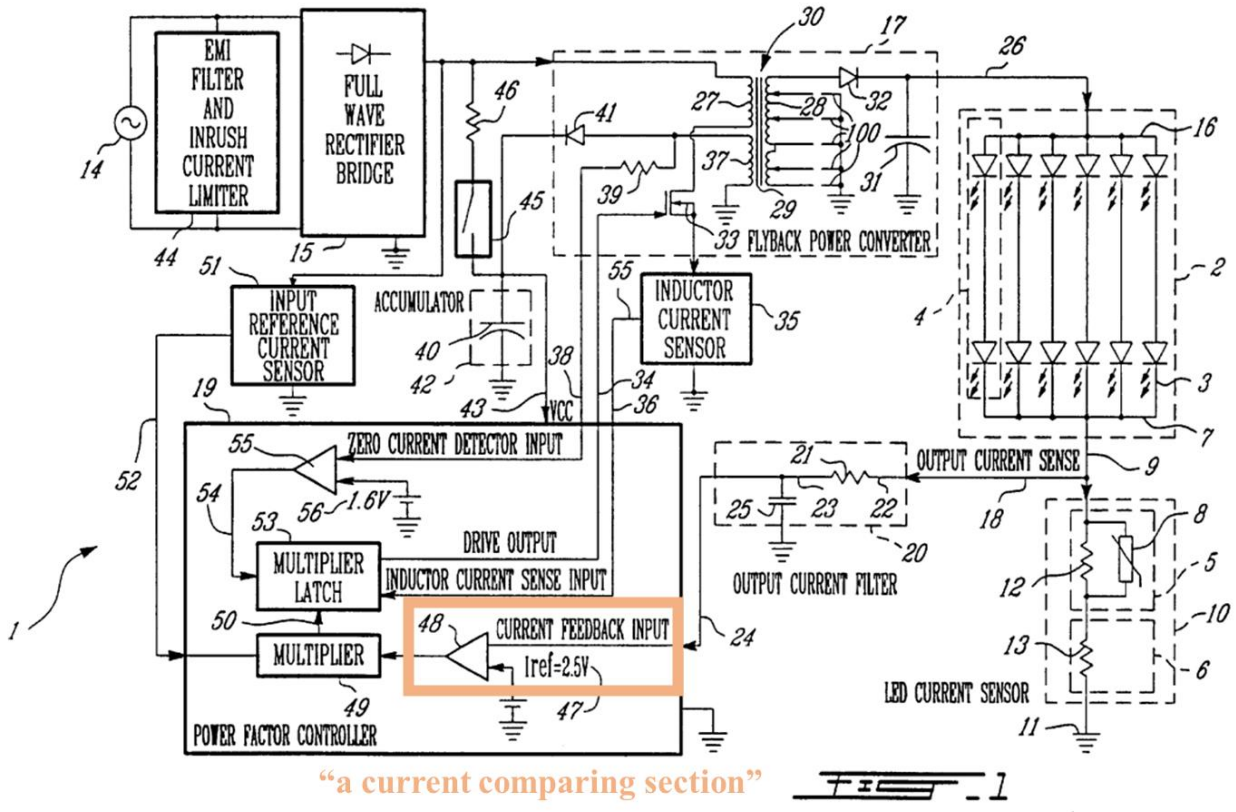


Ghanem, Fig. 1.

For example, **Ghanem** further discloses a "fixed reference current I_{ref} (47)" that "is a voltage providing a fixed LED current reference." Ghanem, 5:33-52, 6:34-36. Figure 1 discloses a voltage source is used to set the I_{ref} value, such as 2.5V. Kattamis, ¶124.

(g) 1(f): "a current comparing section that compares the output current detected by the output current detecting section and the reference value specified by the current command section"

Ghanem discloses a current comparing section (*e.g.*, "comparator 48") **that compares the output current detected by the output current detecting section and the reference value specified by the current command section** (*e.g.*, compares the "LEDs current measure I_{mes}" and the "reference current I_{ref}")**.** Ghanem, 5:18-22, 5:48-52, 6:16-20, 6:30-38, Fig. 1; Kattamis, ¶¶125-128. *See* 1(a), 1(c)-1(e).



Ghanem, Fig. 1.

For example, **Ghanem** discloses "comparator 48" compares "current-representative voltage feedback signal on input 24" (I_{mes}) to "I_{ref} (47)." Ghanem, 6:30-38. The "LEDs current measure I_{mes} (24)" is the "output 18 of the current sensor circuit 10" after passing through "output current filter 20." Ghanem, 5:48-52, 6:16-20, Fig. 1. As such, the current I_{mes} has an "amplitude that is proportional to the magnitude of the current flowing through the current sensor circuit 10." Ghanem, 5:18-22. Based on the result of the comparison by comparator 48, "the LED current is increased by the power supply until the difference $E=I_{ref}-I_{mes}$ equals zero." Ghanem, 5:48-52. This is consistent with the '830, which "compares the output current value detected by output current detecting circuit 120 and the reference value…to find the difference between the output current value and the reference value." '830, 7:23-31. Kattamis, ¶128.

(h) 1(g): "an impedance detecting section that detects an impedance of the semiconductor light source,"

Nishimura discloses an impedance detecting section (*e.g.*, "control circuitry 506" that "acquire[s] readings from the [LEDs'] current and voltage sensors 502, 504") **that detects an impedance of the semiconductor light source** (*e.g.*, "estimate[s] a dynamic impedance of the LED[s]")**.** Nishimura, 4:48-58, Claims 18, 24, Fig. 5; Kattamis, ¶¶129-138.

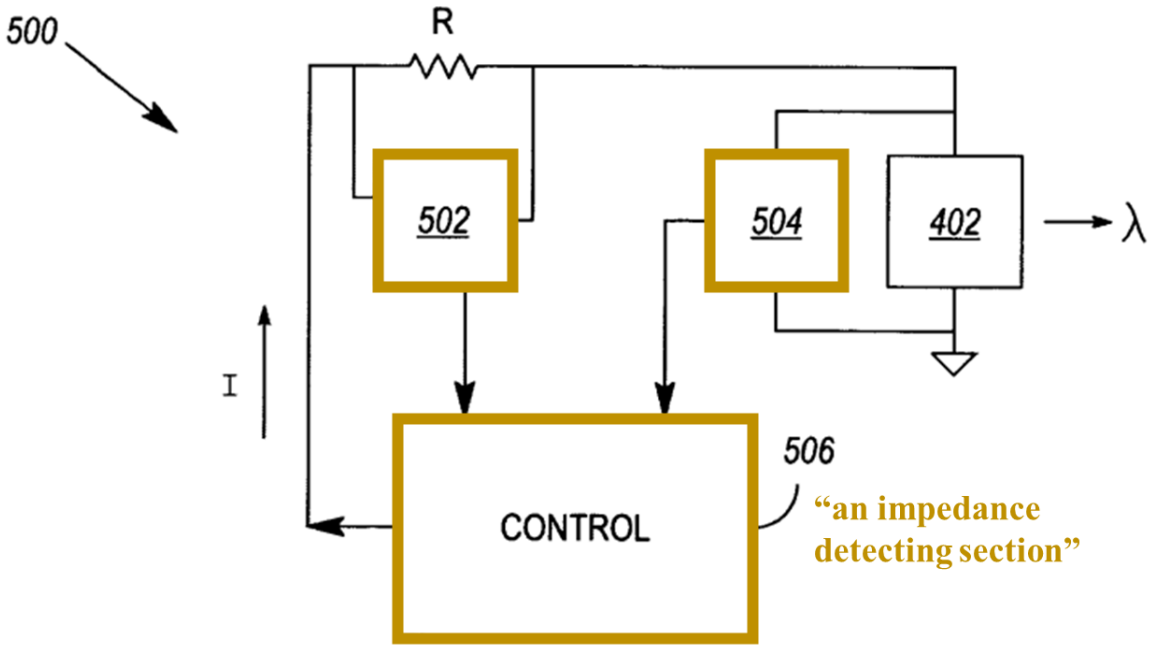


FIG. 5

Nishimura, Fig. 5.

For example, **Nishimura** discloses an LED driver circuit that includes "a current sensor 502, a voltage sensor 504 and control circuitry 506" associated with "at least some of the LEDs." Nishimura, 4:48-51. The current sensor "measures the operating current supplied to the LED 402," and the "voltage sensor 504 measures a voltage of the LED 402." Nishimura, 4:51-54. Control circuitry 506 "coupled to…sensors 502, 504" to "set an operating current (I) of the LED 402 in response to acquired readings from the LED's current and voltage sensors 502, 504," such as by "estimat[ing] a dynamic impedance of the LED." Nishimura, 4:54-58, Claims 18, 24. As such, the current sensor 502, voltage sensor 504, and control circuitry 506

jointly disclose an impedance detecting section. This is consistent with the '830, which "finds…a value corresponding to the impedance of semiconductor light source 110…by div[id]ing the output voltage of voltage source 170 supplied to semiconductor light source 110 by the output current of semiconductor light source 110 detected by output current detecting circuit 120." '830, 7:32-47. Kattamis, ¶131.

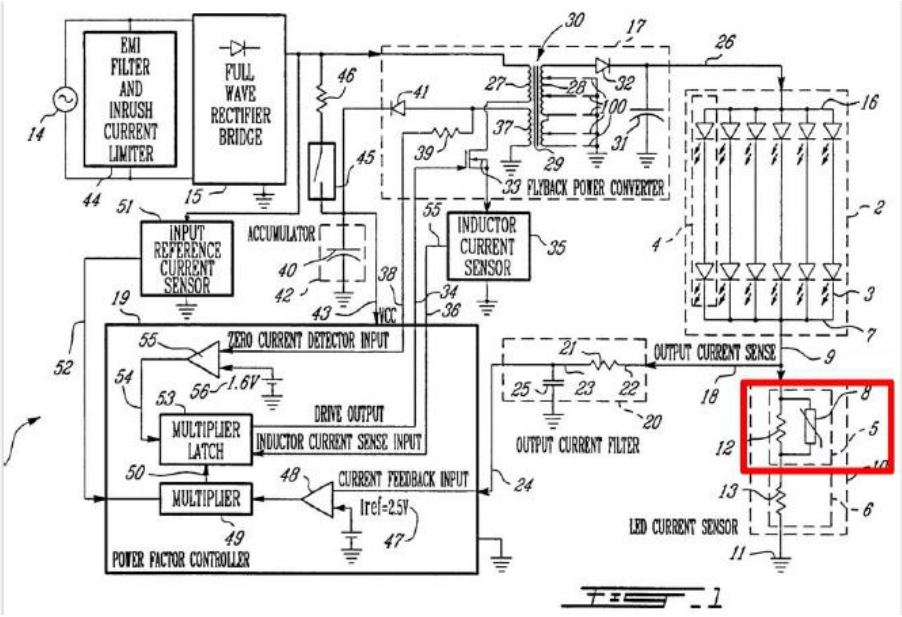
As discussed in §IX.A.3, a POSITA would have been motivated to apply **Nishimura's** impedance detection teachings in implementing **Ghanem's** circuit to advantageously enhance the reliability of the circuit by detecting both load current and dynamic impedance. Kattamis, ¶132.

Alternatively, **Ghanem renders obvious an impedance detecting section that detects an impedance of the semiconductor light source**. Kattamis, ¶133.

Recognizing the non-linear and temperature-dependent impedance of LEDs (Ghanem, 4:40-44, Fig. 2), **Ghanem** discloses a "current sensor circuit 10" that "transform[s] the non-linear relation (LED current/voltage relation with temperature) between the LED supply dc voltage at the output 26 of the power converter 17 and the dc current supplied to the set 2 of light-emitting diodes 3…into a linear relation" in order "[t]o enable the controller 19 to perform variable current feedback control on the set 2 of non-linear light-emitting diodes 3." Ghanem, 4:26-35. As such, the LED current sensor 10 both "detect[s] a current supplied to a non-

linear load" (e.g., LEDs) and "produc[es] a current reading dependent on a condition of operation of the non-linear load" that corrects for the dynamic impedance of the LEDs in order to perform feedback voltage control to "keep the light intensity produced by the light source substantially constant." Ghanem, 2:7-10, 2:33-54; Kattamis, ¶134.

Ghanem further discloses that "current sensor circuit 10" includes a "temperature dependent variable equivalent impedance Z_{eq}" that is based on "thermistor R_{TH} (8)."[4] Ghanem, 4:62-66; Kattamis, ¶135.



Ghanem, Fig. 1.

[4] A thermistor is a temperature-sensitive resistor, a device whose resistance (impedance) changes with temperature. Kattamis, ¶65.

However, a POSITA would have recognized that the thermistor solution of **Ghanem** would not be the best available option to "keep the light intensity produced" by the LEDs "substantially constant" because the thermistor is a separate device from the LEDs and therefore is only an indirect analog for the dynamic impedance of the LEDs. Ghanem, 2:33-54, 4:26-35. A POSITA would have recognized that the changes in impedance to the LEDs would not be completely compensated for through changes in the impedance of the thermistor because the dynamic impedance of the thermistor is not dependent on the dynamic impedance of the LEDs. For example: (1) the temperature at the thermistor may change differently than at the LEDs; (2) the LEDs may age differently than the thermistor; (3) the thermistor may respond differently than the LEDs at different currents, voltages, and/or temperatures; and (4) the dynamic impedance of the thermistor may not perfectly match what is necessary to "transform the non-linear…relation into a linear relation" for a particular set of LEDs. Kattamis, ¶¶136.

Ghanem itself recognized that it disclosed "a simple-low cost circuit" and also taught using other components (e.g., power factor controller). Ghanem, 2:26-32, 8:37-48. A POSITA would have recognized that there were other design choices available that would perform better than the thermistor of **Ghanem** to "keep the light intensity produced" by the LEDs "substantially constant." *Id*., 2:48-54. A solution that would have been obvious to a POSITA would be direct measurement of the

impedance of the LEDs, for example, using Ohm's Law: (V=I*R; or R=V/I). **Ghanem** already discloses that a current sensor and voltage sensor were well-known and to implement them at "the LED supply dc voltage at the output 26 of the power converter 17." *Id*., 6:30-34. Similarly, closed-loop feedback control was a well-known technique for controlling current to LEDs in dynamic circuits and, generally comprises measuring a changing variable and then compensating for that change. In this case, **Ghanem** recognized the need to compensate for the dynamic impedance of the LEDs and standard feedback control instructs a POSITA to measure the impedance (the dynamic component) and then correct for it. Kattamis, ¶137.

A POSITA would have understood that and been motivated to implement a direct measurement of impedance with a reasonable expectation of success through application of the well-known Ohm's law, by dividing the LED supply voltage (either known based on supply voltage or measured before the voltage drop across the LEDs using well-known voltage sensors) by the output current of the LEDs ("output current sense" / "current feedback input" signal of **Ghanem**). Ghanem, Fig. 1. A POSITA would have been motivated (and readily able) to apply this basic calculation, because a direct impedance measurement of the LEDs would be dependent on the impedance of the LEDs and accordingly more accurate than the thermistor, which is only an indirect analog for the impedance of the LEDs. Direct impedance measurement of the LEDs would also not have the same uncertainty (e.g.,

due to temperature, aging, or performance) as the thermistor in trying to compensate for the dynamic impedance of the LEDs. As such, a POSITA would understand that a direct impedance measurement of the LEDs would better provide "substantially constant intensity light source" (as desired in **Ghanem**) than the thermistor solution disclosed by Ghanem. Ghanem, Abstract. And at minimum, these teachings in **Ghanem** and what was known in the art provide yet further motivation to apply **Nishimura's** teachings. Kattamis, ¶138.

(i) 1(h): "wherein the output voltage controlling section controls the output voltage of the voltage source based on an output of the current comparing section and an output of the impedance detecting section."

Ghanem discloses the output voltage controlling section controls the output voltage of the voltage source (*see* 1(c)) **based on an output of the current comparing section** (*e.g.*, "output of comparator 48"). Ghanem, 6:30-61, Fig. 1; Kattamis, ¶¶139-151. *See* 1(b)-1(c), 1(f).

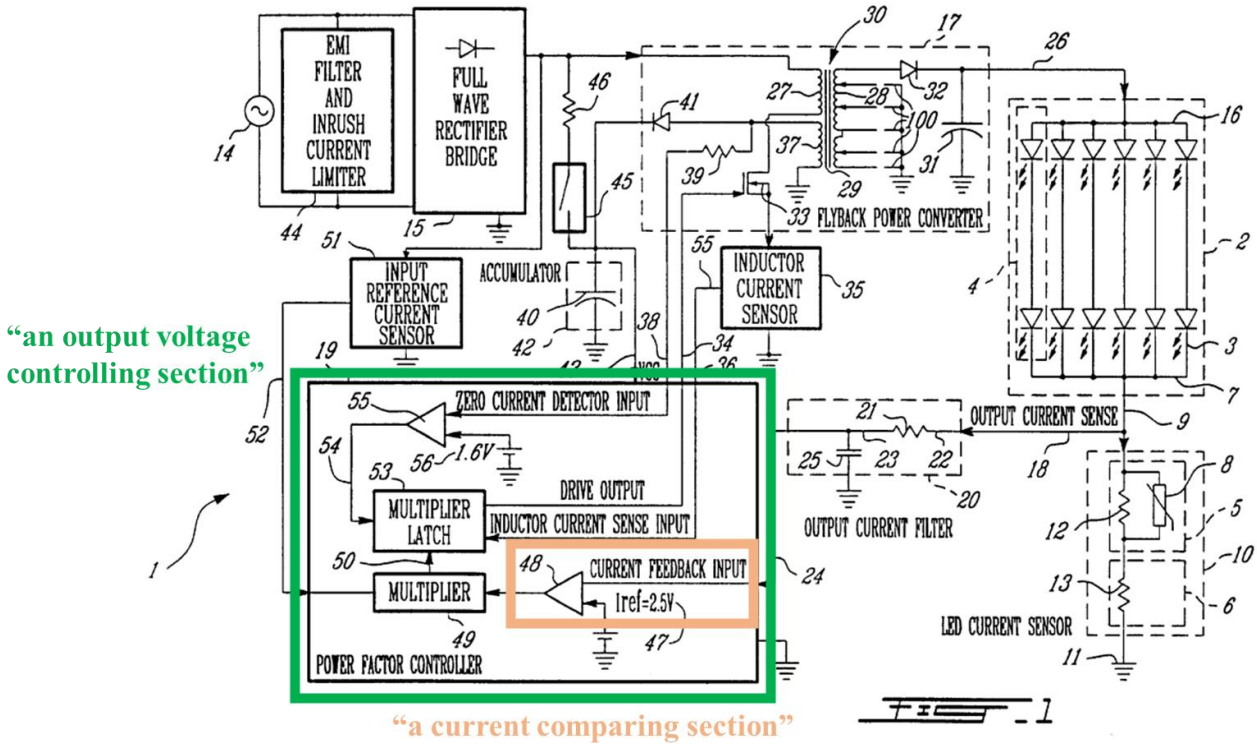


Fig. 1

Ghanem, Fig. 1.

For example, **Ghanem** further discloses the "output of comparator 48 is a high/low difference-representative signal fed to multiplier 49," which "produces a corresponding current reference waveform signal 50" that is fed into "multiplier latch 53." Ghanem, 6:30-61, Fig. 1. The multiplier latch 53 "produce[s] the high or low logic level drive output for controlling MOSFET transistor 33 on or off thereby effectively controlling output 26 of flyback power converter 17." Ghanem, 6:30-61, Fig. 1. Kattamis, ¶142.

Nishimura discloses controlling the output voltage of the voltage source (*e.g.*, "set an operating current (I) of the LED[s]") **based on the impedance detecting section** (*see* 1(g)). Nishimura, 4:54-58, Claim 18, 24; Kattamis, ¶143.

A POSITA would have understood or at least found it obvious that the voltage supplied to the LEDs is controlled by "set[ting] operating current…of the LED." Nishimura, 4:54-58. For example, the voltage supplied would vary based on the operating current set by control circuit 506, as a voltage is produced when the current flows through the resistor and LED 402. Nishimura, Fig. 5, 4:51-54 ("LED's current sensor 502 measures the operating current supplied to the LED 402 (e.g., by sensing the ***voltage across a series resistor R)***."). Control circuitry sets this operating current, and thus the voltage supplied to the LEDs, by "estimat[ing] a dynamic impedance of the LED." Nishimura, Claim 18, 24; Kattamis, ¶144.

As discussed in §IX.A.3, a POSITA would have been motivated to apply **Nishimura's** impedance detection teachings in implementing **Ghanem's** circuit to advantageously enhance the reliability of the circuit by detecting both load current and dynamic impedance. Kattamis, ¶145. As also discussed in §IX.A.3, in implementing **Nishimura's** impedance detection teachings in **Ghanem's** circuit, the controller 19 would have controlled the output voltage on output 26 based on the detected impedance result taught by **Nishimura**. Kattamis, ¶145.

Alternatively, **Ghanem renders obvious controlling the output voltage of the voltage source based on the impedance detecting section**. Kattamis, ¶146.

As discussed in 1(g) (§IX.A.4.h), it would have been obvious to make direct impedance measurements of the LEDs to compensate for the dynamic impedance of the LEDs using standard closed-loop control, rather than rely on the "simple low-cost circuit" using the thermistor of **Ghanem**. For the reasons discussed in 1(g), it would have further been obvious to provide the direct impedance measurement to an "output voltage controlling section" to "control the output voltage of the voltage source. A POSITA would have understood to modify the "power factor controller 19" of **Ghanem** to further receive the detected impedance and to compensate for the dynamic impedance of the LEDs in determining a voltage to apply to maintain a constant current to the LEDs. Kattamis, ¶147.

A POSITA would have recognized that there are many ways to use the detected impedance in closed-loop voltage control and would have been motivated to apply these well-known teachings to advantageously account for the changing impedance of the LED. For example, a POSITA would have known to simply multiply the impedance value by the current using analog circuitry (V=ZxI) and compare the result to a reference to determine the amount of voltage change required to keep a constant current flowing in the LEDs. As another example a POSITA would have known and found it obvious to store the impedance and current values

in a register or memory and compare them to themselves to identify changes over time (ΔZ/t, ΔI/t) and to use these changes to modify the gain to increment the output voltage either up or down to maintain constant LED current. These modifications would allow for more accurate and reliable control over the LED current than the thermistor of Ghanem. Kattamis, ¶148.

A POSITA would have further understood that voltage control would only need to be performed when the output of comparator 48 detects that the LED current was different from the reference current. Ghanem, 6:36-38 ("The output of comparator 48 is a high/low difference-representative signal fed to multiplier 49."). Accordingly, it would have been obvious to a POSITA to improve the circuit of **Ghanem** by replacing the thermistor with a direct impedance measurement (as discussed in 1(g)), and to use the impedance measurement ("output of the impedance detecting section") with the existing output of comparator 48 ("output of the current comparing section") to "control[] the output voltage of the voltage source" as recited in claim 1. Ghanem, 2:26-54, 4:26-35, 6:30-34, 6:58-61, 8:37-48. And at minimum this knowledge of a POSITA would provide yet further motivation to apply **Nishimura's** teachings to **Ghanem**. Kattamis, ¶¶149-151.

5. Claim 2

Claim 2 recites "The semiconductor light source driving apparatus according to claim 1, wherein the impedance detecting section comprises a divider that divides

the output voltage of the voltage source by the output current detected by the output current detecting section, and acquires a value corresponding to the impedance of the semiconductor light source from an output of the divider." Kattamis, ¶152.

Ghanem in view of **Nishimura** renders obvious claim 1 (§IX.A.4). Kattamis, ¶¶152-158.

Ghanem discloses the output voltage of the voltage source (*see* 1(c), 1(h)), **the output current detected by the output current detecting section** (*see* 1(d)), and **the semiconductor light source** (*see* 1(a)). Kattamis, ¶154.

Nishimura discloses the impedance detecting section comprises a divider (*e.g.*, "control circuitry" that performs division) **that divides voltage by current** (*e.g.*, divides "voltage of the LED" by "operating current supplied to the LED") **and acquires a value corresponding to the impedance** (*e.g.*, acquires value of "a dynamic impedance of the LED") **from an output of the divider** (*e.g.*, output of "control circuitry" that performs division)**.** Nishimura, 2:64-3:5; Kattamis, ¶¶155-158. *See* 1(g).

As discussed in 1(g), **Nishimura** discloses control circuitry 506 that estimates a dynamic impedance of the LED using readings from voltage and current sensors. **Nishimura** further discloses that the dynamic impedance of the LEDs is estimated by dividing the measured voltage of the LEDs by the measured current of the LEDs. Nishimura, 2:64-3:5 ("$\Delta V/\Delta I=R$; where ΔV is the difference in two measured

voltages of the LED, where ΔI is the difference in the currents corresponding to the measured voltages, and where R is the LED's dynamic impedance."). A POSITA would have understood or at least found obvious that **Nishimura** teaches that the control circuitry 506 includes a divider to perform the division, such that the control circuitry acquires a value corresponding to the dynamic impedance of the LED from the output of such control circuitry. Kattamis, ¶157.

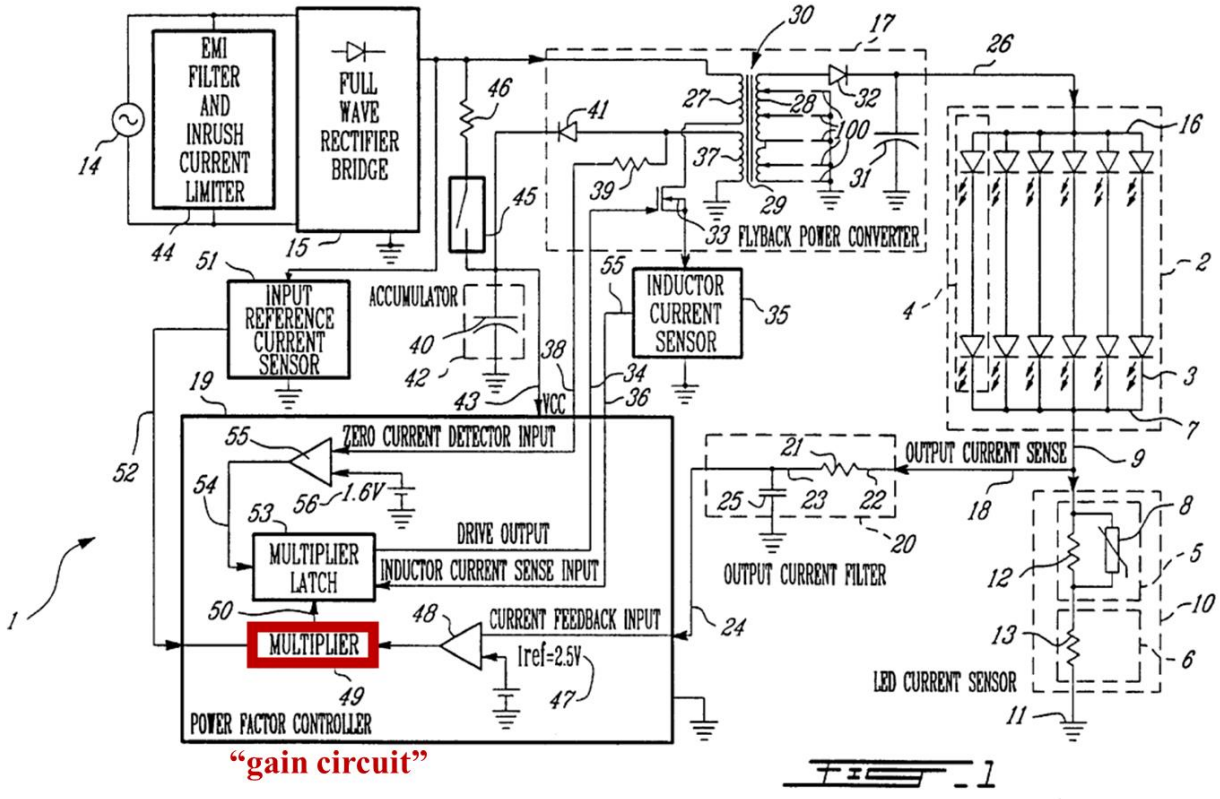
As discussed in §IX.A.3, a POSITA would have been motivated to apply **Nishimura's** impedance detection teachings in implementing **Ghanem's** circuit to advantageously enhance the reliability of the circuit by detecting both load current and dynamic impedance. Kattamis, ¶158.

6. Claim 3

Claim 3 recites "The semiconductor light source driving apparatus according to claim 1, wherein: the output voltage controlling section comprises a gain circuit that sets a gain; and the gain circuit multiplies the impedance of the semiconductor light source detected by the impedance detecting section and the output of the current comparing section to prevent a gain of a control loop from changing even when the impedance of the semiconductor light source changes." Kattamis, ¶159.

Ghanem in view of **Nishimura** renders obvious claim 1 (§IX.A.4). Kattamis, ¶¶158-168.

Ghanem discloses the output voltage controlling section (*see* 1(c), 1(h)) **comprises a gain circuit** (*e.g.*, "multiplier 49") **that sets a gain** (*e.g.*, "multiplier 49…adjusts its gain")**; and the gain circuit multiplies** (*e.g.*, "multiplier 49" multiplies) **and the output of the current comparing section** (*e.g.*, "output of comparator 48") **to prevent a gain of a control loop from changing** (*e.g.*, "[m]ultiplier 49 adjusts its gain according to its inputs" to "effectively control[] output 26 of flyback power converter 17")**.** Ghanem, 6:40-61, Fig. 1; Kattamis, ¶¶161-168. *See* 1(c), 1(h).



Ghanem, Fig. 1.

For example, as discussed in 1(h), **Ghanem** discloses that feedback controller 19 includes multiplier 49 that is fed the "output of comparator 48." Ghanem, 6:36-38. The multiplier "adjusts its gain according to its inputs" and produces signal 50 that is used to regulate the voltage applied to the LEDs, as discussed in 1(c) and 1(h). Ghanem, 6:40-61, 7:57-62, Fig. 1. Therefore, a POSITA therefore would have understood or at least found it obvious that the multiplier is disclosed to prevent the gain of the control loop from changing because it adjusts the characteristics of the control loop, such as the control loop's gain, to the optimal value so that a constant voltage is supplied to the LEDs. This is consistent with the '830, which discloses a gain circuit that "prevent[s] the gain of the control loop from changing" by "automatically adjust[ing] the characteristics of the current control loop, to the optimal value according to the detected impedance equivalent value." '830, 7:62-8:4. Further, a POSITA would have understood or at least found it obvious that the multiplier multiplies signals. *See, e.g.*, U.S. Pat. No. 2007/0091995 ("Ibragimov," Ex. 1012), [0062] ("feedback signals 111 a, 111 b are ***multiplied*** in their respective ***multiplier circuits*** 202 a, 202 b with the error signal 117"); U.S. Pat. No 8,090,198 ("Yoshii," Ex. 1013), 29:44-48 ("a ***multiplier*** in the gradation corrector 6 [that] ***multipl[ies]*** the color difference signals DbBY and DbRY by appropriate parameters."). Kattamis, ¶¶163-164.

Nishimura discloses the impedance of the semiconductor light source (*e.g.*, "dynamic impedance of the LED") **detected by the impedance detecting section** (*e.g.*, "control circuitry 506"). Kattamis, ¶¶165-168. *See* 1(g).

As discussed in §IX.A.3, a POSITA would have been motivated to apply **Nishimura's** impedance detection teachings in implementing **Ghanem's** circuit to advantageously enhance the reliability of the circuit by detecting both load current and dynamic impedance. Kattamis, ¶167.

As discussed in §IX.A.3, in implementing **Nishimura's** teachings in **Ghanem's** driver circuit, a POSITA would have understood that the multiplier would receive both the output from comparator 48 (as taught by **Ghanem**) and the detected impedance result (as taught by **Nishimura**), and would have multiplied those inputs and adjusted its gain to regulate the voltage applied to the LEDs. Such an implementation would have advantageously prevented the gain of the control loop from changing even when the impedance of the LEDs changes such that a constant voltage is applied to them regardless of such changes. Kattamis, ¶168.

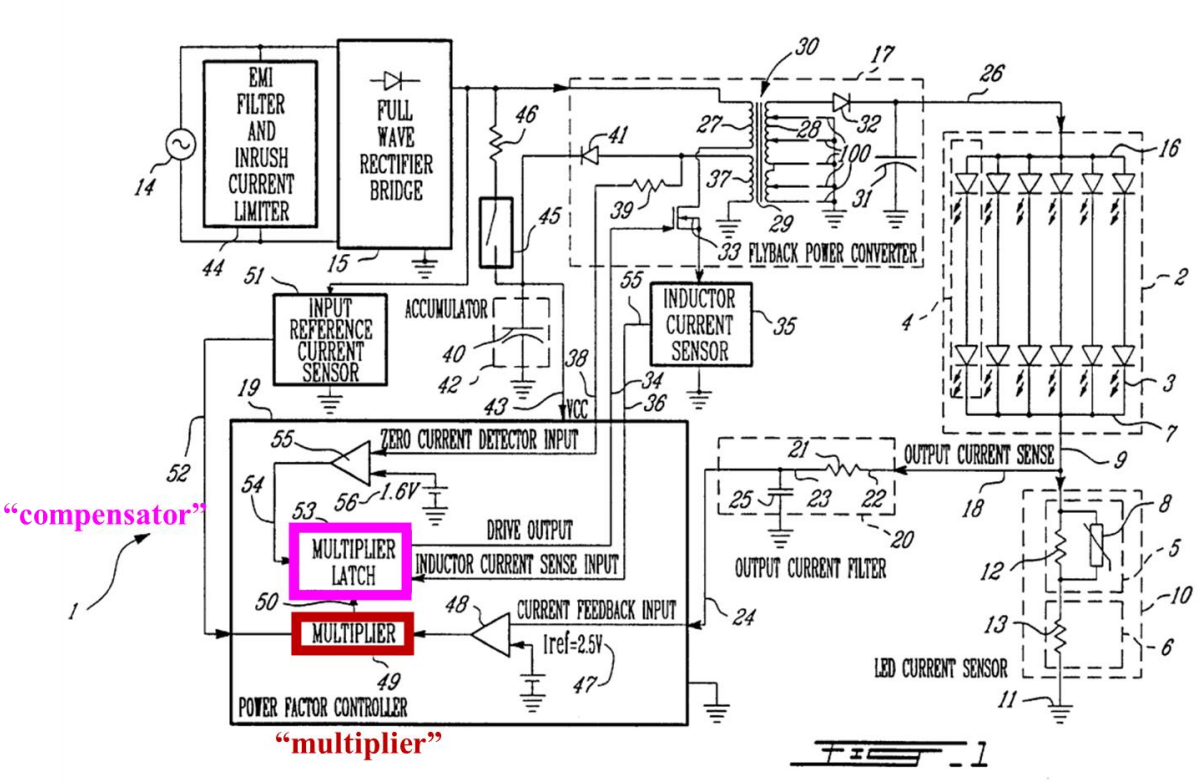
7. Claim 4

Claim 4 recites "The semiconductor light source driving apparatus according to claim 1, wherein the output voltage controlling section comprises: a multiplier that multiplies the impedance of the semiconductor light source detected by the impedance detecting section and the output of the current comparing section; and a

compensator that performs predetermined processing with respect to an output of the multiplier to compensate for control characteristics." Kattamis, ¶169.

Ghanem in view of **Nishimura** renders obvious claim 1 (§IX.A.4). Kattamis, ¶¶170-177.

Ghanem discloses the output voltage controlling section (*see* 1(d)) **comprises: a multiplier** (*e.g.* "multiplier 49") **that multiplies the output of the current comparing section** (*see* 1(f), 1(h))**; and a compensator** (*e.g.*, "multiplier latch 53") **that performs predetermined processing with respect to an output of the multiplier** (*e.g.*, "passes from a high logic level to a low logic level" if "voltage signal from the inductor current sensor 36…exceeds the amplitude of the signal 50 from the multiplier 49") **to compensate for control characteristics** (*e.g.*, "prevent the dc current through" the LEDs from "exceed[ing] a safe level" / "ensure[] that a single pulse appears at the drive output during a given cycle")**.** Ghanem, 6:54-61, 7:49-56, 7:63-8:3, Fig. 1; Kattamis, ¶¶170-177. *See* 1(d), 1(f), 1(h).



Ghanem, Figure 1.

For example, as discussed in 1(h), **Ghanem** discloses that feedback controller 19 includes multiplier 49 that is fed the "output of comparator 48." Ghanem, 6:36-38. **Ghanem** further discloses that "multiplier latch 53" receives a voltage signal "from the inductor current sensor 35" and "signal 50 from multiplier 49." Ghanem, 6:54-61, 7:49-56, 7:63-8:3. If "the voltage signal from the inductor current sensor 36…exceeds the amplitude of the signal 50 from the multiplier 49," the multiplier latch 53 "passes from a high logic level to a low logic level" and turns off transistor 33 to "prevent the dc current through the set 3 of light-emitting diodes 3 exceed[ing] a safe level." Ghanem, 7:63-8:3. The multiplier latch also "ensures that a single

pulse appears at the drive output during a given cycle." Ghanem, 6:56-61. As discussed in claim 3 (§IX.A.4.6), a POSITA would have understood or at least found obvious that a multiplier multiplies signals. Kattamis, ¶173.

Nishimura discloses the impedance of the semiconductor light source (*e.g.*, "dynamic impedance of the LED") **detected by the impedance detecting section** (*e.g.*, "control circuitry")**.** Kattamis, ¶¶174-175. *See* 1(g), (2).

As discussed in §IX.A.3, a POSITA would have been motivated to apply **Nishimura's** impedance detection teachings in implementing **Ghanem's** circuit to advantageously enhance the reliability of the circuit by detecting both load current and dynamic impedance. Kattamis, ¶176.

As discussed in §IX.A.3, in implementing **Nishimura's** teachings in **Ghanem's** circuit, a POSITA would have understood that the multiplier would receive both the output from comparator 48 (as taught by **Ghanem**) and the detected impedance result (as taught by **Nishimura**), and would have multiplied those inputs and provided the result to multiplier latch 53. Kattamis, ¶177.

8. Claim 5

As discussed above, the limitations of claim 5 are subsumed within claim 1. *See* §IX; Kattamis, ¶47 (table correlating claim 5 with claim 1). Claim 5 is rendered obvious by **Ghanem** in view of **Nishimura,** or alternatively **Ghanem** alone, for the

same reasons as described above regarding Ground 1 Claim 1 (§IX.A.4). Kattamis, ¶¶178-179.

B. GROUND 2: TRIPATHI IN VIEW OF NISHIMURA

1. Overview of Tripathi

Similar to the '830, **Tripathi** is directed to a "power supply for LEDs" that is "designed to precisely regulate the LED current to prevent luminous intensity variations." Tripathi, Abstract, 1:9-10, 1:27-31. **Tripathi** recognizes that the brightness "of LEDs depends on the LED current," and further that "electrical characteristics of LEDs are such that small changes in the voltage applied to the LED lamp will cause appreciable current changes." *Id.*, 1:22-27; Kattamis, ¶¶180-181.

As illustrated in Figure 1 below, Tripathi discloses "a power supply for an LED light source" that includes an "**LED light source 10**" coupled to a **voltage source** that supplies "LED current and a LED voltage" to LEDs. Tripathi, 2:4-6, 2:18-24. An "**LED current sensor 25**" detects the "magnitude of the LED current flowing through **LED light source 10**" and provides the detected current to a "**feedback controller 27**," where it is "**compare[d]**" "to a reference signal" from a "**signal reference 28**." Tripathi, Abstract, 2:28-42. The **feedback controller 27** then uses the comparison result to "provide[] a feedback signal" FB to the **voltage source**. Tripathi, 1:26-31, 2:38-45. The power supply "precisely regulate[s]" the "LED

current flowing through **LED light source 10**" to "prevent luminous intensity variations." Tripathi, 1:26-31, 2:38-45; Kattamis, ¶182.

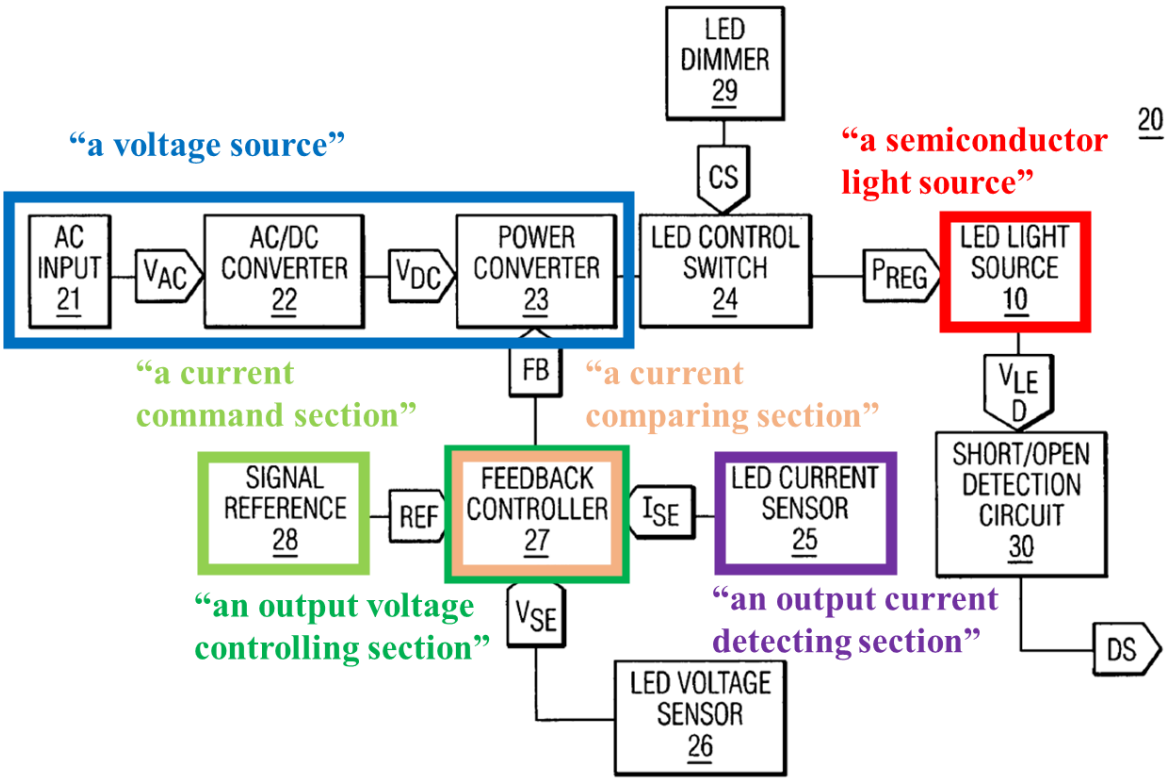


FIG. 1

Tripathi, Fig. 1.

2. Motivation to Apply Nishimura's Teachings to Tripathi

Tripathi and **Nishimura** are in the same field as the '830—which includes LED driving circuits—and are reasonably pertinent to the problems purportedly address by the '830—e.g., controlling LED light intensity. *See, e.g.*, '830, 1:16-18, 3:16-20, 3:47-54, 4:32-5:3, 5:45-50; Tripathi, 1:9-10, 1:22-36; Nishimura, 1:7-23, 1:27-31, 2:7-21; Kattamis, ¶¶183-185.

A POSITA would have been motivated to apply **Nishimura's** impedance detection teachings to **Tripathi's** LED driver circuit to advantageously enhance the reliability of the circuit by "closely predict[ing] the intensity of light emitted by an LED as a function of…operating current" that "can then be used to set the light intensity of an LED." Nishimura, 2:22-34. **Tripathi** discloses "short/open detection circuit 30" that provides "an indication of a short condition or an open condition of LED light source 10," but it does not disclose changing the voltage and current supplied to the LEDs based on temperature effects. Tripathi, 2:56-59. However, **Tripathi** recognizes that "ambient temperature changes…result in LED current changes by changing the forward drop across the LEDs." Tripathi, 1:22-36. **Nishimura** discloses that "LED's junction temperature and aging effects" are functions of "the LED's dynamic impedance" and discloses estimating dynamic impedance to account for such variations. Nishimura, 2:7-25, 4:54-58, Claims 18, 24. Thus, applying **Nishimura's** impedance detection teachings in implementing **Tripathi's** LED driver circuit would have furthered **Tripathi's** objective of regulating output power to the LEDs to maintain a brightness. Further, such an implementation would have advantageously enhanced the reliability of the system by regulating the output power and setting the proper light intensity of the LEDs based on another feedback factor (dynamic impedance), instead of just based on sensed current, sensed voltage, and a reference current signal. Implementing

Tripathi's LED driver circuit to account for a detected impedance, as taught by **Nishimura**, would be nothing more than applying a known technique of impedance detection to a known device ready for improvement to yield predictable results of accounting for junction temperature and aging effects in addition to load current when setting a light intensity of LEDs. Kattamis, ¶¶186-188.

In implementing **Nishimura's** impedance detection teachings in **Tripathi's** driver circuit, a POSITA would have understood or at least found it obvious that the feedback controller would estimate the dynamic impedance of the LEDs, as the feedback controller receives "a sensed voltage V_{SE} indicative of a magnitude of the LED voltage V_{LED} applied to LED light source 10" and "a sensed current I_{SE} indicative of a magnitude of the LED current flowing through LED light source 10." Tripathi, 2:28-42. It would have been obvious for the feedback controller to estimate the dynamic impedance by dividing the sensed voltage by the sensed current. *See* Nishimura, 2:60-3:18 ("estimate the dynamic impedance of the LED" using "$\Delta V/\Delta I=R$; where ΔV is the difference in two measured voltages of the LED, where ΔI is the difference in the currents corresponding to the measured voltages, and where R is the LED's dynamic impedance"). A POSITA would have recognized the benefits in using the dynamic impedance, in addition to the sensed current, sensed voltage, and signal reference, to "provide[] a feedback signal FB to power converter 23" to "regulate[] power P_{REG} including a LED current and a LED voltage V_{LED}," as

such an implementation would have advantageously enhanced the reliability of the circuit as discussed above. Tripathi, 2:24-42, Fig. 1. Kattamis, ¶189.

Accordingly, a POSITA would have had a reasonable expectation of success in applying **Nishimura's** impedance detection teaching in implementing **Tripathi's** driver circuit, as it was known in the art to use dynamic impedance measurements to "set an operating current" of LEDs. Nishimura, 4:48-58, Claims 18, 24. A POSITA would have also had a reasonable expectation of success in applying **Nishimura's** impedance detection teachings in implementing **Tripathi**, as both references teach feedback control to maintain voltage supplied to and current drawn from LEDs. Tripathi, Abstract, 2:18-42; Nishimura, Abstract, 4:54-58; Kattamis, ¶190. Further, both **Tripathi** and **Nishimura** disclose using control circuitry to regulate the brightness of the LEDs, and implementing **Nishimura's** impedance detection teaching in **Tripathi's** feedback controller would have merely required using the already sensed current and voltage measurement to calculate the impedance. This would have been a straightforward application of **Nishimura's** impedance detection teachings in a manner that advantageously improves **Tripathi's** driver circuit. Kattamis, ¶190. Thus, a POSITA would have found it straightforward and advantageous to apply **Nishimura's** impedance detection teachings to **Tripathi's** driver circuit, and would have known such a combination

(yielding the claimed limitations) would predictably work and provide the expected functionality. Kattamis, ¶190.

3. Claim 1

(a) 1(pre): "1. A semiconductor light source driving apparatus comprising:"

To the extent the preamble is limiting, **Tripathi discloses a semiconductor light source driving apparatus** (*e.g.*, "a power supply for LEDs"). Tripathi, Abstract, 1:9-10; Kattamis, ¶¶191-194.

For example, **Tripathi** discloses a "power supply (20) for LEDs [that] provides power to a LED light source." Tripathi, Abstract, 1:9-10 ("The technical field of this disclosure is…a power supply for LEDs."), Figs. 1-2. A POSITA would have understood that an LED is a semiconductor light source. *See* '830, 1:24-25 (PO admitting "[s]emiconductor light sources include…light-emitting diodes" in the prior art); Kattamis, ¶¶193-194.

(b) 1(a): "a semiconductor light source that is driven by a current;"

Tripathi discloses a semiconductor light source that is driven by a current (*e.g.*, "LED current through the LED light source 10"). Tripathi, 2:18-36; Kattamis, ¶¶195-198. *See* 1(pre).

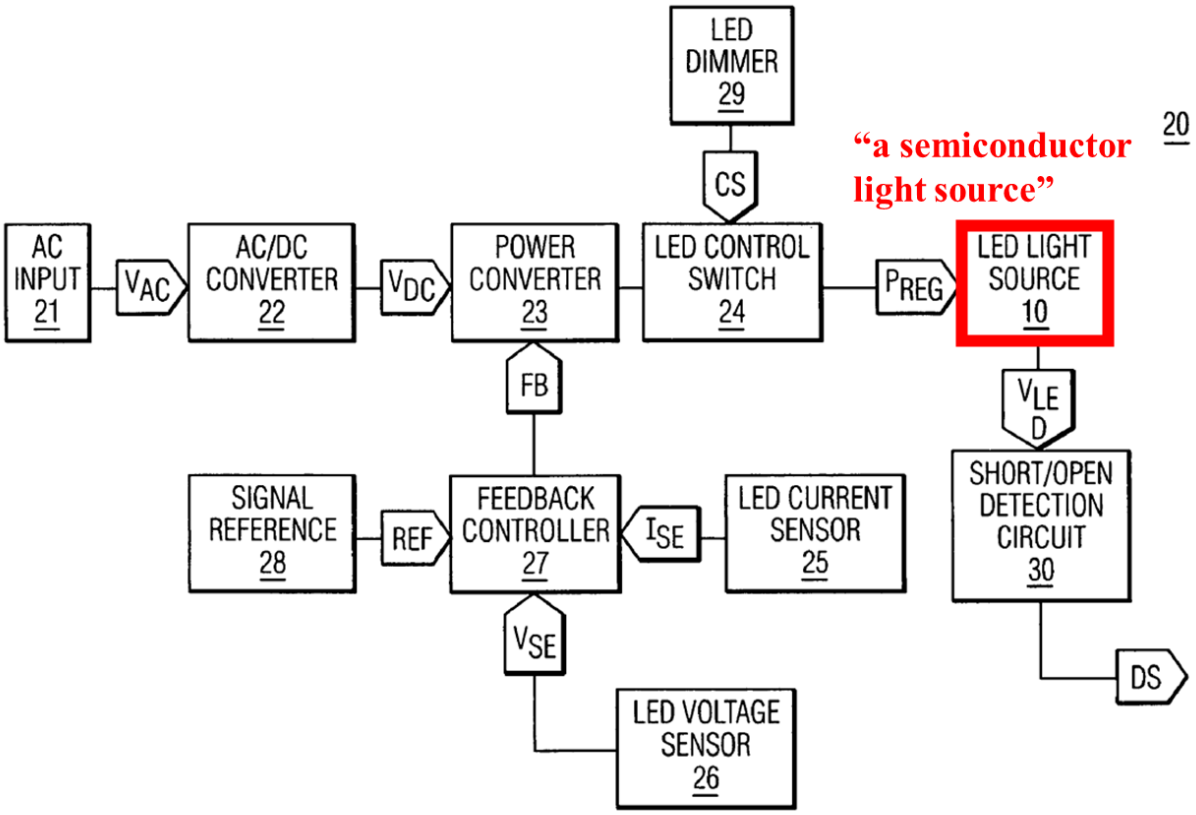


FIG. 1

Tripathi, Fig. 1.

For example, **Tripathi** further discloses "power converter 23" that "generates a regulated power P_{REG} including a LED current and a LED voltage V_{LED}" provided to "LED light source 10." Control switch 24 "controls a flow of the LED current through the LED light source 10." Tripathi, 2:18-31. Kattamis, ¶198.

(c) 1(b): "a voltage source that drives the semiconductor light source;"

Tripathi discloses a voltage source (*e.g.*, "single-phase ac input 21," "AC/DC converter 22," and a "power converter 23") **that drives the semiconductor**

light source (*e.g.*, "provides regulated" "LED current and a LED voltage" to "LED light source 10"). Tripathi, 2:18-27, 3:12-26; Kattamis, ¶¶199-202. *See* 1(a).

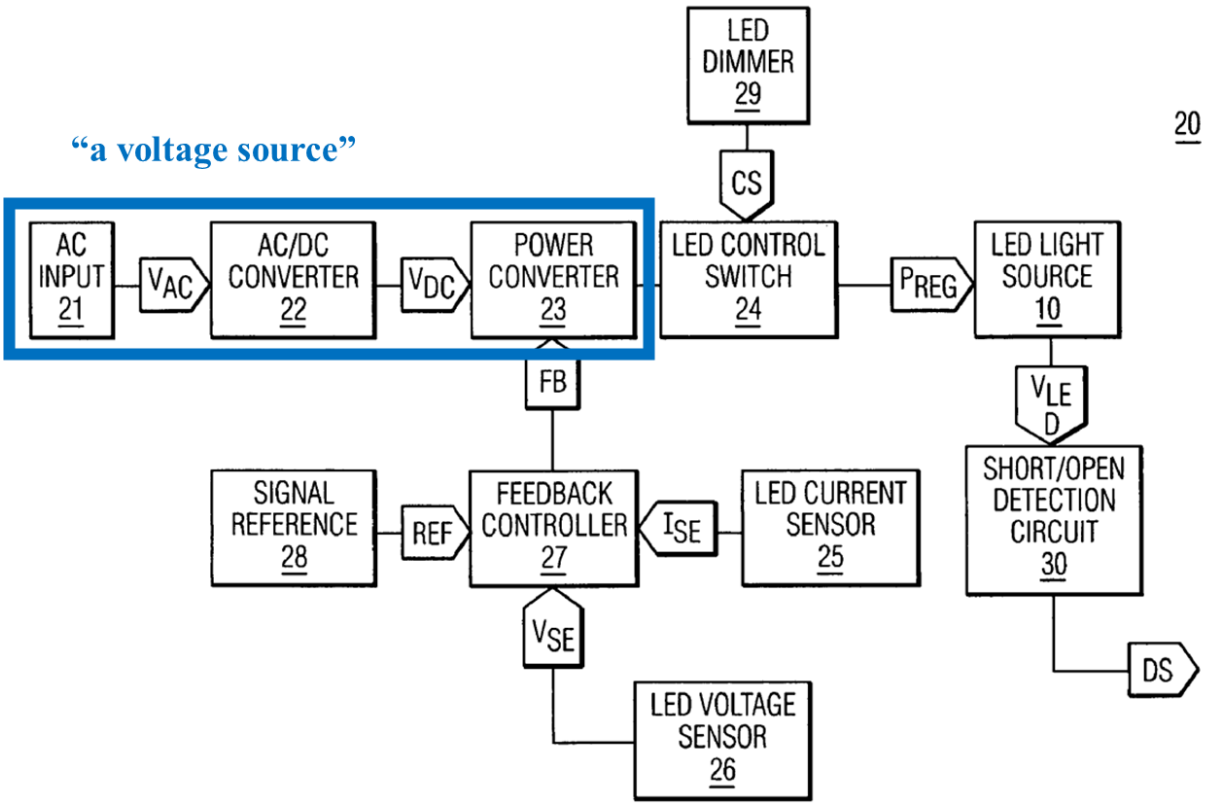


FIG. 1

Tripathi, Fig. 1.

For example, **Tripathi** further discloses power supply 20 includes a "single-phase ac input 21" that "provides a voltage V_{AC} to an AC/DC converter 22," which "converts voltage V_{AC} into a voltage V_{DC}." Tripathi, 2:18-24. The V_{DC} is provided "to a power converter 23" that "generates a regulated power P_{REG} including a LED current and a LED voltage V_{LED}" supplied to the LEDs. Tripathi, 2:24-27, 3:12-26. Kattamis, ¶202.

(d) 1(c): "an output voltage controlling section that controls a drive current value for driving the semiconductor light source by controlling an output voltage of the voltage source;"

Tripathi discloses an output voltage controlling section (*e.g.*, "feedback controller") **that controls a drive current value** (*e.g.*, "regulat[ing] power P_{REG} including a LED current") **for driving the semiconductor light source** (*see* 1(a)) **by controlling an output voltage of the voltage source** (*e.g.*, "regulat[ing] power P_{REG} including…LED voltage V_{LED}")**.** Tripathi, 2:18-42, Fig. 1; Kattamis, ¶¶203-206. *See* 1(a)-1(b).

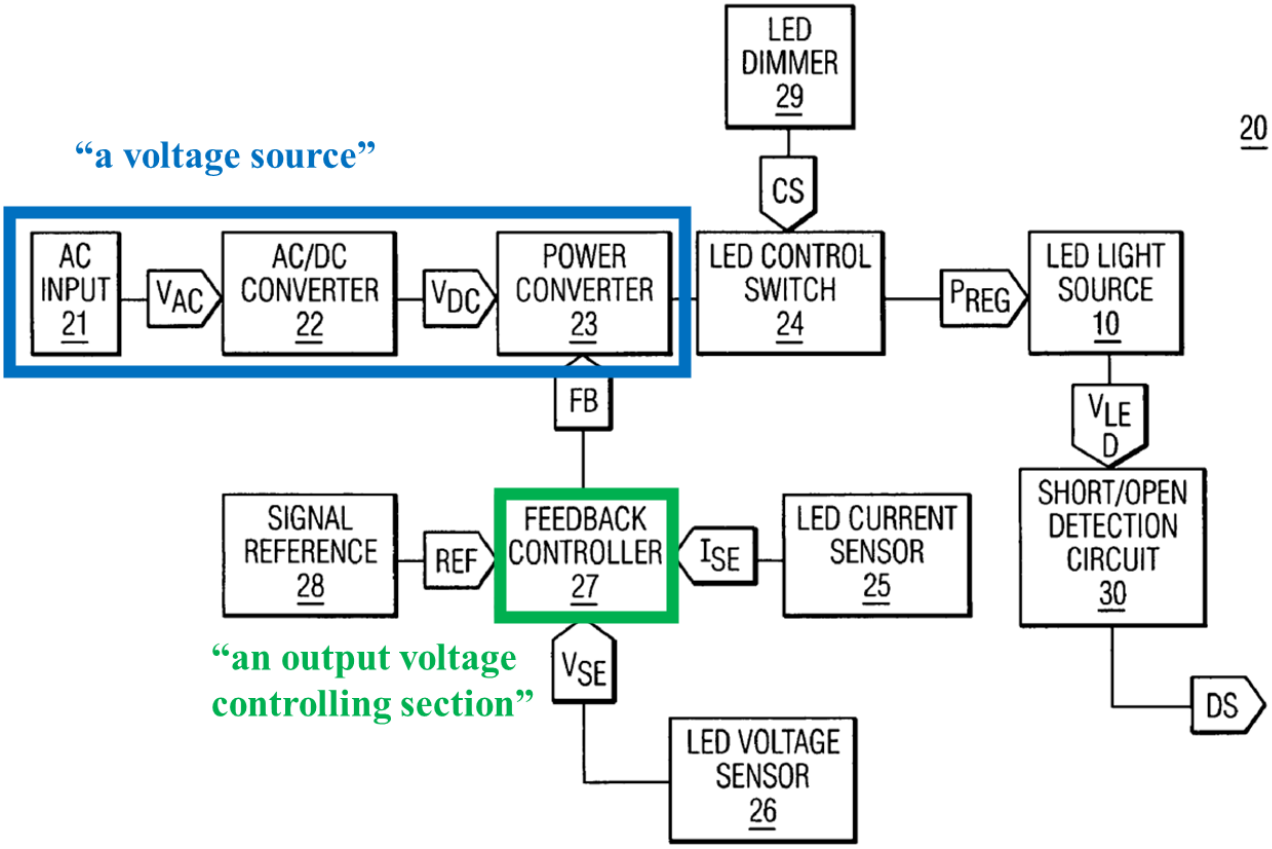


FIG. 1

Tripathi, Fig. 1.

For example, **Tripathi** further discloses a "feedback controller" that receives "[s]ensed current I_{SE} and sensed voltage V_{SE}" and "reference signal REF," and based on these inputs, "provides a feedback signal FB to power converter 23" to "regulate[] power P_{REG} including a LED current and a LED voltage V_{LED}" supplied to the LEDs. Tripathi, 2:24-42. Thus, the feedback controller controls the LED current supplied to the LEDs by controlling an output voltage of the power converter. Kattamis, ¶206.

(e) 1(d): "an output current detecting section that detects an output current of the semiconductor light source;"

Tripathi discloses an output current detecting section (*e.g.*, "LED current sensor 25") **that detects an output current of the semiconductor light source** (*e.g.*, "sense[s]…a magnitude of the LED current flowing through LED light source")**.** Tripathi, 2:31-33, 3:40-44; Kattamis, ¶¶207-210. *See* 1(a)-1(b).

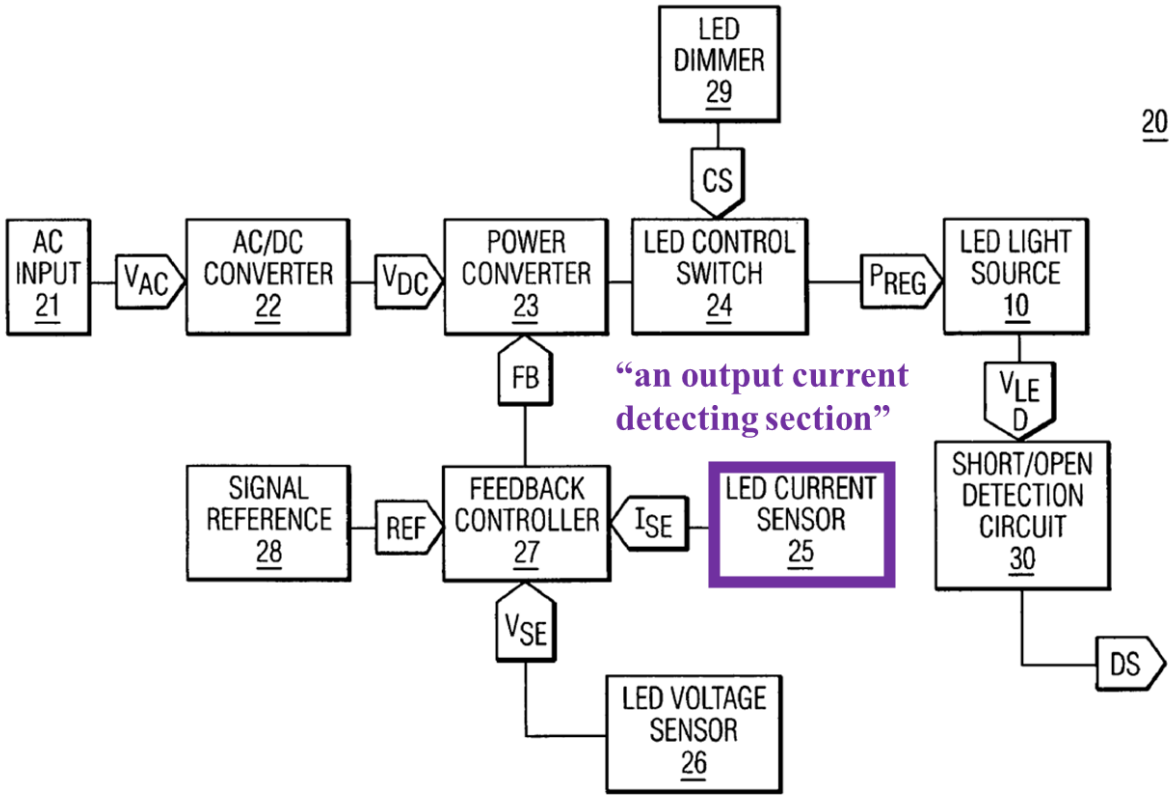


FIG. 1

Tripathi, Fig. 1.

For example, **Tripathi** further discloses a "LED current sensor 25" that "sense[s] LED current I_{SE}," which is a "voltage representative" of the "magnitude of the LED current flowing through LED light source." Tripathi, 2:31-33, 3:40-44; Kattamis, ¶210.

(f) 1(e): "a current command section that specifies a reference value of a drive current which is applied to the semiconductor light source;"

Tripathi discloses a current command section (*e.g.*, "signal reference 28") **that specifies a reference value** (*e.g.*, "REF") **of a drive current which is applied**

to the semiconductor light source (*e.g.*, "reference current signal" for "LED light source 110")**.** Tripathi, 2:38-42, 3:24-35; Kattamis, ¶¶211-214. *See* 1(a), 1(c)-1(d).

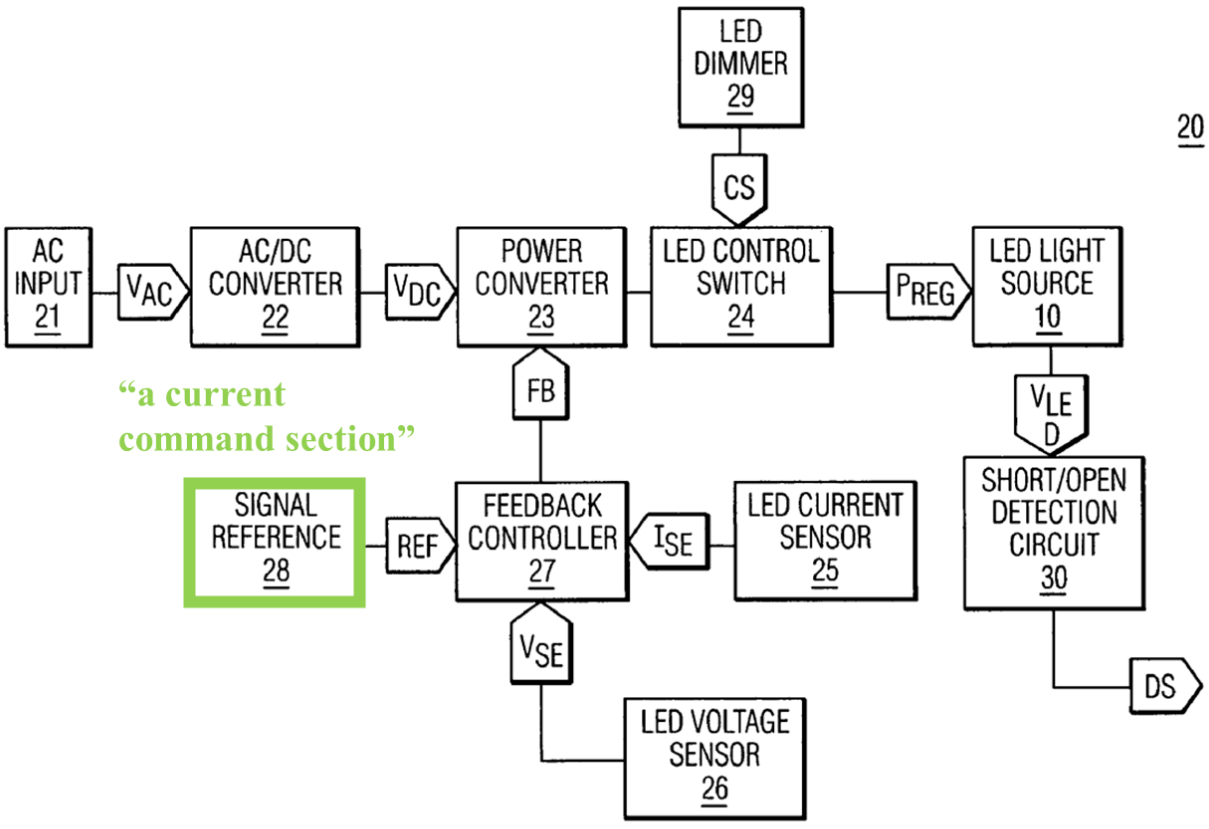


FIG. 1

Tripathi, Fig. 1.

For example, **Tripathi** further discloses "signal reference 28" that provides a "reference current signal" to feedback controller 27 to control the voltage and current supplied to the LEDs, as discussed in 1(c). Tripathi, 2:38-42, 3:24-35, Fig. 1. A POSITA would have understood or at least found it obvious that the reference current signal is a reference drive current applied to the LEDs. Kattamis, ¶214.

(g) 1(f): "a current comparing section that compares the output current detected by the output current detecting section and the reference value specified by the current command section; and"

Tripathi discloses a current comparing section that compares the output current detected by the output current detecting section and the reference value specified by the current command section (*e.g.*, "feedback controller" "compares sensed current…to a reference signal")**.** Tripathi, Abstract, 2:38-42, 3:40-52; Kattamis, ¶¶215-218. *See* 1(a), 1(c)-1(e).

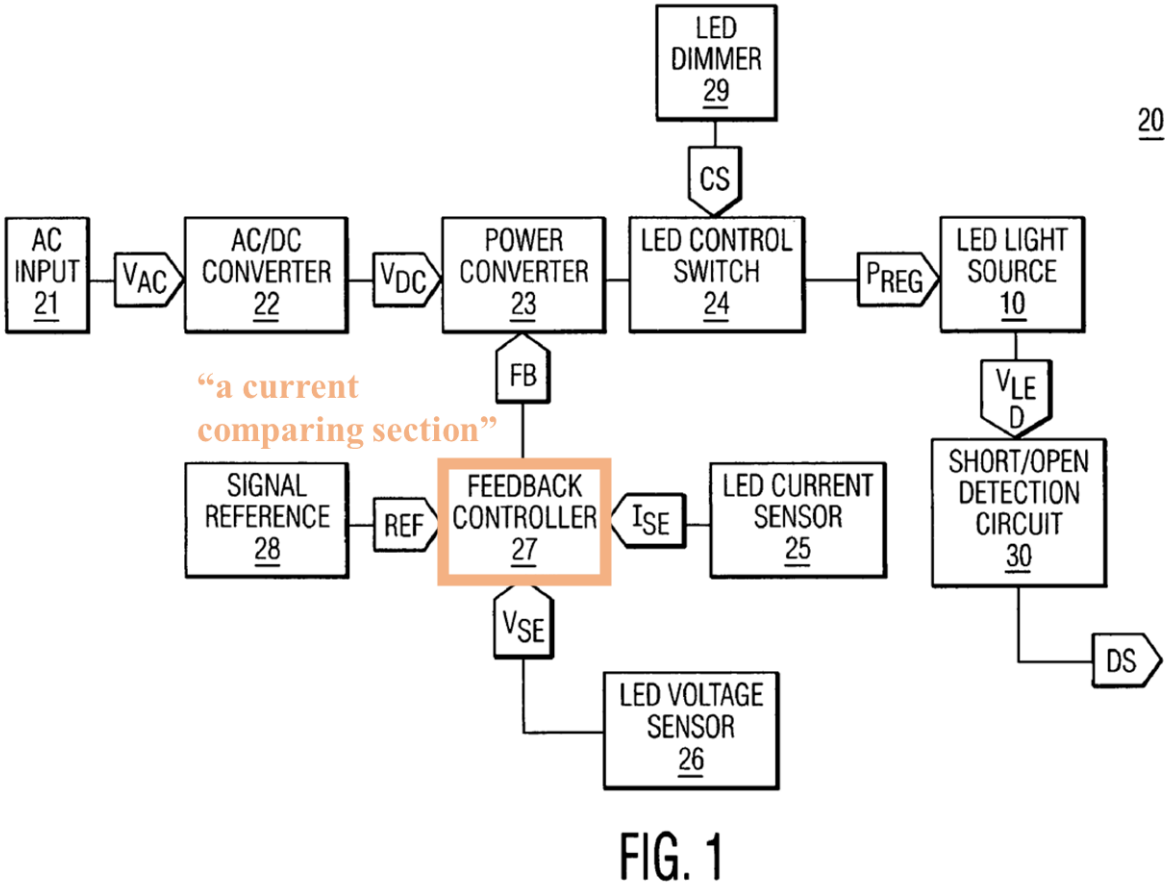


FIG. 1

Tripathi, Fig. 1.

For example, **Tripathi** further discloses the feedback controller "compares sensed current" I_{SE} (*see* 1(d)) to "reference current signal" (*see* 1(e)). Tripathi, Abstract, 2:38-42, 3:40-52. The feedback controller generates the feedback signal based on these inputs. Tripathi, Abstract, 2:38-42, 3:40-52; Kattamis, ¶218.

(h) 1(g): "an impedance detecting section that detects an impedance of the semiconductor light source,"

Nishimura discloses an impedance detecting section that detects an impedance of the semiconductor light source (*e.g.*, "control circuitry 506" that "acquire[s] readings from the [LEDs'] current and voltage sensors 502, 504" and "estimate[s] a dynamic impedance of the LED[s]")**.** Nishimura, 4:54-58, Claims 18, 24; Kattamis, ¶¶219-223.

See §IX.A.4.h above.

As discussed in §IX.B.2, a POSITA would have been motivated to apply **Nishimura's** impedance detection teachings in implementing **Tripathi's** circuit to advantageously enhance the reliability of the circuit by detecting both load current and dynamic impedance. Kattamis, ¶222.

Alternatively, **Tripathi renders obvious an impedance detection section that detects an impedance of the semiconductor light source**. For example, as discussed in 1(d), the feedback controller already receives "[s]ensed current I_{SE} and sensed voltage V_{SE}" to generate "a feedback signal FB to power converter 23" to

"regulate[] power P_{REG} including a LED current and a LED voltage V_{LED}" supplied to the LEDs. Tripathi, 2:24-42. For the same reasons discussed in Ground 1, 1(g) (§IX.A.4.h), it would have been obvious to use the sensed current I_{SE} and sensed voltage V_{SE} to calculate an impedance of the LEDs to advantageously account for LED junction temperature and aging effects, which were known factors a POSITA would have been aware of that affect LED brightness. And at minimum, a POSITA would have been motivated to apply these **Nishimura's** teachings to **Tripathi** for these same reasons. Kattamis, ¶223.

(i) 1(h): "wherein the output voltage controlling section controls the output voltage of the voltage source based on an output of the current comparing section and an output of the impedance detecting section."

Tripathi discloses the output voltage controlling section controls the output voltage of the voltage source (*see* 1(c)) **based on an output of the current comparing section** (*e.g.*, output "voltage feedback V_{FB} from feedback controller"). Tripathi, 3:45-49; Kattamis, ¶¶224-230. *See* 1(b)-1(c), 1(f).

For example, as discussed in 1(c) and 1(f) (§§XI.B.3.d, g), **Tripathi** discloses the "feedback controller" provides "regulate[d]…LED voltage V_{LED}" to the LEDs based on "feedback signal FB" that includes the result when "compar[ing] sensed current…to a reference signal." Tripathi, Abstract, 2:24-42, Fig. 1; Kattamis, ¶227.

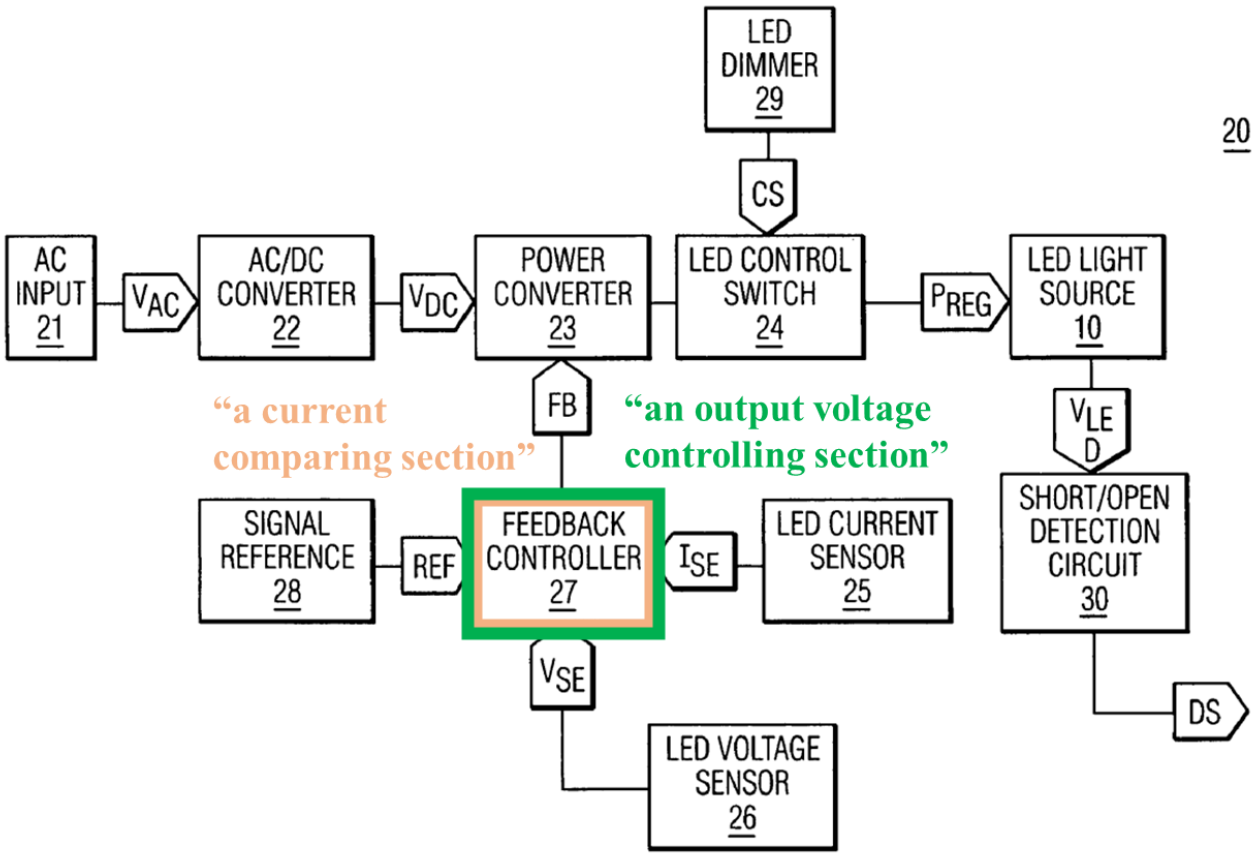


FIG. 1

Tripathi, Fig. 1.

Nishimura discloses controlling the output voltage of the voltage source based on the impedance detecting section (*see* 1(g)). Kattamis, ¶¶228-230.

As discussed in §IX.B.2, a POSITA would have been motivated to apply **Nishimura's** impedance detection teachings in implementing **Tripathi's** circuit to advantageously enhance the reliability of the circuit by detecting both load current and dynamic impedance. Kattamis, ¶229. As also discussed in §IX.B.2, in implementing **Nishimura's** impedance detection teachings in **Tripathi's** circuit, the

feedback controller would have controlled the output voltage of the power converter based on the detected impedance result as taught by **Nishimura**. Kattamis, ¶229.

Alternatively, **Tripathi renders obvious the output voltage controlling section controls the output voltage of the voltage source based on an output of the current comparing section and an output of the impedance detecting section**. For example, as discussed in 1(g), it would have been obvious to implement **Tripathi** to use the already sensed current and voltage to calculate the impedance of the LEDs. For the same reasons discussed in Ground 1, 1(g) (§IX.A.4.h), it would have been obvious to use that result to "regulate[] power P_{REG} including a LED current and a LED voltage V_{LED}" supplied to the LEDs by generating a feedback signal that accounts for the impedance calculation. Tripathi, 2:24-42. And at minimum, a POSITA would have been motivated to apply these **Nishimura's** teachings to **Tripathi** for these same reasons. Kattamis, ¶230.

4. Claim 2

Claim 2 recites "The semiconductor light source driving apparatus according to claim 1, wherein the impedance detecting section comprises a divider that divides the output voltage of the voltage source by the output current detected by the output current detecting section, and acquires a value corresponding to the impedance of the semiconductor light source from an output of the divider." Kattamis, ¶231.

Tripathi in view of **Nishimura** renders obvious claim 1 (§IX.B.3). Kattamis, ¶¶232-236.

Tripathi discloses the output voltage of the voltage source (*see* 1(c), 1(h))**, the output current detected by the output current detecting section** (*see* 1(d))**, and the semiconductor light source** (*see* 1(a)). Kattamis, ¶¶233, 235.

Nishimura discloses the impedance detecting section comprises a divider that divides voltage by current and acquires a value corresponding to the impedance from an output of the divider. *See* claim 2 (§IX.A.5). Kattamis, ¶¶234-235.

As discussed in §IX.A.3, a POSITA would have been motivated to apply **Nishimura's** impedance detection teachings in implementing **Tripathi's** circuit to advantageously enhance the reliability of the circuit by detecting both load current and dynamic impedance. Kattamis, ¶236.

5. Claim 5

As discussed above, the limitations of claim 5 are subsumed within claim 1. *See supra* §IX; Kattamis, ¶42 (table correlating claim 5 with claim 1). Claim 5 is rendered obvious by the **Tripathi** in view of **Nishimura**, or alternatively **Tripathi** alone, for the same reasons as described above regarding Ground 2 Claim 1 (§IX.B.3). Kattamis, ¶¶237-238.

X. SECONDARY CONSIDERATIONS

There is no evidence in the '830's prosecution history or elsewhere supporting any secondary considerations arguments, or evidence of nexus to any challenged Claim. *See generally* '830FH; Kattamis, ¶¶43-44. Indeed, as demonstrated by the prior art referenced herein, any purported solutions to problems or unexpected results in the '830 were already well known. Kattamis, ¶239. To the extent PO asserts the existence of any secondary considerations in its responses, Petitioner reserves the right to address any such evidence.

XI. CONCLUSION

Substantial, new, and noncumulative technical teachings have been presented for '830 Claims 1-5, which are obvious for the reasons set forth above. Kattamis, ¶¶240-245. There is a reasonable likelihood that Petitioner will prevail as to Claims 1-5. *Inter partes* review of Claims 1-5 is accordingly requested.

Respectfully submitted,

Dated: July 28, 2025

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CERTIFICATE OF COMPLIANCE

Pursuant to §42.24(d), the undersigned certifies that the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 8,093,830 contains, as measured by the word-processing system used to prepare this paper, 12,542 words. This word count does not include the items excluded by §42.24 as not counting towards the word limit.

Dated: July 28, 2025

/James L. Davis, Jr./
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CERTIFICATE OF SERVICE

I hereby certify that on July 28, 2025, I caused a true and correct copy of the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 8,093,830 and supporting exhibits to be served via Federal Express on the Patent Owner at the following correspondence address of record as listed on Patent Center:

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A courtesy copy was also sent via electronic mail to Patent Owner's litigation counsel at the following addresses:

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