

IPR2022-00503
Petition for IPR of USP 8,093,830

UNITED STATES PATENT AND TRADEMARK OFFICE
PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.

Petitioner

v.

BISHOP DISPLAY TECH LLC

Patent Owner

Case No. IPR2022-00503
Patent No. 8,093,830

PETITION FOR *INTER PARTES* REVIEW

TABLE OF CONTENTS

	Page
MANDATORY NOTICES UNDER 37 C.F.R. §42.8	1
A. Real Party-In-Interest under 37 C.F.R. §42.8(b)(1).....	1
B. Related Matters under 37 C.F.R. §42.8(b)(2)	1
C. Designation of Counsel under 37 C.F.R. §42.8(b)(3).....	2
D. Service Information under 37 C.F.R. §42.8(b)(4)	2
I. REQUIREMENTS UNDER 37 C.F.R. §42.104	7
A. Standing.....	7
B. Summary of Grounds	7
II. DISCRETIONARY DENIAL IS NOT WARRANTED	7
A. Factor 1: Potential for a Stay Renders This Factor Neutral.....	8
B. Factor 2: Uncertainty in Litigation Schedule Favors Institution	9
C. Factor 3: The District Court Has Not Invested Significant Resources, and Petitioner Has Acted Diligently, Which Favors Institution	10
D. Factor 4: Lack of Overlap in Issues Favors Institution.....	12
E. Factor 5: Whether Petitioner and Defendant in Parallel Proceeding Are Same Party	13
F. Factor 6: The Petition’s Merits Are Strong and Favor Institution.....	13
III. PERSON OF ORDINARY SKILL IN THE ART (“POSITA”)	14
A. Level of Ordinary Skill	14
B. Background Knowledge of a POSITA	14
IV. OVERVIEW OF ’830 PATENT	18
A. Subject Matter	18
B. Prosecution History	23
C. Comparison of Claim 1 and Claim 5	23
V. CLAIM CONSTRUCTION	24
VI. OVERVIEW OF PRIOR ART	25
A. Ghanem: Ex. 1004.....	25

B. Nishimura: Ex. 1005	26
C. Tripathi: Ex. 1006	28
VII. GROUND 1: GHANEM.....	30
A. Claim 1	30
B. Claim 5	48
VIII. GROUND 2: GHANEM IN VIEW OF NISHIMURA	48
A. Reasons to Combine.....	49
B. Claim 1	54
C. Claim 2	59
D. Claim 5	61
IX. GROUND 3: TRIPATHI	61
A. Claim 1	61
B. Claim 5	78
X. GROUND 4: TRIPATHI IN VIEW OF NISHIMURA.....	78
A. Reasons to Combine.....	80
B. Claim 1	84
C. Claim 2	88
D. Claim 5	88
XI. SECONDARY CONSIDERATIONS	88
XII. CONCLUSION	88

TABLE OF AUTHORITIES

	Page(s)
CASES	
<i>Apple Inc. v. Maxell, Ltd.</i> , IPR2020-00200, Paper 11 (PTAB July 15, 2020)	12
<i>Apple Inc., v. Parus Holdings, Inc.</i> , IPR2020-00686, Paper 9 (PTAB Sept. 23, 2020)	8, 10
<i>Apple Inc. v. Seven Networks</i> , IPR2020-00266, Paper 12 (PTAB Aug. 14, 2020)	10
<i>Apple Inc. v. Seven Networks, LLC</i> , IPR2020-00156, Paper 10 (PTAB June 15, 2020)	13
<i>Apple Inc. v. Seven Networks, LLC</i> , IPR2020-00157, Paper 10 (PTAB June 15, 2020)	12
<i>Apple Inc. v. Seven Networks, LLC</i> , IPR2020-00506, Paper 11 (PTAB Sept. 1, 2020)	9
<i>Apple, Inc. v. Fintiv, Inc.</i> , IPR2020-0019, Paper 11 (PTAB March 20, 2020)	8
<i>Comcast Cable Commn's, LLC v. Rovi Guides, Inc.</i> , IPR2019-00231, Paper 14 (PTAB May 20, 2019)	13
<i>Dish Network L.L.C. v. Broadband iTV, Inc.</i> , IPR2020-01267, Paper 15 (P.T.A.B. Jan. 21, 2021)	14
<i>Google LLC v. Parus Holdings, Inc.</i> , IPR2020-00846, Paper 9 (PTAB Oct. 21, 2020)	13
<i>HP Inc. v. Slingshot Printing LLC</i> , IPR2020-01084, Paper 13 (PTAB Jan. 14, 2021)	9
<i>Koninklijke Philips N.V. v. Google LLC</i> , 948 F.3d 1330 (Fed. Cir. 2020)	14

Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.,
868 F.3d 1013 (Fed. Cir. 2017) 24

Sand Revolution II, LLC v. Cont'l Intermodal Grp-Trucking LLC,
IPR2019-01393, Paper 24 (PTAB June 16, 2020) 8, 9, 12

Sotera Wireless, Inc. v. Masimo Corp.,
IPR2020-01019, Paper 12 (PTAB Dec. 1, 2020) 11

OTHER AUTHORITIES

M.P.E.P §2133(II).....25

PETITIONER'S LIST OF EXHIBITS

Ex.	Description of Exhibits
1001	U.S. Patent No. 8,093,830 to Shuji Inoue, entitled “Semiconductor Light Source Driving Apparatus and Semiconductor Light Source Driving Method” (filed July 1, 2009 and issued Jan. 10, 2012) (“ 830 Patent ” or “ Challenged Patent ”)
1002	Declaration of Dr. Alex Kattamis in Support of Petition for <i>Inter Partes</i> Review of U.S. Patent No. 8,093,830, with CV attached as Appendix A (“ Kattamis Decl. ”)
1003	File History of U.S Patent No. 8,093,830 (App. No. 12/496,472) (“ 830 Patent File History ”)
1004	U.S. Patent No. 6,285,139 to Mohamed Sherif Ghanem, entitled “Non-Linear Light-Emitting Load Current Control” (filed December 23, 1999 and issued September 4, 2001) (“ Ghanem ”)
1005	U.S. Patent No. 7,332,699 to Ken A. Nishimura, entitled “Feed-Forward Methods and Apparatus for Setting the Light Intensities of One or More LEDs” (filed July 23, 2004 and issued February 19, 2008) (“ Nishimura ”)
1006	U.S. Patent No. 7,262,559 to Ajay Tripathi et al., entitled “LEDS DRIVER” (filed Dec. 11, 2003 and issued Aug. 28, 2007) (“ Tripathi ”)
1007	Paul Horowitz et al., THE ART OF ELECTRONICS, 2 nd ed. (Cambridge University Press: 1989), ISBN: 0-521-37095-7
1008	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
1009	Steve Winder, POWER SUPPLIES FOR LED DRIVING, 1 st ed. (Newnes: 2008), ISBN: 0-750683-41-4
1010-1027	RESERVED

1028	Amended Complaint, <i>Bishop Display Tech LLC v. Samsung Electronics Co., LTD. et al.</i> , 2:21-cv-00136-JRG, Dkt. No. 2 (E.D. Tex., Apr. 20, 2021)
1029	Complaint, <i>Bishop Display Tech LLC v. Samsung Electronics Co., LTD. et al.</i> , 2:21-cv-00139-JRG, Dkt. No. 1 (E.D. Tex., Apr. 20, 2021)
1030	Docket Control Order, <i>Bishop Display Tech LLC v. Samsung Electronics Co., LTD. et al.</i> , 2:21-cv-00136-JRG, Dkt. No. 55 (E.D. Tex., Nov. 19, 2021)
1031	Docket Control Order, <i>Bishop Display Tech LLC v. Samsung Electronics Co., LTD. et al.</i> , 2:21-cv-00139-JRG, Dkt. No. 60 (E.D. Tex., Nov. 19, 2021)
1032	Joint Motion for Entry of Partially Disputed Docket Control Order, <i>Bishop Display Tech LLC v. Samsung Electronics Co., LTD. et al.</i> , 2:21-cv-00136-JRG, Dkt. No. 51 (E.D. Tex., Oct. 27, 2021)
1033	Joint Motion for Entry of Partially Disputed Docket Control Order, <i>Bishop Display Tech LLC v. Samsung Electronics Co., LTD. et al.</i> , 2:21-cv-00139-JRG, Dkt. No. 50 (E.D. Tex., Oct. 27, 2021)
1034	Joint Notice Regarding Consolidation, <i>Bishop Display Tech LLC v. Samsung Electronics Co., LTD. et al.</i> , 2:21-cv-00136-JRG, Dkt. No. 49 (E.D. Tex., Oct. 27, 2021)
1035	Joint Notice Regarding Consolidation, <i>Bishop Display Tech LLC v. Samsung Electronics Co., LTD. et al.</i> , 2:21-cv-00139-JRG, Dkt. No. 48 (E.D. Tex., Oct. 27, 2021)
1036	PACER Calendar Events Set for 12/5/2022-12/5/2022, U.S. District Court Eastern District of Texas, Judge Rodney Gilstrap (last accessed Jan. 27, 2022)
1037	Model Order Focusing Patent Claims and Prior Art to Reduce Costs, available at: https://www.txed.uscourts.gov/sites/default/files/forms/ModelPatentOrder.pdf
1038	<i>Revolaze LLC v. J.C. Penney Co., Inc.</i> , 2:19-CV-00043-JRG, Dkt. No. 32 (E.D. Tex., June 4, 2019)
1039	<i>Trioptima AB v. Quantile Techs. Ltd.</i> , 2:19-CV-390-JRG, Hr'g Tr. (E.D. Tex. Sept. 4, 2020) (excerpted)

1040	Cover Pleading and Appendix 1 to Plaintiff's Disclosure of Asserted Claims and Infringement Contentions, <i>Bishop Display Tech LLC v. Samsung Electronics Co., LTD. et al.</i> , 2:21-cv-00139-JRG (E.D. Tex., Sept. 19, 2021)
------	---

Other than the prosecution history, Ex. 1003, all citations to exhibits reference original page numbers found in the underlying document. Unless noted, all emphases are added.

MANDATORY NOTICES UNDER 37 C.F.R. §42.8

A. REAL PARTY-IN-INTEREST UNDER 37 C.F.R. §42.8(B)(1)

Samsung Electronics Co., Ltd. (“**Samsung**” or “**Petitioner**”) is a real-party in-interest for this *inter partes* review (“IPR”).

Petitioner also identifies the following real-parties-in-interest: Samsung Electronics America, Inc.; Samsung Display Co., Ltd.; and Coretronic Corp. Samsung Electronics America, Inc. and Samsung Display Co., Ltd. are parties to lawsuits where they have been accused of infringement by Patent Owner in:

- *Bishop Display Tech LLC v. Samsung Electrons. Co.*, No. 2:21-cv-00136-JRG (“**136 Litigation**”); and
- *Bishop Display Tech LLC v. Samsung Electrons. Co.*, No. 2:21-cv-00136-JRG, 2:21-cv-00139-JRG (E.D. Tex.) (“**139 Litigation**”) (collectively, “**Texas Litigations**”)

B. RELATED MATTERS UNDER 37 C.F.R. §42.8(B)(2)

U.S. Patent No. 8,093,830 (“**830 Patent**” or “**Challenged Patent**”) is currently asserted by Patent Owner against Petitioner in a case styled: *Bishop Display Tech LLC v. Samsung Electrons. Co., Ltd. et al.*, No. 2:21-cv-00139-JRG (E.D. Tex.) (“**139 Litigation**”). The original complaint for the 139 Litigation was originally filed April 20, 2021.

In addition, Petitioner is concurrently filing Petitions for IPR against other patents held by Patent Owner, including: IPR2022-00500 against U.S. Patent No.

6,822,706; IPR2022-00501 against U.S. Patent No. 7,995,047; and IPR2022-00502 against U.S. Patent No. 8,016,449.

C. DESIGNATION OF COUNSEL UNDER 37 C.F.R. §42.8(B)(3)

LEAD COUNSEL	BACK-UP COUNSEL
Eliot D. Williams Reg. No. 50,822 Baker Botts L.L.P. 1001 Page Mill Road Building One, Suite 200 Palo Alto, CA 94304 Phone: 650-739-7500 Fax: 650-739-7699 eliot.williams@bakerbotts.com	Neil Sirota, Reg. No. 38,306 Baker Botts L.L.P. 30 Rockefeller Plaza, Ste 4340 New York, NY 10112-4498 Phone: 212.408.2548 Fax: 212.259.2548 neil.sirota@bakerbotts.com James Williams, RE. No. 67,945 Baker Botts L.L.P. 2001 Ross Ave, Suite 900 Dallas, TX 75201-2980 Phone: 214.953.6925 Fax: 214.661.4925 james.williams@bakerbotts.com David Tobin, Reg. No. 60,776 Baker Botts L.L.P. 2001 Ross Ave, Suite 900 Dallas, TX 75201-2980 Phone: 214.953.6925 Fax: 214.661.4925 david.tobin@bakerbotts.com

D. SERVICE INFORMATION UNDER 37 C.F.R. §42.8(B)(4)

A copy of the entire Petition, including all Exhibits and a Power of Attorney, is being served by FedEx, costs prepaid, to:

- the address of the attorney or agent of record for Patent Owner at the USPTO:

HAMRE, SCHUMANN, MUELLER & LARSON P.C.
45 South Seventh Street
Suite 2700
MINNEAPOLIS MN 55402-1683

Attn:
Kerry Culpepper
Sandra Epp Ryan
Amol Kavathekar
Naoko Koyano
James Larson
Michael Lasky
David Lee
Thomas Lee
Anthony Marshik
Yuhgo Maruta
Douglas Mueller
Michael Schumann
Bryan Wong
Min Xu
Bing Yang
Rong Yang
Masako Yoshida
Alexander Zumbulyadis

- Counsel for the Texas Litigations:

Patrick J. Conroy
Nelson Bumgardner Conroy PC
2727 North Harwood Street
Suite 250
Dallas, TX 75201

Petitioner may be served at lead counsel's address provided above and consents to e-mail service, provided service is made to all the following e-mail addresses: eliot.williams@bakerbotts.com, neil.sirota@bakerbotts.com,

james.williams@bakerbotts.com, david.tobin@bakerbotts.com, and
DLBishopDisplaySECBB@BakerBotts.com.

A Power of Attorney is filed herewith under 37 C.F.R. §42.10(b).

CLAIM LISTING

Claim Element	Claim Language from '830 Patent
1(pre)	1. A semiconductor light source driving apparatus comprising:
1(a)	a semiconductor light source that is driven by a current;
1(b)	a voltage source that drives the semiconductor light source;
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;
1(d)	an output current detecting section that detects an output current of the semiconductor light source;
1(e)	a current command section that specifies a reference value of a drive current which is applied to the semiconductor light source;
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
1(g)	an impedance detecting section that detects an impedance of the semiconductor light source,
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.
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.
5(pre)	5. A semiconductor light source driving method in a semiconductor light source driving apparatus that comprises:

Claim Element	Claim Language from '830 Patent
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(f)	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.

I. REQUIREMENTS UNDER 37 C.F.R. §42.104

A. STANDING

Petitioner certifies under 37 C.F.R. §42.104(a) that the '830 Patent is eligible for *inter partes* review and that Petitioner is not barred or estopped from requesting *inter partes* review on the grounds set forth herein.

B. SUMMARY OF GROUNDS

Claims 1, 2, and 5 (“**Challenged Claims**”) of the '830 Patent are unpatentable as follows: Ex. 1002, ¶16

Ground	'830 Patent Claims	Basis for Invalidity
1	1 and 5	Obvious over Ghanem (Ex. 1004) in view of the knowledge of a POSITA
2	1, 2, and 5	Obvious over Ghanem (Ex. 1004) and Nishimura (Ex. 1005) in view of the knowledge of a POSITA
3	1 and 5	Obvious over Tripathi (Ex. 1006) in view of the knowledge of a POSITA
4	1, 2, and 5	Obvious over Tripathi (Ex. 1006) and Nishimura (Ex. 1005) in view of the knowledge of a POSITA

II. DISCRETIONARY DENIAL IS NOT WARRANTED

The Board should not exercise discretion under 35 U.S.C. §325(d), because *none* of the asserted references (Ghanem, Tripathi, or Nishimura) are cited on the cover of the '830 Patent.

The existence of parallel proceedings in the Eastern District of Texas should not prevent institution of this Petition under 35 U.S.C. §314(a). The '830 patent is

asserted among 13 mostly unrelated patents asserted across two lawsuits that Patent Owner brought against Petitioner and other real parties-in-interest (“RPIs”): 7 patents in case no. 2:21-cv-00136 (Ex. 1028), and 6 patents in 2:21-cv-00139 (Ex. 1029).

Petitioner is filing IPR challenges to the majority of these 13 patents. In view of Petitioner’s diligence in filing this petition (and others), the uncertainty in the parallel litigation schedule, and the stipulation offered to remove any overlap of issues, the factors described in *Apple, Inc. v. Fintiv, Inc.*, IPR2020-0019, Paper 11 (PTAB March 20, 2020) (precedential) favor institution.

A. FACTOR 1: POTENTIAL FOR A STAY RENDERS THIS FACTOR NEUTRAL

Institution could relieve the district court of addressing liability of the ’830 patent. This factor is at least neutral, given the “variety of circumstances and facts beyond [the Board’s] control and to which [it] is not privy” relating to how the district court may rule on a stay motion. *Sand Revolution II, LLC v. Cont’l Intermodal Grp–Trucking LLC*, IPR2019-01393, Paper 24 at 7 (PTAB June 16, 2020) (informative); *see also Apple Inc., v. Parus Holdings, Inc.*, IPR2020-00686, Paper 9 at 10–11 (PTAB Sept. 23, 2020).

B. FACTOR 2: UNCERTAINTY IN LITIGATION SCHEDULE FAVORS INSTITUTION

The cases against Petitioner and RPIs are scheduled for jury selection starting December 5, 2022 across 13 asserted patents. Exs. 1030-1031. As the Board has recognized, when “the *same trial date is set for two cases involving a total of thirteen asserted patents*, there is a possibility that the [scheduled] trial date may be moved back, at least with respect to the [challenged] patent.” *HP Inc. v. Slingshot Printing LLC*, IPR2020-01084, Paper 13 at 9 (PTAB Jan. 14, 2021) (emphasis added). Here too, there is a real possibility that the trial date may move, and Factor 2 favors institution.

First, the trial date has already moved once. At Patent Owner’s request, the parties jointly sought—and the district court granted—a motion to move the trial date from September 12 to December 5, 2022. Exs. 1032-1033. Thus, “it is unclear that the court in the related district court litigation will adhere to any currently scheduled jury trial date or, if it is changed, when such a trial will be held.” *Sand Revolution II*, IPR2019-01393, Paper 24 at 9.

Second, Patent Owner has filed two cases against Petitioner and RPIs. Exs. 1028-1029 (complaints). Both cases are currently scheduled to begin jury selection on December 5, 2022. However, the parties did not agree to consolidation, Exs. 1034-1035, so trial of both cases cannot proceed as currently scheduled. Further,

there are six *other* cases scheduled for trial on December 5. Ex. 1036. *See Apple Inc. v. Seven Networks, LLC*, IPR2020-00506, Paper 11 at 7-8 (PTAB Sept. 1, 2020) (declining to exercise discretion even though “trial is scheduled to begin ... ten months before” the final written decision, noting the number of other trials scheduled for the same day).

Third, with 13 patents asserted across the two cases, several of the patents will undoubtedly be withdrawn before trials. If Patent Owner does not voluntarily withdraw patents at a reasonable time, the district court previously has required plaintiffs to narrow their case. *See, e.g.*, Ex. 1037 (Model Order); Ex. 1038; Ex. 1039, Hr’g Tr. at 24:8-25:14. Accordingly, even if trials proceed as currently scheduled, there is a real possibility the ’830 Patent will not be asserted.

C. FACTOR 3: THE DISTRICT COURT HAS NOT INVESTED SIGNIFICANT RESOURCES, AND PETITIONER HAS ACTED DILIGENTLY, WHICH FAVORS INSTITUTION

Factor 3 also favors institution. The district court proceeding is at an early stage, with relatively little investment from the court and parties. Fact discovery only recently began and is not set to conclude until June 24, 2022. Exs. 1030-1031 (Scheduling Orders). The parties have not exchanged claim terms or proposed constructions, a *Markman* hearing is not scheduled until May 18, 2022, and deadlines for expert discovery and dispositive motions fall many months later. *Id.* No depositions have been taken and no dispositive motions have been filed. *Cf.*

Apple Inc. v. Seven Networks, IPR2020-00266, Paper 12 at 13–14 (PTAB Aug. 14, 2020) (favoring institution when “unclear to what extent the ... [c]ourt has invested resources ... that bear directly on the issue of ... validity”); *Apple v. Parus*, IPR2020-00686, Paper 9 at 15–17 (no dispositive motions, expert reports, or Daubert challenges).

Second, Petitioner diligently prepared and filed this Petition. As previously noted, Patent Owner filed two cases against Petitioner asserting 13 patents in the span of two days. The infringement contentions in each matter were first served September 29, 2021, and were supplemented on December 24, 2021. Between the two cases, Patent Owner asserts infringement of over 1,000 products from 11 unrelated patent families. *See* Ex. 1040 (Infringement Contentions). Given the broad allegations, Petitioner spent considerable time locating and analyzing prior art for 13 different patents. In addition, as explained below, Petitioner is challenging two claims not asserted in district court, which required additional analysis beyond that needed for district court invalidity contentions.

Petitioner filed this Petition around four months after receiving Patent Owner’s voluminous infringement contentions, around one month after Patent Owner supplemented those contentions, and more than three months before the

statutory bar.¹ Petitioner diligently prepared and filed this Petition, and has not delayed filing for any strategic advantage. *See Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 at 17 (PTAB Dec. 1, 2020) (precedential) (filing petition two weeks before statutory deadline not dilatory, “particularly in view of the large number of patents and claims challenged”).

D. FACTOR 4: LACK OF OVERLAP IN ISSUES FAVORS INSTITUTION

This factor favors institution. First, the district court will not determine patentability of all Challenged Claims, because Patent Owner has not asserted claims 2 or 5 of the ’830 patent in the district court. Ex. 1040; *see, e.g., Apple Inc. v. Maxell, Ltd.*, IPR2020-00200, Paper 11 at 22 (PTAB July 15, 2020) (factor 4 favored institution where unasserted claims are challenged before the Board); *Apple Inc. v. Seven Networks, LLC*, IPR2020-00157, Paper 10 at 17–20 (PTAB June 15, 2020) (“*Fintiv* factor 4 weighs strongly in favor of Petitioner” where the IPR trial would resolve claims “which the District Court Action will not address”).

Second, the issues raised in this Petition will not overlap with the issues in district court. Petitioner (and RPIs) offers a stipulation broader than in *Sand Revolution II*, IPR2019-01393, Paper 24 (June 16, 2020) (informative). Petitioner

¹ Patent Owner filed its complaint on April 20, 2021, and purports to have effectuated service as of May 14, 2021.

stipulates that if this IPR is instituted and the Board proceeds with a trial, Petitioner will not, as to any claims upon which institution is granted, pursue in the district court case: (1) the same grounds presented in this Petition, or (2) any invalidity defenses under 35 U.S.C. §§102 or 103 that make use of the prior art references asserted in the grounds of this Petition (Ghanem, Nishimura, and Tripathi). Thus, there will be no overlap of issues between the two proceedings, and this factor weighs against the Board exercising discretion to deny.

E. FACTOR 5: WHETHER PETITIONER AND DEFENDANT IN PARALLEL PROCEEDING ARE SAME PARTY

The parties in the two proceedings are the same, and it would be speculative to determine which tribunal will reach a final decision first. This factor is therefore neutral. *Google LLC v. Parus Holdings, Inc.*, IPR2020-00846, Paper 9 at 20-21 (PTAB Oct. 21, 2020) (“[W]e decline to speculate as to whether we are likely to address the challenged patent before the Texas court. Thus, this factor is neutral.”).

F. FACTOR 6: THE PETITION’S MERITS ARE STRONG AND FAVOR INSTITUTION

This Petition is strong and merits institution, for all of the reasons explained in the preceding sections. For example, none of the references asserted herein were previously considered by the Patent Office. *Cf. Comcast Cable Comm’n’s, LLC v. Rovi Guides, Inc.*, IPR2019-00231, Paper 14 at 11 (PTAB May 20, 2019)

(obviousness challenges not previously considered by the Patent Office weigh in favor of not denying institution).

Finally, “trial here avoids potentially complicated and overlapping jury issues” concerning multiple patents. *Apple Inc. v. Seven Networks, LLC*, IPR2020-00156, Paper 10 at 22 (PTAB June 15, 2020) (finding factor 6 strongly favored institution). As noted above, the related district court cases involve 13 asserted patents and over 1,000 accused products. Institution of this IPR provides the opportunity for narrowing and simplifying the litigation for the district court and the jury.

III. PERSON OF ORDINARY SKILL IN THE ART (“POSITA”)

A. LEVEL OF ORDINARY SKILL

A POSITA would have 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. Ex. 1002, ¶¶17-18.

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,

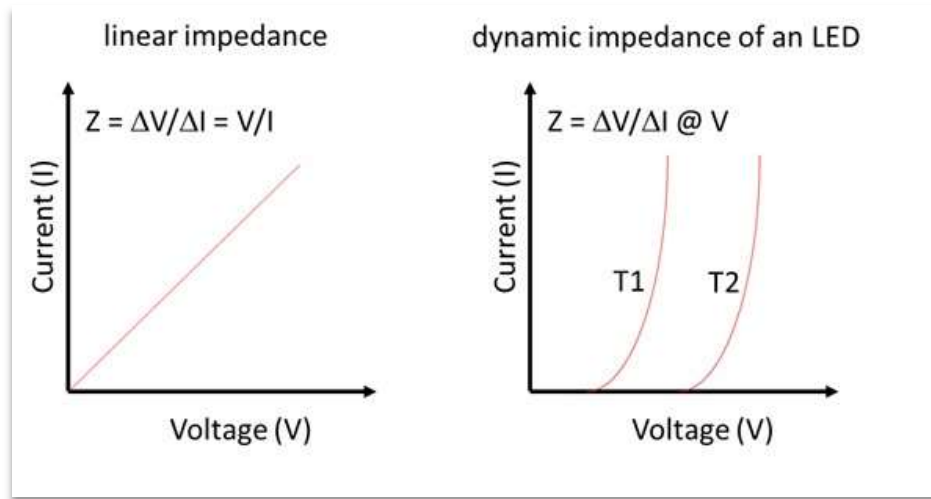
1337 (Fed. Cir. 2020). The subjects below were “within the general knowledge” of a POSITA. *See id.* at 1338; *Dish Network L.L.C. v. Broadband iTV, Inc.*, IPR2020-01267, Paper 15 at 10 n.4 (P.T.A.B. Jan. 21, 2021) (“[W]e do not include the general knowledge of a person of ordinary skill in the art in 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 (Ex. 1007-1009) published before the ’830 Patent. Ex. 1002, ¶¶49-50, 52-55; *see also* ¶¶1-16, 19-31.

a. 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:

$$V \text{ (volts)} = I \text{ (amperes)} \times Z \text{ (ohms)}$$

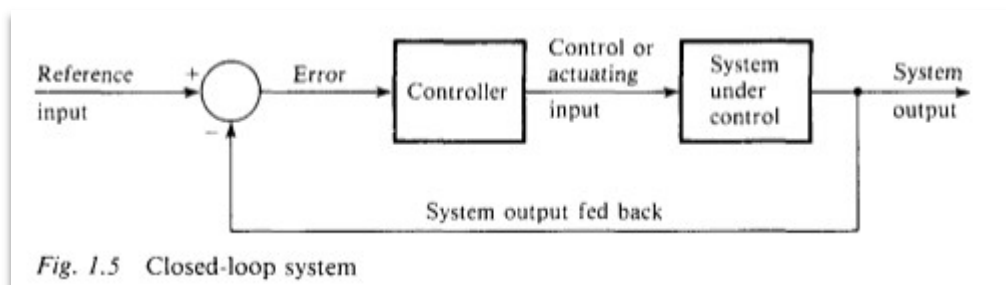
Materials such as metal have linear impedance (below, left). For LEDs (below, right), impedance changes depending on many factors, including manufacturing variations, applied voltage, and temperature. Ex. 1009, §2.4, §3.1. The temperature dependent impedance of LEDs is shown in the figure below where 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. Ex. 1009, §2.1, §3.1; Ex. 1002, ¶¶56-61.

b. Feedback Control

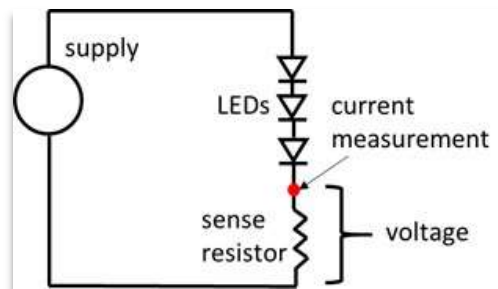
Feedback control was known in the art, in which an output signal or parameter is measured and then compared with an input or reference signal. The results of the comparison are used to adjust the output signal:



Ex. 1008, §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. Ex. 1008, §3.4.4; Ex. 1002, ¶¶62-66.

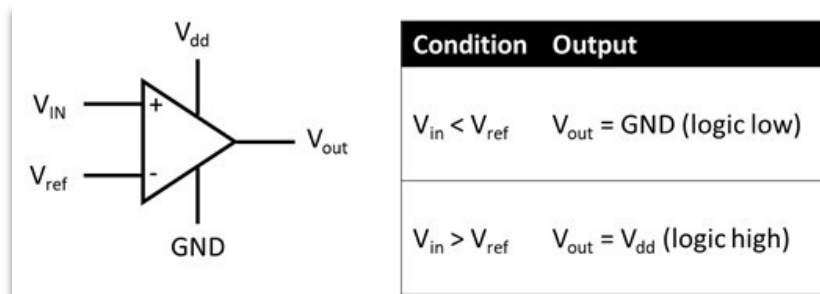
It was well-known that analog sensors generate outputs (e.g., voltage outputs) that correspond to a physical quantity to be measured, and that these outputs can be used in a feedback control system. For LEDs, it was known that the current flowing is generally measured or sensed via a “current sense” 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. Ex. 1008, §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. Ex. 1002, ¶¶67-71; 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 ($\sim 0V$ or ground) is generated and when V_{in} is greater than V_{ref} a high output ($\sim V_{dd}$) is generated. Ex. 1007, §4.23; Ex. 1002, ¶¶72-74.

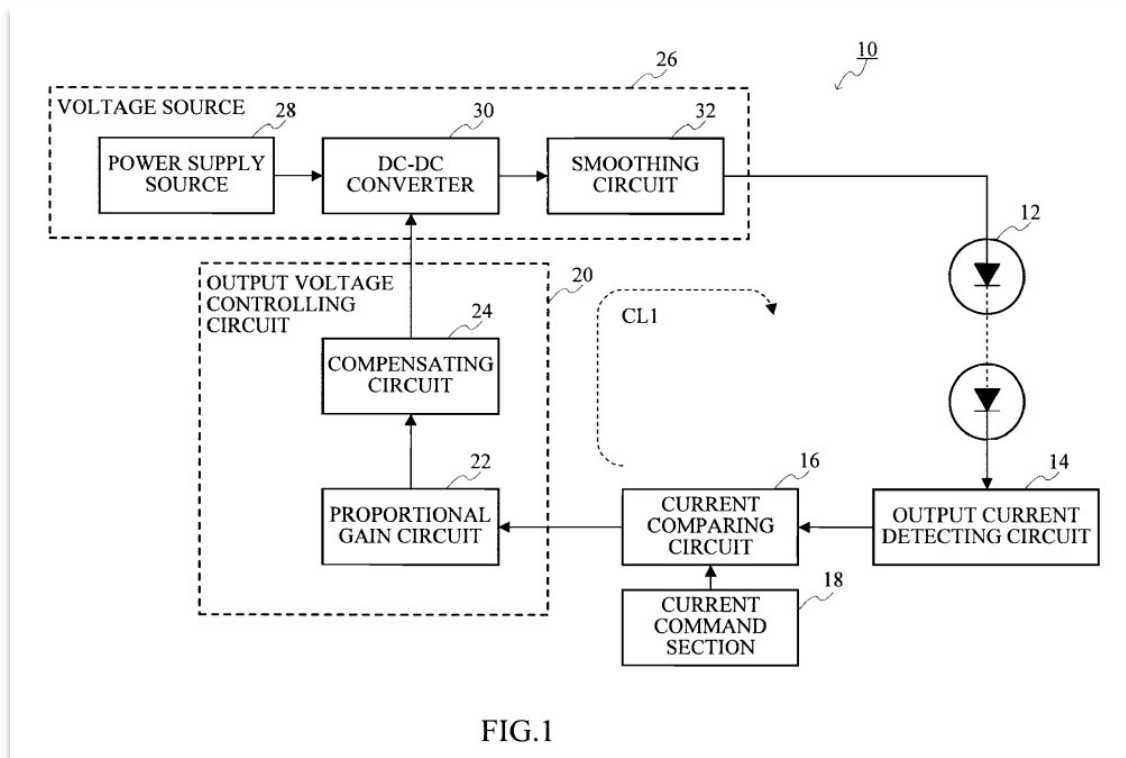


IV. OVERVIEW OF '830 PATENT

A. SUBJECT MATTER

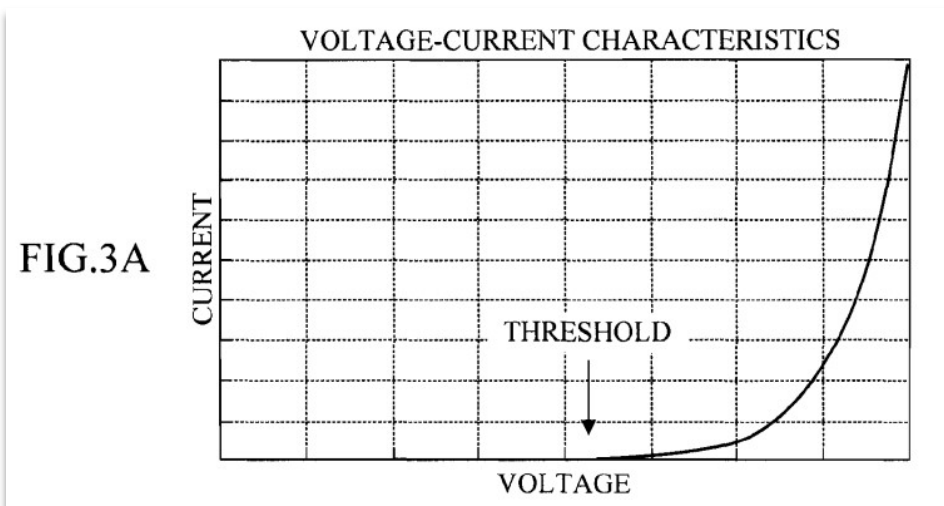
The “object” of the '830 Patent “is to provide a semiconductor light source driving apparatus ... that can achieve constant control performance regardless of whether the drive current is great or small when a drive current value is increased and decreased while light is adjusted.” Ex. 1001, 4:65-5:3. The '830 Patent recognizes in the “Background Art” that “the 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. Also in the “Background Art,” the '830 Patent discloses an example of a “configuration of a *conventional* semiconductor light source driving

apparatus that is generally used to perform a constant-current control of a semiconductor light source.” Ex. 1001, 1:35-37.



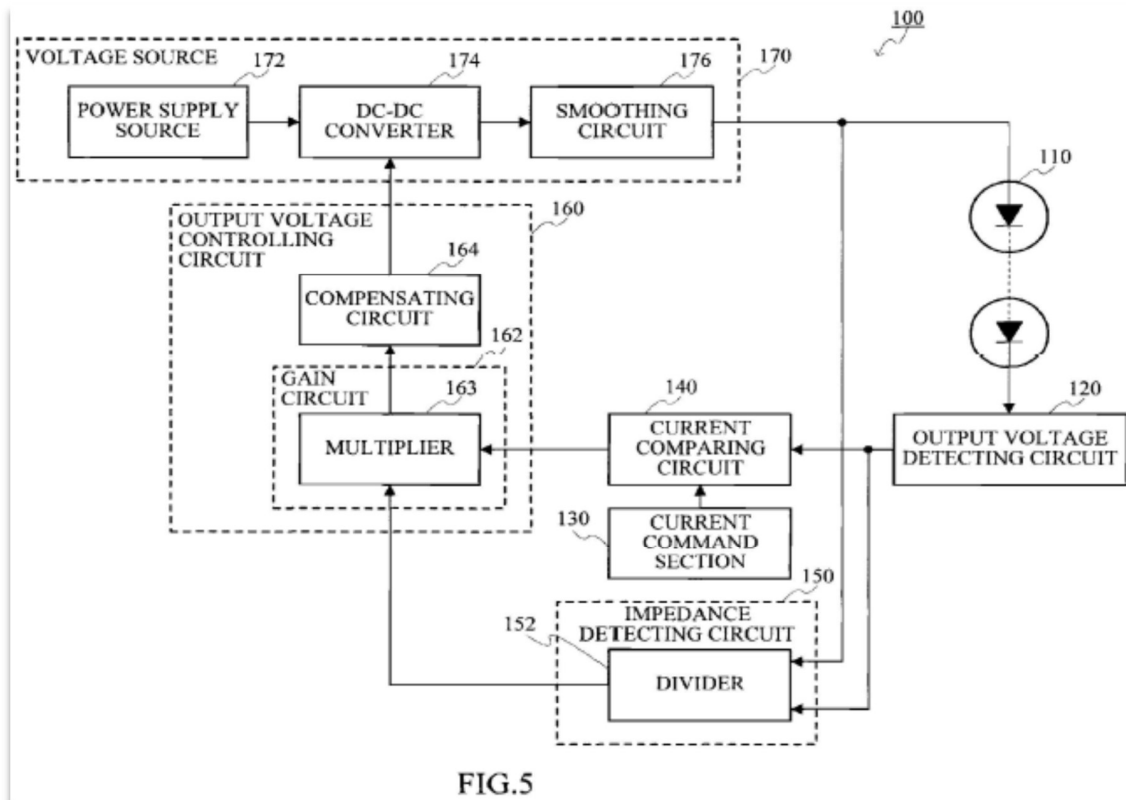
Thus, the '830 Patent acknowledges that this disclosure (including the block diagram of Figure 1) was known in the prior art. Ex. 1002, ¶¶32-35.

In addition to the admitted prior art of Figure 1, the '830 Patent recognizes that it was known in the art that semiconductor light sources have “electrical characteristics that equal the characteristics of a diode,” and that “fluctuations in load” can include “the well-known voltage-current characteristics of a diode [a]s shown in FIG. 3A.” Ex. 1001, 1:30-34, 3:29-32.



Because of these well-known problems, the '830 Patent asserts that “it is difficult with conventional constant-current control to adjust light of a semiconductor light source stably.” *Id.*, 3:51-53; Ex. 1002, ¶36.

As a solution, the '830 Patent proposes an “[i]mpedance detecting circuit [that] detects the impedance of semiconductor light source 110,” and an “output voltage controlling circuit” that compensates for the dynamic impedance of the semiconductor light source by multiplying the “impedance characteristics and the gain characteristics of the semiconductor light source.” *Id.*, 7:32-42, 8:62-9:19. Figure 5 of the '830 Patent is described as “an embodiment of the present invention.” Ex. 1001, 6:1-3.



Highlighted below are the differences between the admitted prior art (Figure 1) and the alleged invention of the '830 Patent set forth in claims 1, 2, and 5 (Figure 5):

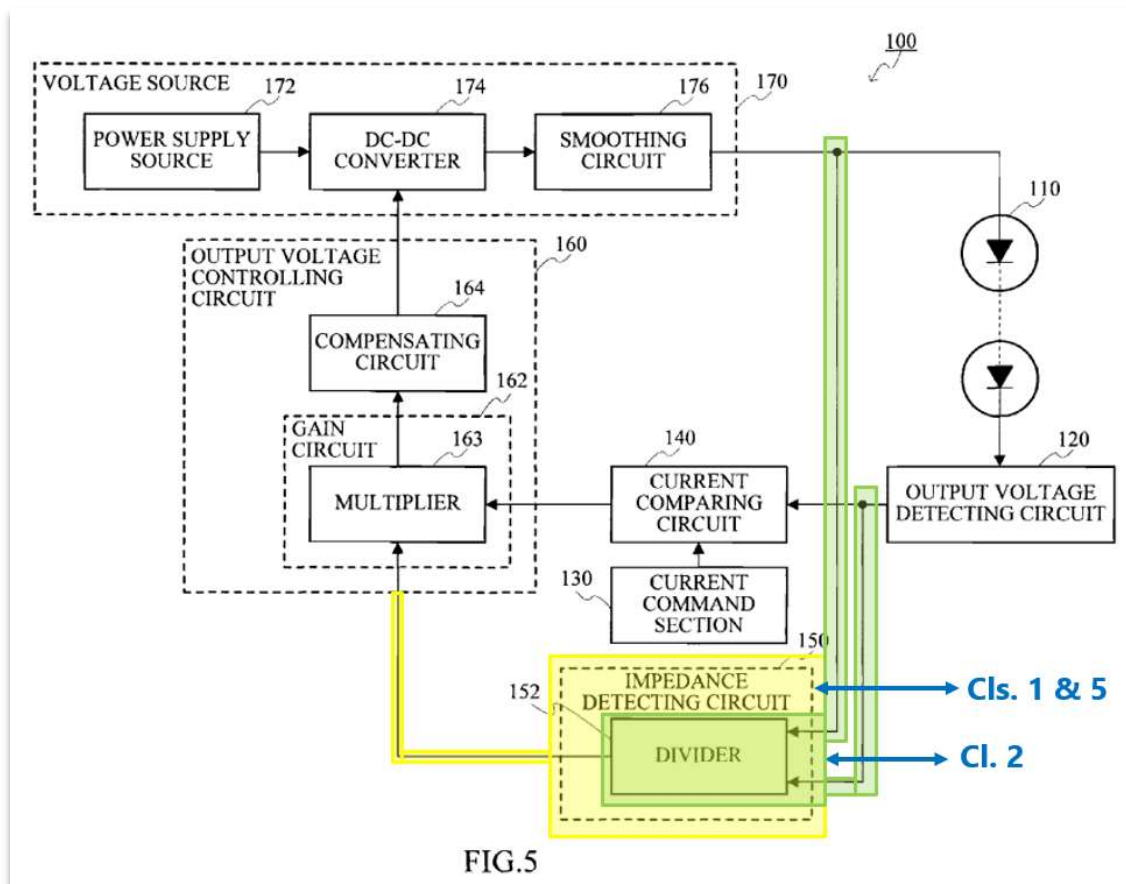


Fig. 5 identifies block 120 as “output *voltage* detecting circuit,” however, this appears to be a typo. Block 120 is disclosed in the specification as “output *current* detecting circuit 120,” and the specification explains that block 120 “detects the drive *current* ... that is applied to semiconductor light source 110.” Block 120 of Figure 5 (showing the alleged invention) is the same as block 14 of Figure 1 (the prior art). Ex. 1002, ¶¶37-44.

In view of Figure 1 and the accompanying disclosure, '830 Patent 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 ... the impedance of the semiconductor light source”

Ex. 1002, ¶45.

B. PROSECUTION HISTORY

The '830 Patent was filed in the United States on July 1, 2009 as Application No. 12/496,472. The USPTO examiner did not issue any office actions during prosecution. Ex. 1003, 13; Ex. 1002, ¶48.

C. COMPARISON OF CLAIM 1 AND CLAIM 5

Claims 1 and 5, the two independent claims of the '830 Patent, 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.” Ex. 1001, Claims 1 and 5. All limitations of claim 5 are already subsumed within claim 1. The following table correlates Claim 5 with Claim 1. Ex. 1002, ¶¶46-47.

Limitation	Text	Cross-Cite to Claim 1
5[preamble]	“A semiconductor light source driving method in a semiconductor light source driving apparatus that comprises:”	1[preamble]
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 [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 the impedance of the semiconductor light source.”	1[h]

V. CLAIM CONSTRUCTION

For purposes of this proceeding, Petitioner applies the ordinary and customary meaning of the claims. Ex. 1002, ¶51. Constructions are proposed “only to the extent necessary.” *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017).

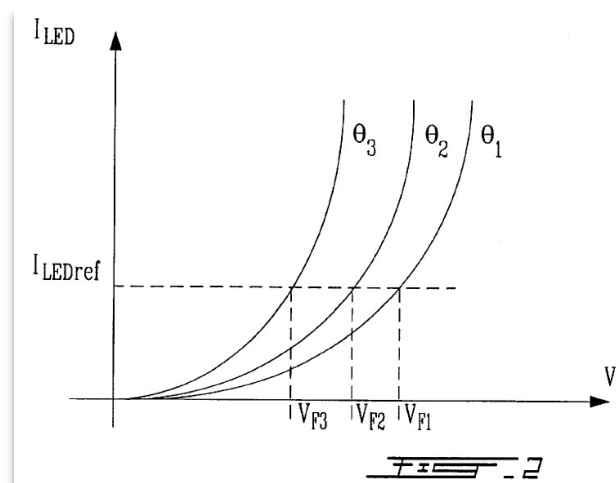
VI. OVERVIEW OF PRIOR ART

The asserted references qualified as printed publications more than one year before the 7/1/2009 filing date in the United States, and are thus prior art under 35 U.S.C. §102(b). *See* M.P.E.P §2133(II) (“The 1-year time bar is measured from the U.S. filing date”). Ex. 1002, ¶¶79-103.

A. GHANEM: EX. 1004

U.S. Patent No. 6,285,139 (Ghanem) issued on September 4, 2001 and thus qualifies as prior art under 35 U.S.C. §§102(b) and 102(e). Ex. 1002, ¶79.

Similar to the '830 Patent, Ghanem is directed to “adjust[ing] the dc voltage and current [supplied to LEDs] to amplitudes that keep the light intensity produced by the light source substantially constant” and recognizes that that, as shown in Figure 2, LEDs have an impedance that changes with temperature (θ) (e.g., dynamic impedance). Ex. 1004, 1:39-2:53, 4:40-44.



Ex. 1004, Fig. 2. Based on Ohm's Law, a POSITA would understand from the disclosure in Ghanem that a measure of impedance at a given temperature (θ) is the inverse of the slope, where the slope is I_{LED}/V_F and the measure of impedance is V_F/I_{LED} . Ex. 1002, ¶¶80, 82-85.

Recognizing the non-linear and temperature-dependent impedance of LEDs, Ghanem discloses a “current sensor circuit 10” that “transform[s] the non-linear relation (LED current/voltage relation with temperature) ... into a linear relation” in order to “perform variable current feedback control [on the] non-linear light-emitting diodes.” Ex. 1004, 4:26-35. As such, the LED current sensor 10 both detects the current from the LEDs and 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.” *Id.*, 2:33-54; Ex. 1002, ¶¶81; 86-87.

B. NISHIMURA: EX. 1005

U.S. Patent No. 7,332,699 (“Nishimura”) was filed in the United States on July 23, 2004 and issued on February 19, 2008. Thus, Nishimura issued in the United States more than one year before the '830 Patent was filed in the United States (July 1, 2009), and Nishimura qualifies as prior art at least under 35 U.S.C. §§102(b) and 102(e). Ex. 1002, ¶96.

Nishimura discloses an LED drive circuit that includes “a plurality of LEDs” and, “for at least some of the LEDs, a current sensor to measure an operating current

supplied to the LED.” Ex. 1005, Claim 18. As in the ’830 Patent, 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; Ex. 1002, ¶¶ 97-100.

To address the dynamic impedance of the LEDs, an LED drive circuit includes “a voltage sensor to measure a voltage of the LED” and “control circuitry, coupled to the LED and sensors, to set the operating current in response to ... readings from [the] current and voltage sensors in order to set desired light intensities of the LEDs,” where these “readings” are “used to estimate a dynamic impedance of the LED.” Ex. 1005, Claims 18, 24. Nishimura teaches that the dynamic impedance of the LEDs can be estimated by dividing the measured voltage of the LEDs by the measured current of the LEDs.

[V]oltage measurements may be taken at operating current values [and] may be used to estimate the dynamic impedance of the LED (e.g., $\Delta V/\Delta I=R$; 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.)

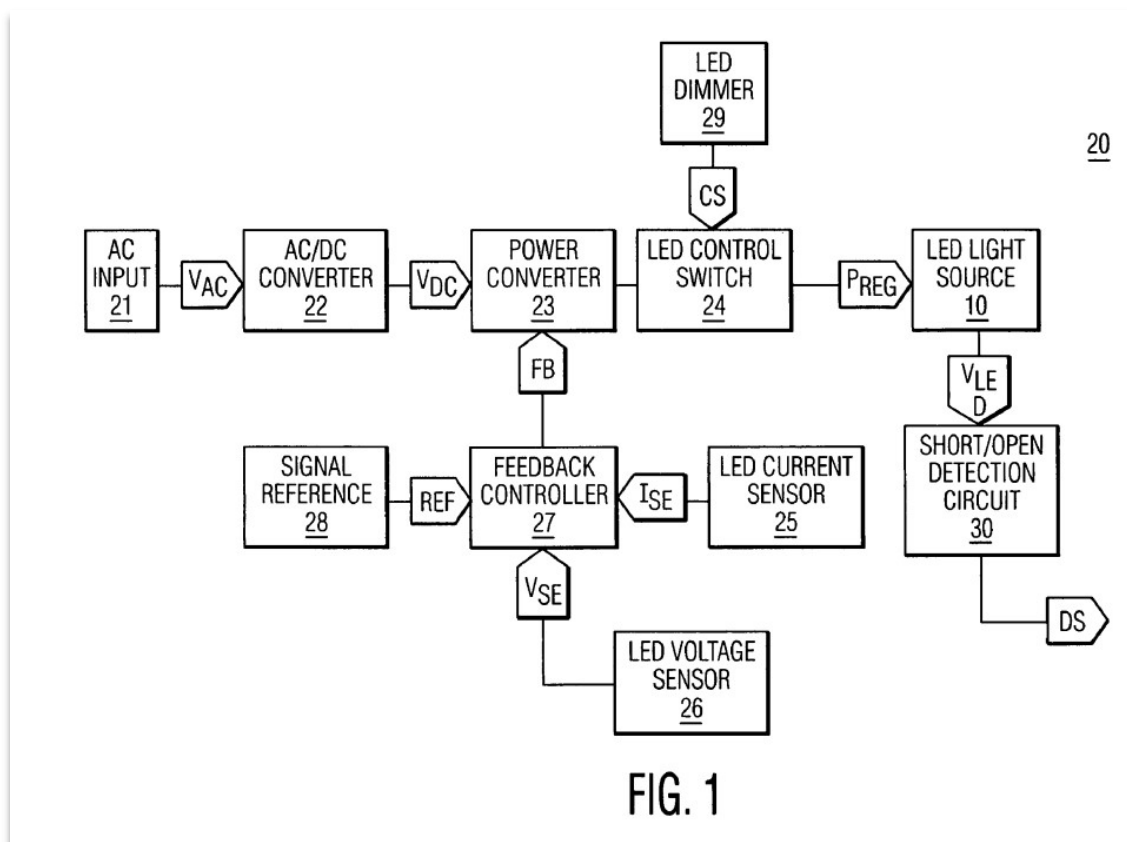
Ex. 1005, 2:64-3:5. Nishimura explains that “preferably all of” the LEDs are “associated with a current sensor ..., a voltage sensor ... and control circuitry” in order to “set an operating current ... of the LED ... in response to acquired readings from the LED’s current and voltage sensors.” *Id.*, 4:48-58. Thus, Nishimura uses

“[t]he LED’s ... dynamic impedance ... to closely predict the intensity of light emitted by an LED as a function of its operating current” and that “[t]his prediction can then be used to set the light intensity of an LED.” *Id.*, 2:22-34, Claims 18 and 24; Ex. 1002, ¶¶101-103.

C. TRIPATHI: EX. 1006

U.S. Patent No. 7,262,559 (Tripathi) was filed as a PCT application on December 11, 2003 and issued in the United States on August 28, 2007. Thus, Tripathi issued in the United States more than one year before the ’830 Patent was filed in the United States (July 1, 2009), and Tripathi qualifies as prior art at least under 35 U.S.C. §§102(b) and 102(e). Ex. 1002, ¶88.

Similar to the ’830 Patent, Tripathi is directed to controlling the current supplied to LEDs by regulating the voltage applied to the output of the LEDs. Ex. 1006, 1:39-62. Tripathi recognizes that the brightness “of LEDs depends on the LED current.” *Id.*, 1:26-27. The feedback controller 27 in the block diagram of Figure 1 relies on measured LED voltage (V_{SE}), measured current (I_{SE}), and a signal reference (REF) to perform voltage feedback control to set the drive current for the LEDs:



Ex. 1006, Figure 1, 3:44-47. Feedback controller 125, shown in the circuit of Figure 2, is represented in the block diagram of Figure 1 as feedback controller 27. The feedback controller “maintains an accurate voltage feedback V_{FB} to thereby avoid large errors in LED current flowing through LED light source 110.” *Id.*, 3:53-56. The “feedback controller (27) compares sensed current and sensed voltage to a reference signal and generates a feedback signal, which is processed by a power factor corrector (124) to adjust the current flow through the transformer supplying current to the LEDs.” *Id.*, Abstract. Ex. 1002, ¶¶89-92.

Tripathi further discloses a “short / open detection circuit 30 [that] provides a detection signal DS as an indication of a short condition or an open condition of LED light source 10 based on the LED voltage V_{LED} applied to LED light source 10.” Ex. 1006, 2:56-59. A short condition is a low impedance condition in which “the LED voltage drop V_{LD} approximates zero (0) volts when the LED light source 110 ... is shorted,” and an open condition is a high impedance condition in which “the LED voltage drop V_{LD} ... approximates the LED voltage V_{LED} of regulated power P_{REG} ... when LED light source 100 is an open circuit.” Ex. 1006, 5:44-52. Figure 1 (above) further illustrates “short / open detection circuit 30” generating the “DS” detection signal based on the “ V_{LED} ” voltage output of “LED light source 10.” *Id.*; Ex. 1002, ¶¶93-95.

VII. GROUND 1: GHANEM

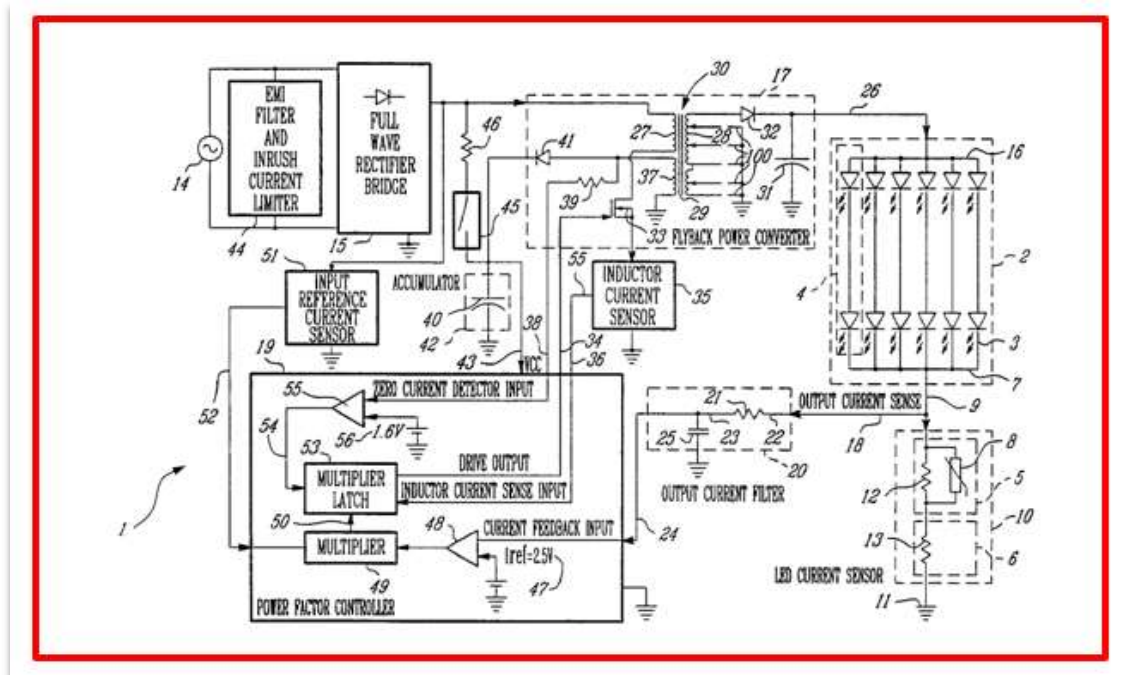
Claims 1 and 5 are rendered obvious by Ghanem (Ex. 1004) in view of the knowledge of a POSITA.

A. CLAIM 1

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

To the extent the preamble is limiting, Ghanem discloses it. “Referring to FIG. 1 ... the LED lamp is generally identified by the reference **1**” (annotated red) which “comprises a set **2** of light-emitting diodes such as **3**.” Ex. 1004, 3:61-67; *see*

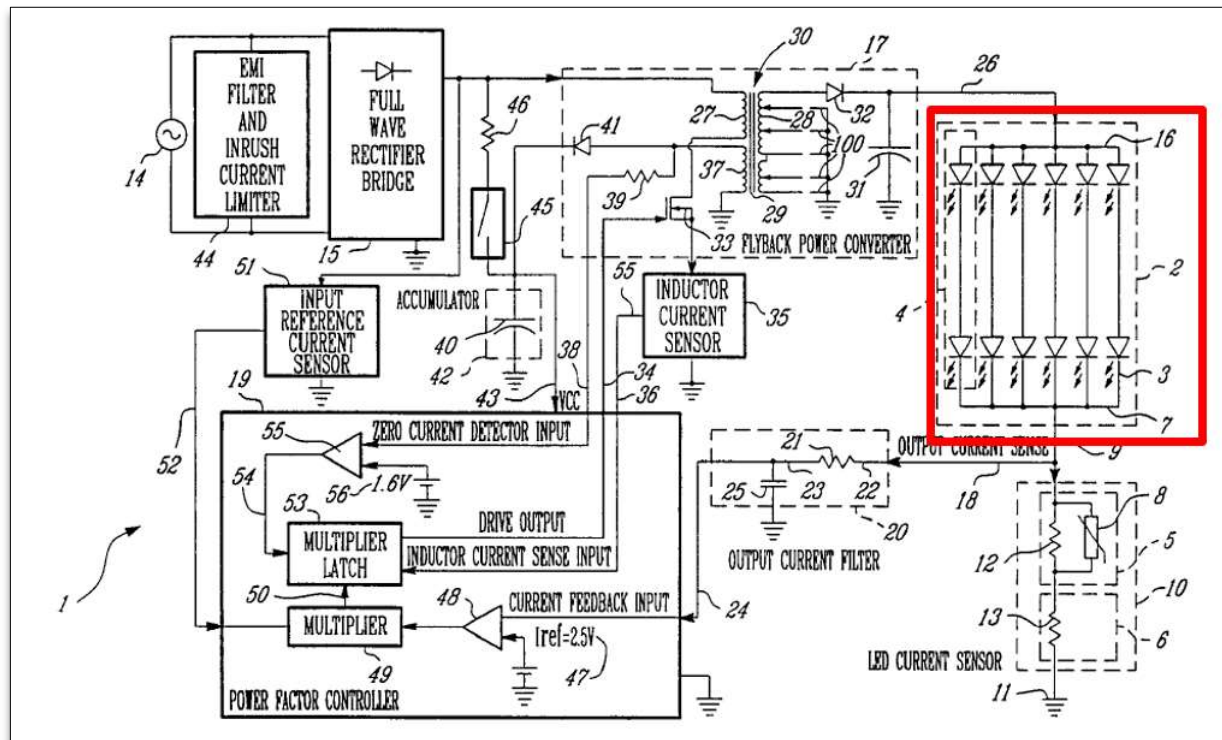
Ex. 1001, 1:24-25 (referring to “light-emitting diodes” as an example of semiconductor light source).



Id., Fig. 1 (annotated). Ghanem further describes a “controllable dc voltage and current source for supplying the non-linear light emitting load with dc voltage and current” with “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* Ex. 1004, 2:33-39; Ex. 1002, ¶¶104-05.

b. 1(a): “a semiconductor light source that is driven by a current;”

Ghanem discloses this limitation. Ghanem discloses that: “Referring to FIG. 1 ... the LED lamp is generally identified by the reference **1**” which “comprises a set **2** of light-emitting diodes such as **3**.” Ex. 1004, 3:61-67.

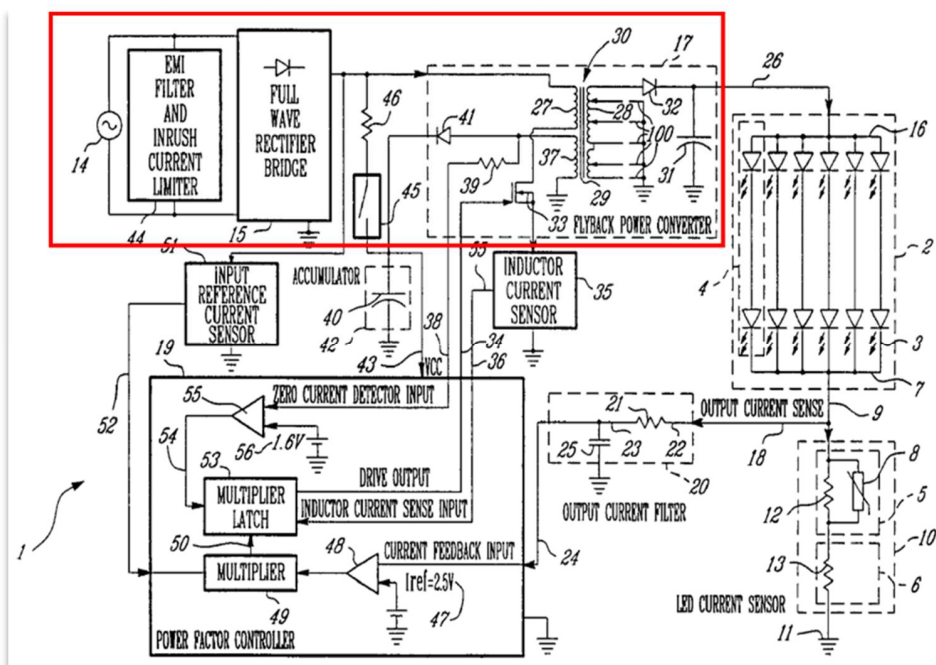


Id., Fig. 1 (annotated). Ghanem describes that the LEDs are driven by a current. For example, Ghanem discloses “a controllable dc voltage and current source for supplying the non-linear light-emitting load with dc voltage and current.” *Id.*, 2:33-39; Ex. 1002, ¶106.

c. **1(b): “a voltage source that drives the semiconductor light source;”**

Ghanem discloses this limitation. 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.” Ex. 1004, 2:33-39. An exemplary voltage source that drives the LEDs (annotated below) includes voltage source 14 that is rectified by a full-wave rectifier bridge 15 and adjusted by power converter

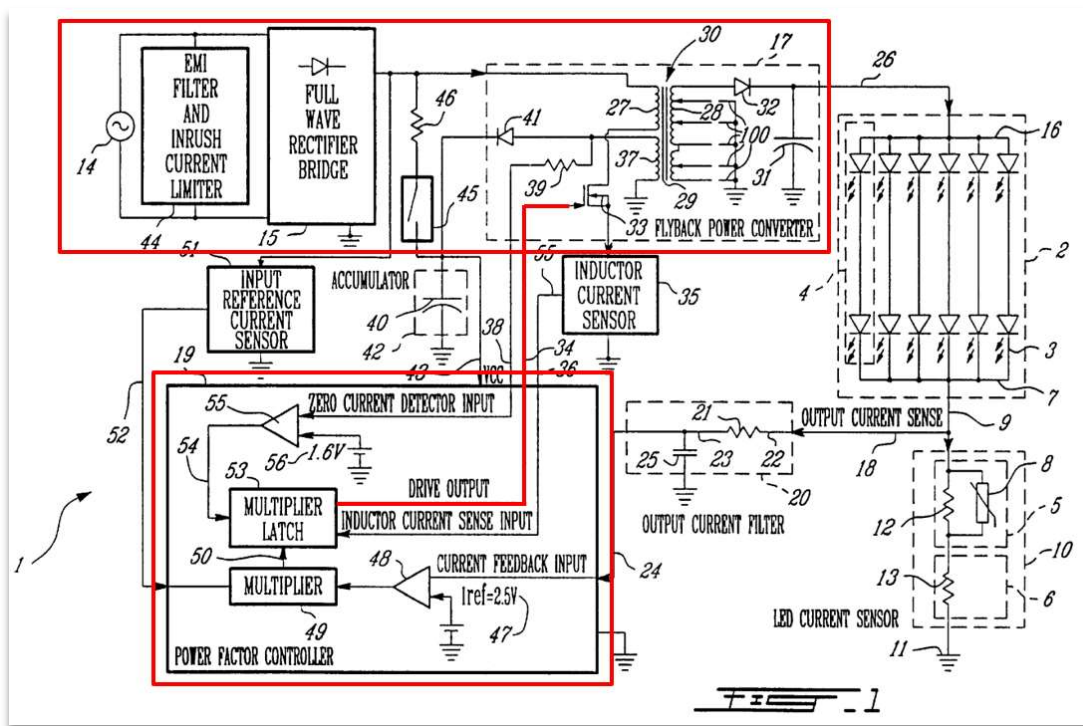
17. Ex. 1004, 4:6-13. “[T]he LED supply dc voltage” is “at the output 26 of the power converter 17[.]” *Id.*, 4:30-35.



Ex. 1004, Fig. 1 (annotated) ; Ex. 1002, ¶107.

- 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 this limitation. This is shown in Figure 1, annotated below to highlight the output voltage controlling section (bottom rectangle) and the voltage source (top rectangle).



Ex. 1004, Fig. 1 (annotated). For example, “power factor controller 19” is an example of the claimed “output voltage controlling section.” Power factor controller 19 controls a drive current value for driving the semiconductor light source by controlling an output voltage of the voltage source.

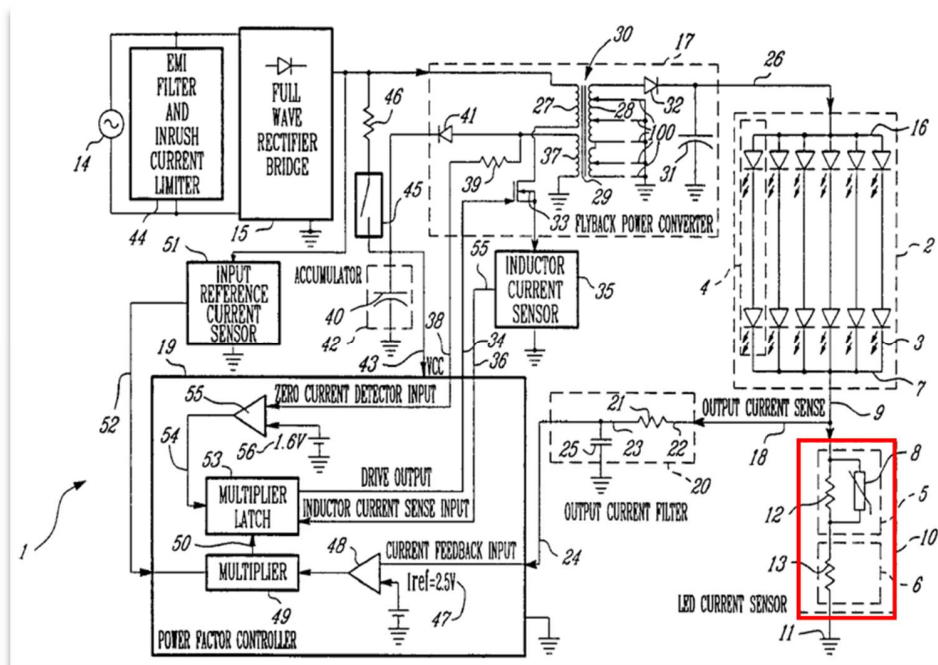
To enable the controller 19 to perform variable current feedback control on the set 2 of non-linear light-emitting diodes 3, the current sensor circuit 10 is connected to the input 24 of the power factor controller 19 through the filter circuit 20.

Id., 4:25-35. Power factor controller 19 (the “output voltage controlling section”) sends a control signal to MOSFET transistor 33 (within the “voltage source” at the end of the “drive output” line from the power factor controller 19) to adjust the drive current value for driving the LEDs by controlling the current through coil 27. *Id.*

“[T]he ... drive output for controlling MOSFET transistor 33” from power factor controller 19 “effectively control[s] output 26 of flyback power converter 17.” 6:58-61, 7:15-17 (“Supply coil 27 ... is controlled by an output 34 of controller 19 through the ... MOSFET power transistor 33.”); Ex. 1002, ¶108.

e. **1(d): “an output current detecting section that detects an output current of the semiconductor light source;”**

Ghanem discloses this limitation. Current sensor 10 (annotated red) is an example of the claimed “output current detection section.”



Ex. 1004, Fig. 1 (annotated). In Figure 1, item 10 is labeled “LED CURRENT SENSOR,” and it detects an output current of the LEDs (labeled “OUTPUT CURRENT SENSE”). As shown in Fig. 1, current sensor **10** comprises a series of resistors (impedances) that measure the output current of the LEDs.

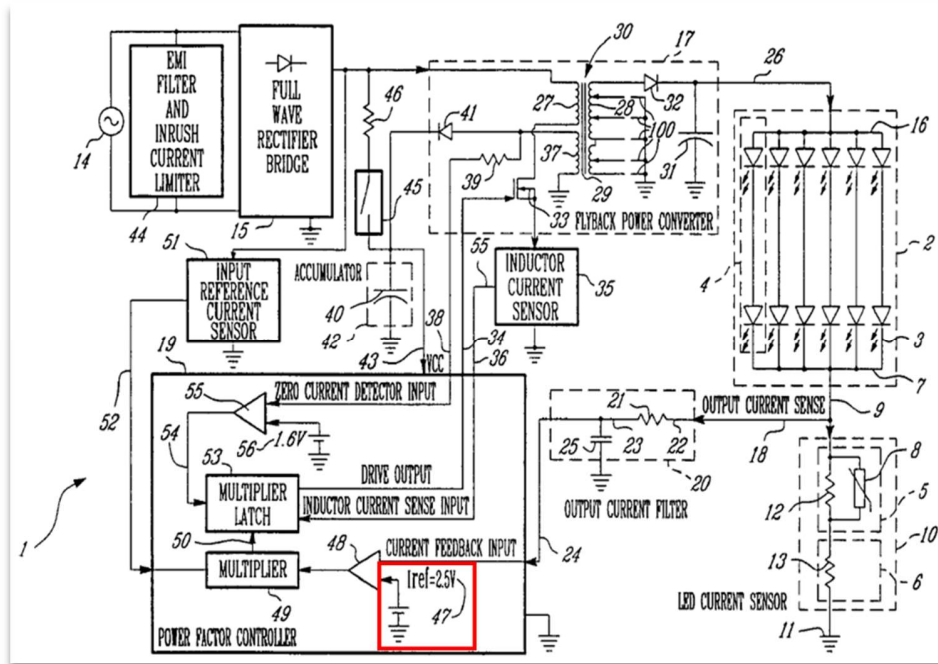
The current flowing in all the subsets 4 of light-emitting diodes 3 flows through impedances 5 and 6 of the current sensor circuit 10 serially interconnected between the terminals 9 and 11 to convert the total current flowing through the set 2 of light-emitting diodes 3 to a corresponding current-representative voltage signal present on an output 18 of current sensor circuit 10.

Ex. 1004, 2:13-22; Ex. 1002, ¶109.²

- 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 this limitation. Ghanem discloses structure specifying “reference current I_{ref} ,” which is an example of the claimed “current command section that specifies a reference value of a drive current.” Ghanem states that I_{ref} specifies a “reference” value for the drive current of the LEDs. Ex. 1004, 5:47-48 (“ I_{ref} is a voltage providing a fixed LED current reference”). “The current-representative voltage feedback signal on input 24 will be compared to I_{ref} (47) in comparator 48.” *Id.*, 6:34-36. I_{ref} is identified as item 47 in Figure 1, annotated below.

² See *infra* n.3

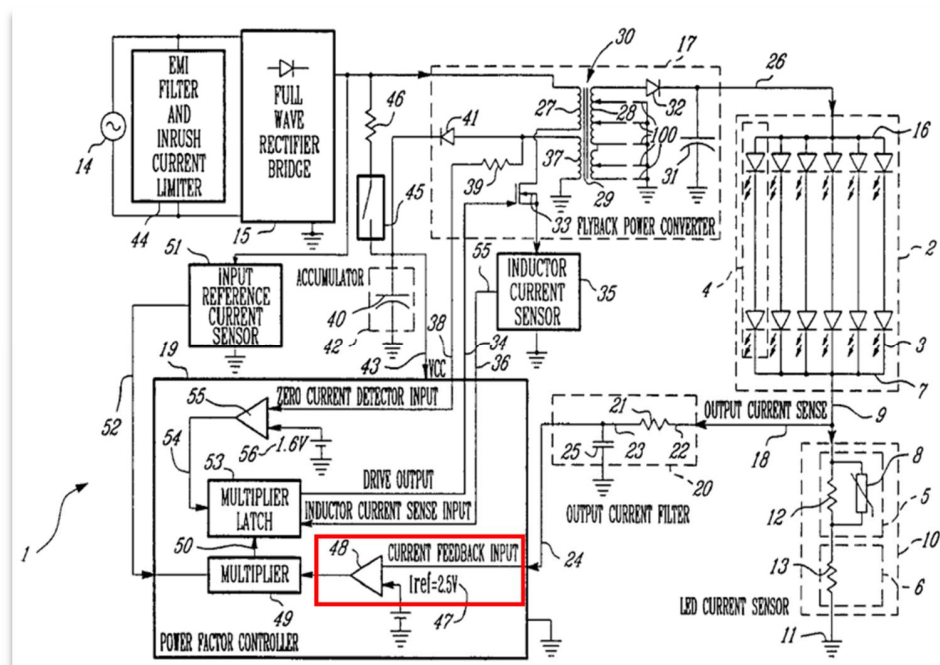


Ex. 1004, Fig. 1 (annotated); Ex. 1002, ¶110.

- 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 this limitation. For example, Ghanem discloses “comparator 48” (annotated red), which is an example of the claimed “current comparing section.”³

³A POSITA would understand that although comparator 48 is comparing voltages, these voltages are representations of currents. This analysis is consistent with the description in the '830 Patent, which also relies on a measured voltage to detect current. Ex. 1001, 7:9-13; Ex. 1002, ¶111.



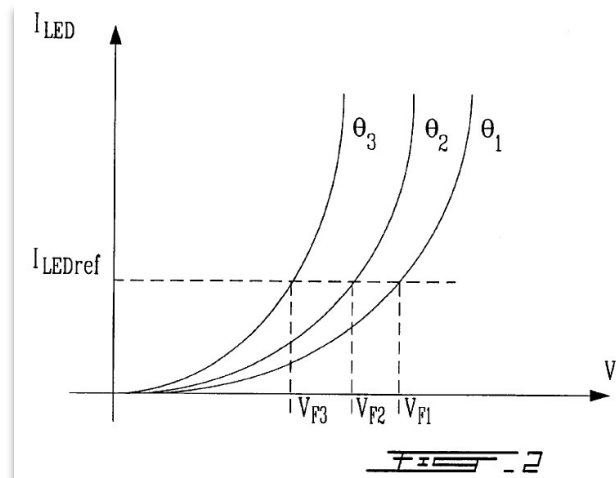
Ex. 1004, Fig. 1 (annotated). The current comparator has two inputs: I_{ref} (item 47) and I_{mes} (item 24, labeled “current feedback input” in Fig. 1). I_{ref} was discussed above for Claim Limitation 1(e). I_{mes} corresponds to the measured “output current detected by the current detecting section.” The “LEDs current measure I_{mes} (24),” is the “output 18 of the current sensor circuit 10” after passing through “output current filter 20.” Ex. 1004, 5:48-52, 6:16-20, Fig. 1.

The current-representative voltage feedback signal on input **24** will be compared to I_{ref} (47) in comparator 48. The output of comparator **48** is a high/low difference-representative signal fed to multiplier **49**.

Ex. 1004, 6:34-39; Ex. 1002, ¶111.

h. **1(g): “an impedance detecting section that detects an impedance of the semiconductor light source,”**

Ghanem renders this limitation obvious. Ghanem recognizes that, as shown in Figure 2, LEDs have an impedance that changes with temperature (θ) (e.g., dynamic impedance). Ex. 1004, 4:40-44.



Id., Fig. 2. Based on Ohm’s Law, a POSITA would understand from the disclosure in Ghanem that a measure of impedance at a given temperature (θ) is the inverse of the slope, where the slope is I_{LED}/V_F and the measure of impedance is V_F/I_{LED} . Ex. 1002, ¶¶112-13.

Recognizing the non-linear and temperature-dependent impedance of LEDs, 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.” Ex. 1004, 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.” Ex. 1004, 2:7-10, 2:33-54; Ex. 1002, ¶114.

The “current sensor circuit 10” includes a “temperature dependent variable equivalent impedance Z_{eq} ” that is based on “thermistor R_{TH} (8).”⁴ Ex. 1004, 4:62-66.

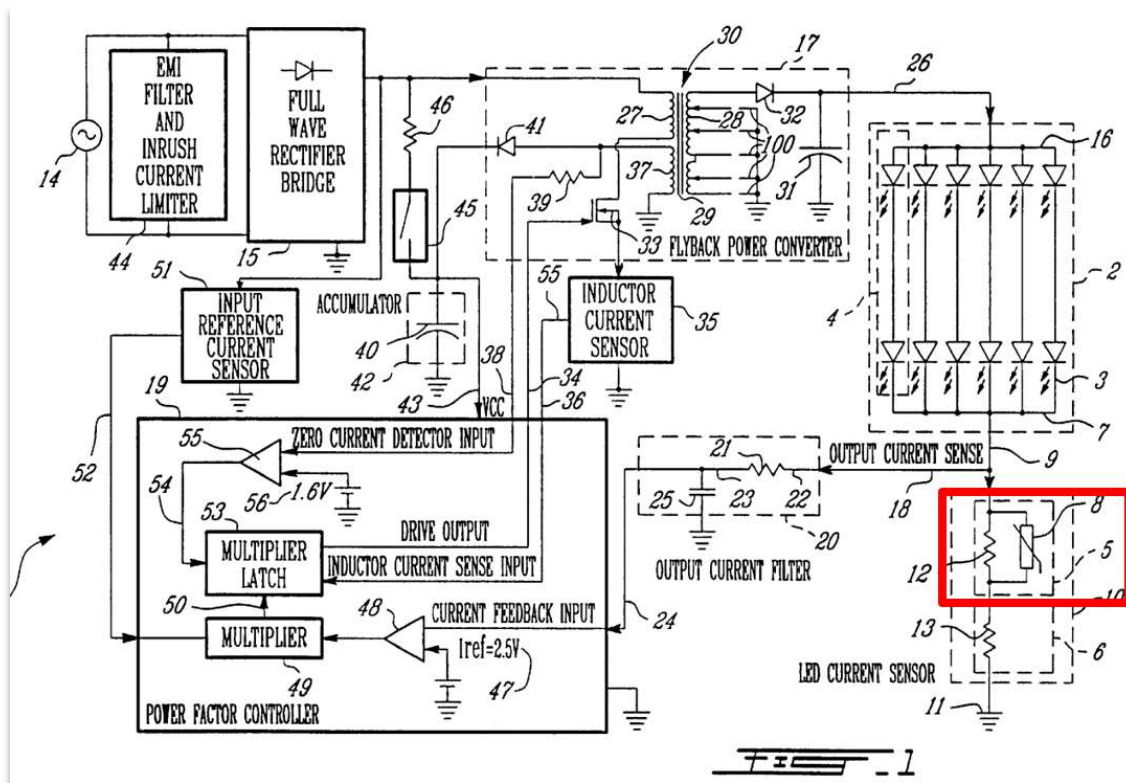
This circuit enables regulation of the dc current supplied to the LEDs as a function of temperature θ .

When the temperature θ is constant, the current sensor circuit impedance value Z_{eq} is constant and the LEDs are driven by a constant current.

[W]hen the temperature [of the LEDs] θ rises ... the value of the thermistor R_{TH} decreases

⁴ A thermistor is a temperature-sensitive resistor, a device whose resistance (impedance) changes with temperature. Ex. 1002, ¶68.

Id., 5:23-27. Using the thermistor, Ghanem discloses the ability to “transform the non-linear relation [between voltage and current] into a linear relation.” Ex. 1004, 6:22-25. Figure 1 of Ghanem is annotated below to highlight the thermistor.



Ex. 1004, Fig. 1 (annotated); Ex. 1002, ¶¶115-18.

A POSITA would understand from the disclosure in Ghanem that there was a need to correct for “the non-linear relation” of the “LED current/voltage relation” (i.e., the dynamic impedance) to “enable ... variable current feedback control on ... light-emitting diodes” in order to “keep the light intensity produced by the light source substantially constant.” Ex. 1004, 2:33-54, 4:26-35. 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.” *Id.* The thermistor is a separate device from the LEDs and therefore is only an indirect analog for the dynamic impedance of the LEDs. A POSITA would recognize 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. Ex. 1002, ¶¶116-20.

A POSITA would understand that, because the thermistor is not dependent on the LEDs, that it’s dynamic impedance could change differently than what was necessary to “transform the non-linear ... LED current/voltage relation ... into a linear relation.” *Id.*, 4:26-35. 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. Ex. 1002, ¶120.

Ghanem itself recognized that it disclosed a “a simple-low cost circuit” and other components (e.g., power factor controller) could be used. *Id.*, 2:26-32, 8:37-48. A POSITA would recognize that there were other design choices available that would perform better than the thermistor of Ghanem to “keep the light intensity

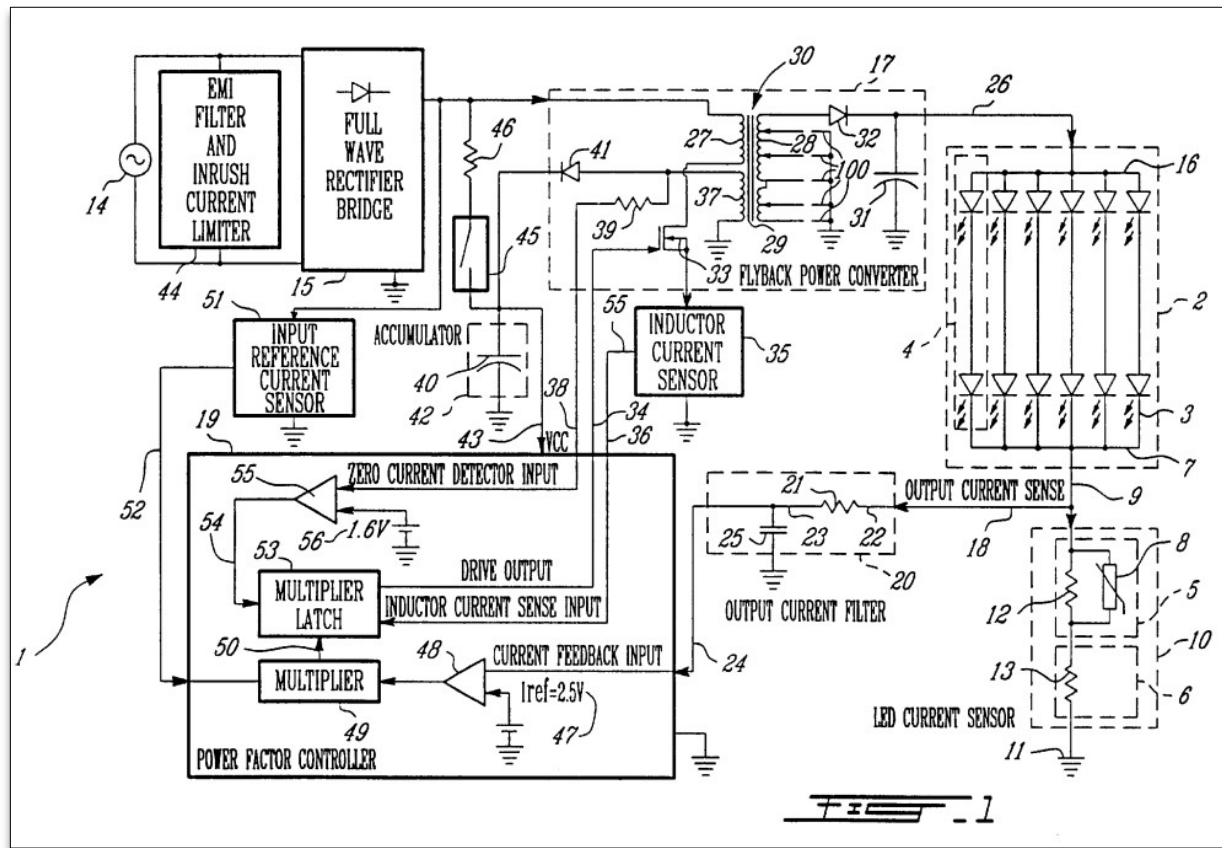
produced” by the LEDs “substantially constant.” *Id.* A solution that would have been obvious to a POSITA would be direct measurement of the impedance of the LEDs, for example, using Ohm’s Law: ($V=I*R$; or $R=V/I$). Ghanem already includes a current sensor and voltage sensors were well-known and could be implemented 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 (they dynamic component) and then correct for it. Ex. 1002, ¶121.

A POSITA would have understood that a direct measurement of impedance could be accomplished 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). Ex. 1004, 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. Ex. 1004, Abstract; Ex. 1002, ¶122.

- 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 renders this limitation obvious. As discussed above, power factor controller 19 is an example of the claimed “output voltage controlling section” (*see* Claim Limitation 1(c)), and comparator 48 is an example of the claimed “output current comparing section” (*see* Claim Limitation 1(f)).



Ex. 1004, Fig. 1; Ex. 1002, ¶¶123-24.

Ghanem discloses that “the output voltage controlling section controls the output voltage of the voltage source based on an output of the current comparing section.” The output of comparator 48 is provided to multiplier 49 of power factor controller 19, and “[m]ultiplier 49 adjusts its gain according to its inputs and produces a corresponding current reference waveform signal 50.” Ex. 1004, 6:36-44. The current reference waveform signal is used by controller 19 to set the “drive output signal 34” to control voltage (and thereby current) supplied to the LEDs. *Id.*, 7:15-23, Fig. 1. Accordingly, Ghanem discloses that the “output voltage controlling

section” (e.g., power factor controller 19) “controls the output voltage of the voltage source based on an output of the current comparing section” (e.g., comparator 48). Ex. 1002, ¶125.

Ghanem further renders obvious an “output voltage controlling section” that “controls the output voltage of the voltage source based on ... an output of the impedance detecting section,” as recited in Claim 1. As discussed for Claim Limitation 1(g), 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 Limitation 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. Ex. 1002, ¶126.

Ghanem already includes a “power factor controller 19” that performs closed-loop voltage control and “adjusts its gain according to its inputs and produces a corresponding current reference waveform signal 50” to “effectively[control[] output 26 of flyback power converter 17” to control the supply voltage to the LEDs. Ex. 1004, Fig. 1; 6:30-61. A POSITA would understand 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. Ex. 1002, ¶127.

A POSITA would recognize that there are many ways to use the detected impedance in closed-loop voltage control. For example, a POSITA would know to simply multiply the impedance value by the current using analog circuitry ($V=Z \times I$) 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 know that the impedance and current values could be stored in a register or memory and compared to themselves to identify changes over time ($\Delta Z/t$, $\Delta I/t$) and these changes could be used 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. Ex. 1002, ¶128.

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. Ex. 1004, 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 Claim Limitation 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. Ex. 1002, ¶¶129-31.

B. CLAIM 5

As discussed above, the limitations of claim 5 are subsumed within claim 1. *See supra* §IV(C); Ex. 1002, ¶47 (table correlating claim 5 with claim 1). Claim 5 is rendered obvious by Ghanem for the same reasons as described above regarding Ground 1 Claim 1. Ex. 1002, ¶¶132-39.

VIII. GROUND 2: GHANEM IN VIEW OF NISHIMURA

Claims 1, 2, and 5 would have been obvious over Ghanem (Ex. 1004) in view of Nishimura (Ex. 1005). Elements and claims not mentioned below are not affected by the combination with Nishimura, and are disclosed or rendered obvious for the same reasons stated above in Ground 1, which is incorporated by reference into Ground 2.

As discussed for Claim Limitation 1(g) and Limitation 1(h) of Ground 1, Ghanem discloses that the output voltage controlling section controls the output voltage of the voltage source based on an output of the current comparing section. And as discussed, Ghanem discloses a “simple low-cost circuit” using a thermistor that detects impedance. In view of Nishimura, it would have been obvious to perform a direct measurement of the impedance. Nishimura discloses directly

measuring the impedance of the semiconductor light source, and using that impedance measurement to control output voltage. The subsections below discuss the why a POSITA would have been motivated with a reasonable expectation of success to combine Nishimura with Ghanem, followed by the disclosure of the combination. Ex. 1002, ¶¶140-41.

A. REASONS TO COMBINE

A POSITA would have been motivated to combine Ghanem (Ex. 1004) and Nishimura (Ex. 1005) for several reasons. Ex. 1002, ¶¶ 142-43.

a. Interrelated teachings between Ghanem and Nishimura

Nishimura is in in the same field of technology as Ghanem and both disclose circuits for driving LEDs. Ex. 1004, 2:1-3 (“regulate the output power, hence the light intensity, of a non-linear light-emitting load.”); Ex. 1005, 1:27-31 (“[A]n operating current of an LED is varied and, at one or more values of the operating current, a corresponding voltage of the LED is measured. The measured voltages are then used as feed-forward variables to set the light intensity of the LED.”) Ex. 1002, ¶144.

Both Ghanem and Nishimura address a similar problem of the dynamic-impedance characteristics of LEDs. For example, Ghanem states:

[T]he voltage/current characteristic of a light emitting diode is sensitive to temperature causing the current through a light-emitting diode to

change very rapidly and non-linearly with the voltage across the light-emitting diode.

... Also, a fixed LED output current presents the following drawbacks: at higher temperature the output LED power decreases, and at lower temperature the output LED power increases.

Ex. 1004, 1:39-43, 1:59-63. Similarly, Nishimura states:

Temperature, aging and other factors can lead to a shift in the intensity of light emitted by a light emitting diode (LED).

A shift in the intensity of light emitted by an LED may be precipitated by factors such as a change in temperature of the LED's junction, or aging effects.

It 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. The LEDs turn-on voltage and/or dynamic impedance may therefore be used to closely predict the intensity of light emitted by an LED as a function of its operating current.

Ex. 1005, 1:7-9, 2:7-9, 2:22-28; Ex. 1002, ¶¶145-46.

b. Applying a known technique to a known device ready for improvement to yield predictable results

A POSITA would have recognized that the impedance detection of Nishimura was a known technique that could be applied to the known device of Ghanem that was ready for improvement (e.g., improved transformation of the “non-linear ... current/voltage relation with temperature” of the LEDs “to “enable ... variable current feedback control” in order to “keep the light intensity produced by the light

source substantially constant”) to yield predictable results (e.g., impedance detection and correction. Ex. 1004, 2:33-54, 4:26-35.; Ex. 1002, ¶147.

Ghanem acknowledges that the thermistor solution is “a simple-low cost circuit” for “[c]urrent feedback control” of a “non-linear load.” Ex. 1004, 2:25-32. A POSITA would have recognized that the thermistor of Ghanem is an indirect analog for the dynamic impedance of the LEDs, and would not perform as accurately as a direct impedance measurement of the LEDs (such as done in Nishimura). Ex. 1002, ¶148.

Nishimura discloses that “[t]he LED’s ... dynamic impedance may ... be used to closely predict the intensity of light emitted by an LED as a function of its operating current” and that “[t]his prediction can then be used to set the light intensity of an LED.” Ex. 1005, 2:22-34. For example, Nishimura discloses using “control circuitry, coupled to the LED and sensors, to set the operating current in response to ... readings from [the] current and voltage sensors in order to set desired light intensities of the LEDs.” Ex. 1005, Claims 18 and 24. 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 “simple-low cost” thermistor of Ghanem. Ex. 1004, Abstract. Further, Ghanem teaches to provide a “substantially constant intensity light source” and a POSITA would have understood that more accurate

compensation for the dynamic impedance of the LEDs would allow for a more constant current thereby providing a more “constant intensity light” from the LEDs. Ex. 1004, Abstract; Ex. 1002, ¶149.

A POSITA would have understood that the direct measurement of impedance disclosed by Nishimura could be accomplished in the circuit of Ghanem by modifying the “power factor controller” of Ghanem to perform closed-loop feedback control using the impedance detection of Nishimura. A POSITA would recognize that there are many ways to use the detected impedance of Nishimura in closed-loop voltage control. For example, a POSITA would know to simply multiply the impedance value by the current using analog circuitry ($V=Z \times I$) 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 know that the impedance and current values could be stored in a register or memory and compared to themselves to identify changes over time ($\Delta Z/t$, $\Delta I/t$) and these changes could be used 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. Ex. 1002, ¶177.

c. Reasonable expectation of success

A POSITA would have had a reasonable expectation of success in combining Ghanem with Nishimura. A POSITA would have understood that the direct measurement of impedance based on measured LED voltage and LED current (disclosed by Nishimura) could be accomplished with a reasonable expectation of success in the circuit of Ghanem. Ex. 1002, ¶150.

As described above, a POSITA would be motivated to combine Nishimura with Ghanem to replace the thermistor of Ghanem (which Ghanem discloses corrects for the dynamic impedance of the LEDs) with the direct impedance measurement of Nishimura to allow for more accurate voltage control to compensate for the gain from the dynamic impedance of the LEDs. Ex. 1004, 6:36-44. A POSITA would be motivated to use the impedance detection of Nishimura in lieu of the thermistor of Ghanem as it would allow a direct impedance measurement that was more accurate and reliable than the thermistor of Ghanem used to correct for the dynamic impedance of the LEDs. This would improve the functionality of Ghanem. Ex. 1002, ¶151.

A POSITA would have understood the combination of Ghanem and Nishimura to be applying a known technique (direct impedance measurement of Nishimura) to a known device ready for improvement (the simple low-cost LED driver circuit with thermistor of Ghanem) to yield predictable results (more accurate

measurement and correction of LED dynamic impedance in voltage control, with a more constant current supplied to the LEDs). Ex. 1002, ¶¶152-57.

B. CLAIM 1

a. 1(g): “an impedance detecting section that detects an impedance of the semiconductor light source,”

Nishimura discloses this limitation. Nishimura discloses an LED drive circuit that includes “a plurality of LEDs” and “for at least some of the LEDs, a current sensor to measure an operating current supplied to the LED.” Ex. 1005, Claim 18. As in Ghanem, LEDs are examples of a semiconductor light source. The LED drive circuit also includes “a voltage sensor to measure a voltage of the LED” and “control circuitry, coupled to the LED and sensors, to set the operating current in response to ... readings from [the] current and voltage sensors in order to set desired light intensities of the LEDs.” *Id.* Those “readings” are “used to estimate a dynamic impedance of the LED.” *Id.*, Claim 24. Nishimura discloses that the dynamic impedance of the LEDs can be estimated by dividing the measured voltage of the LEDs by the measured current of the LEDs.

[V]oltage measurements may be taken at operating current values [and] may be used to estimate the dynamic impedance of the LED (e.g., $\Delta V/\Delta I=R$; 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.)

Ex. 1005, 2:64-3:5; Ex. 1002, ¶¶158-166.

- b. **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.”**

The Ghanem-Nishimura combination renders this limitation obvious. As discussed in Ground 1 for limitation 1[h], Ghanem discloses “wherein the output voltage controlling section controls the output of the voltage source based on an output of the current comparing section[.]” Ex. 1002, ¶167.

Nishimura further discloses and/or renders obvious “the output voltage controlling section controls the output voltage of the voltage source based on ... an output of the impedance detecting section,” as recited by claim 1. As discussed in Ground 2 for Claim Limitation 1(g), Nishimura discloses an “impedance detecting section.” Nishimura further discloses “control circuitry, coupled to the LED and sensors, to set the operating current in response to ... readings from [the] current and voltage sensors in order to set desired light intensities of the LEDs” where these “readings” are “used to estimate a dynamic impedance of the LED.” Ex. 1005, Claims 18 and 24; Ex. 1002, ¶¶167-73.

A POSITA would have understood that Nishimura discloses, or at least renders obvious, “the output voltage controlling section controls the output voltage of the voltage source based on ... an output of the impedance detecting section,” as recited by claim 1. Nishimura discloses that “[a]n LED's current sensor **502**

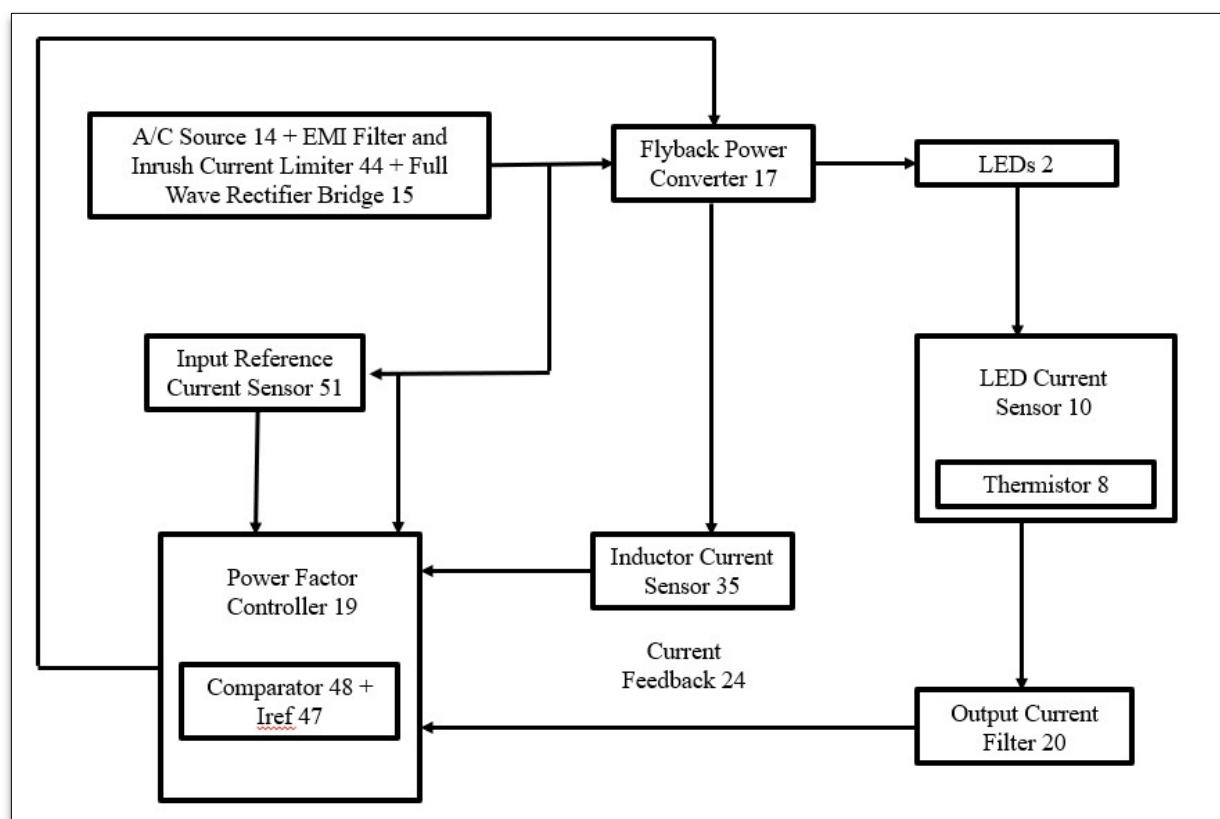
measures the operating current supplied to the LED **402** (e.g., by sensing the voltage across a series resistor R) and an LED's voltage sensor **504** measures a voltage of the LED **402**." Ex. 1005, 4:48-58. Nishimura further discloses that "[t]he LED's control circuitry **506** is coupled to both the LED **402** and its sensors **502**, **504**, to thereby set an operating current (I) of the LED **402** in response to acquired readings from the LED's current and voltage sensors **502**, **504**." *Id.*; Ex. 1002, ¶174.

Nishimura discloses that these "readings" used "to set an operating current (I) of the LED" include an estimation of the dynamic impedance of the LEDs. Ex. 1005, 4:48-58, Claim 24.

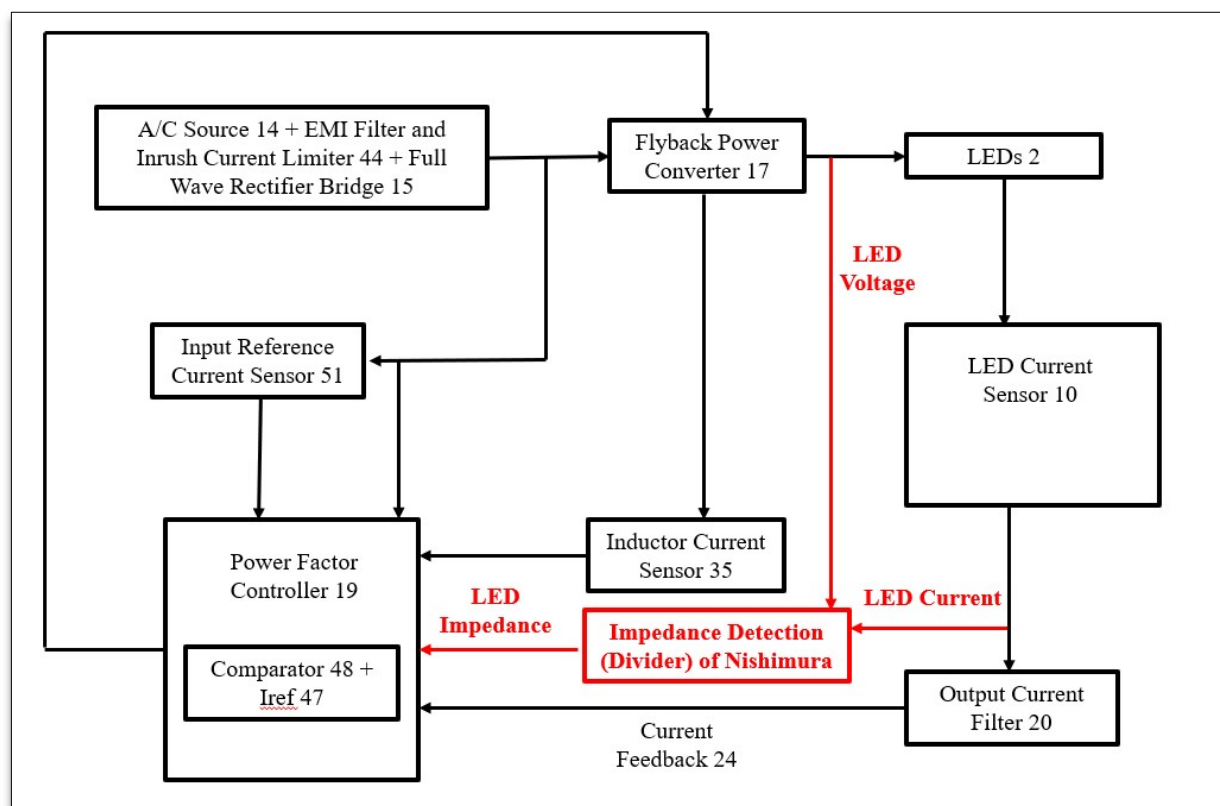
[V]oltage measurements may be taken at operating current values [and] may be used to estimate the dynamic impedance of the LED (e.g., $\Delta V/\Delta I=R$; where ΔV is the difference in two measured voltages of the LED, where ΔI is the difference in the currents corresponding to the measured voltages, and where R is the LED's dynamic impedance.)

Ex. 1005, 2:64-3:5. Nishimura teaches that "[t]he LED's ... dynamic impedance may therefore be used to closely predict the intensity of light emitted by an LED as a function of its operating current" and that "[t]his prediction can then be used to set the light intensity of an LED." Ex. 1005, 2:22-34. For example, Nishimura discloses using "control circuitry, coupled to the LED and sensors, to set the operating current in response to ... readings from [the] current and voltage sensors in order to set desired light intensities of the LEDs." Ex. 1005, Claims 18 and 24; Ex. 1002, ¶175.

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 the impedance of the thermistor.



The figure below show an embodiment of how a POSITA would have modified Ghanem to implement the direct impedance calculation of Nishimura.



Ex. 1002, ¶176.

A POSITA would have understood that the direct measurement of impedance disclosed by Nishimura could be accomplished with a reasonable expectation of success in the circuit of Ghanem by modifying the “power factor controller” of Ghanem to perform closed-loop feedback control using the impedance detection of Nishimura. A POSITA would recognize that there are many ways to use the detected impedance of Nishimura in closed-loop voltage control. For example, a POSITA would know to simply multiply the impedance value by the current using analog circuitry ($V=Z \times I$) 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 know that the impedance and current values could be stored in a register or memory and compared to themselves to identify changes over time ($\Delta Z/t$, $\Delta I/t$) and these changes could be used 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. Ex. 1002, ¶177.

A POSITA would further understand that voltage control of the LED current would only need to be done in the circuit of Ghanem when the output of comparator 48 indicated that the LED current had did not match the reference current and accordingly the voltage needed to be adjusted to correct the current supplied to the LEDs. Ex. 1004, 6:36-38 (“The output of comparator 48 is a high/low difference-representative signal fed to multiplier 49.”); Ex. 1002, ¶¶178-79.

C. CLAIM 2

- a. “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.”

In addition to the reasons discussed in Ground 2 claim 1, the Ghanem-Nishimura combination also renders obvious claim 2.

Nishimura discloses an LED drive circuit that includes “a plurality of LEDs” and “for at least some of the LEDs, a current sensor to measure an operating current supplied to the LED.” Ex. 1005, Claim 18. The circuit also includes “a voltage sensor to measure a voltage of the LED” and “control circuitry, coupled to the LED and sensors, to set the operating current in response to ... readings from [the] current and voltage sensors in order to set desired light intensities of the LEDs” where these “readings” are “used to estimate a dynamic impedance of the LED.” Ex. 1005, Claims 18 and 24. Nishimura discloses that this circuit is applicable to LEDs “backlighting a liquid crystal display (LCD)).” Ex. 1005, 4:42-48; Ex. 1002, ¶¶180-83.

Nishimura discloses that the dynamic impedance of the LEDs can be estimated by dividing the measured voltage of the LEDs by the measured current of the LEDs.

[V]oltage measurements may be taken at operating current values [and] may be used to estimate the dynamic impedance of the LED (e.g., $\Delta V/\Delta I=R$; 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.)

Ex. 1005, 2:64-3:5. A POSITA would understand Nishimura to divide “ ΔV ” (voltage change) by “ ΔI ” (current change) to acquire “ R ” (value of LED's dynamic impedance) using “a divider.” To the extent not expressly disclosed, a POSITA

would have found it obvious for a division operation ($\Delta V/\Delta I=R$) to be implemented using a divider. Ex. 1002, ¶¶184-87.

D. CLAIM 5

As discussed above, the limitations of claim 5 are subsumed within claim 1. *See supra* §IV(C); Ex. 1002, ¶47 (table correlating claim 5 with claim 1). Claim 5 is rendered obvious by the Ghanem-Nishimura combination for the same reasons as described above regarding Ground 2 Claim 1. Ex. 1002, ¶¶188-89.

IX. GROUND 3: TRIPATHI

Claims 1 and 5 are rendered obvious by Tripathi (Ex. 1006) in view of the knowledge of a POSITA. Ex. 1002, ¶190.

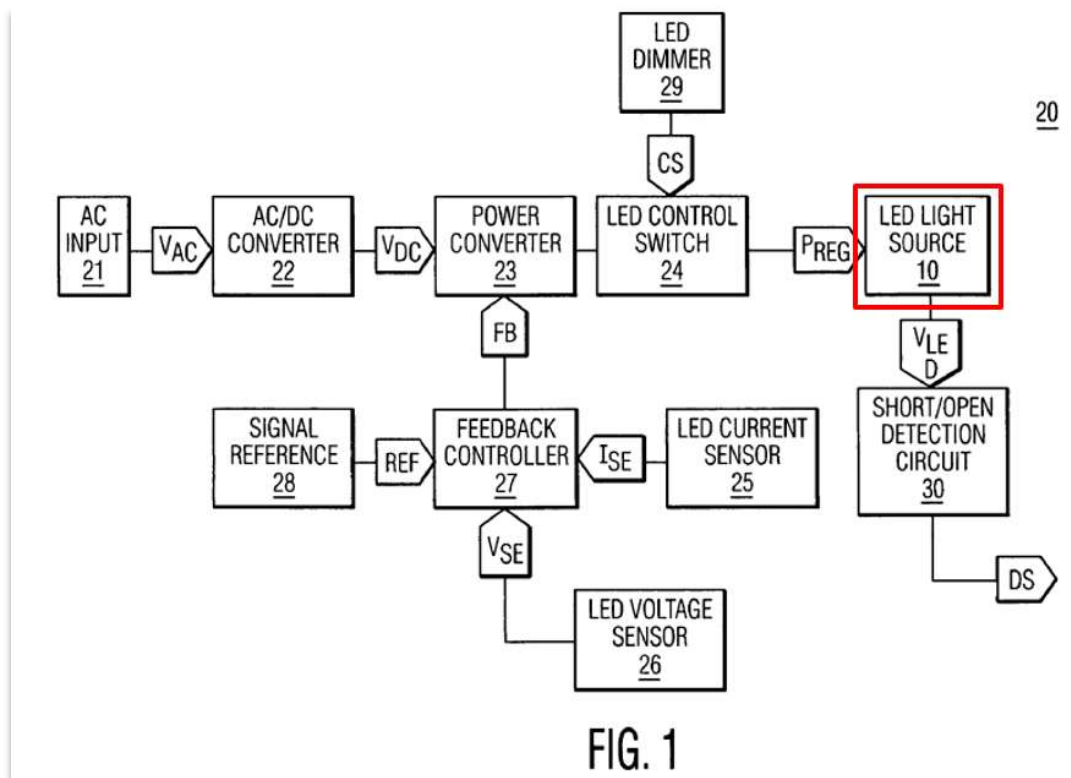
A. CLAIM 1

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

To the extent the preamble is limiting, Tripathi discloses it. For example, Tripathi discloses a power supply for driving LEDs, which is an example of the claimed “semiconductor light source driving apparatus.” Ex. 1006, Abstract; *see* 1:9-10 (“The technical field of this disclosure is ... a power supply for LEDs.”); Figs. 1-2; *see* Ex. 1001, 1:24-25 (referring to “light-emitting diodes” as an example of semiconductor light source); Ex. 1002, ¶191.

b. 1(a): “a semiconductor light source that is driven by a current;”

Tripathi discloses this limitation. The semiconductor light source (annotated red) is identified as item 10 in Figure 1 and as item 110 in Figure 2. Ex. 1006, 2:18-20, 2:67-3:5.



Ex. 1006, Fig. 1 (annotated).



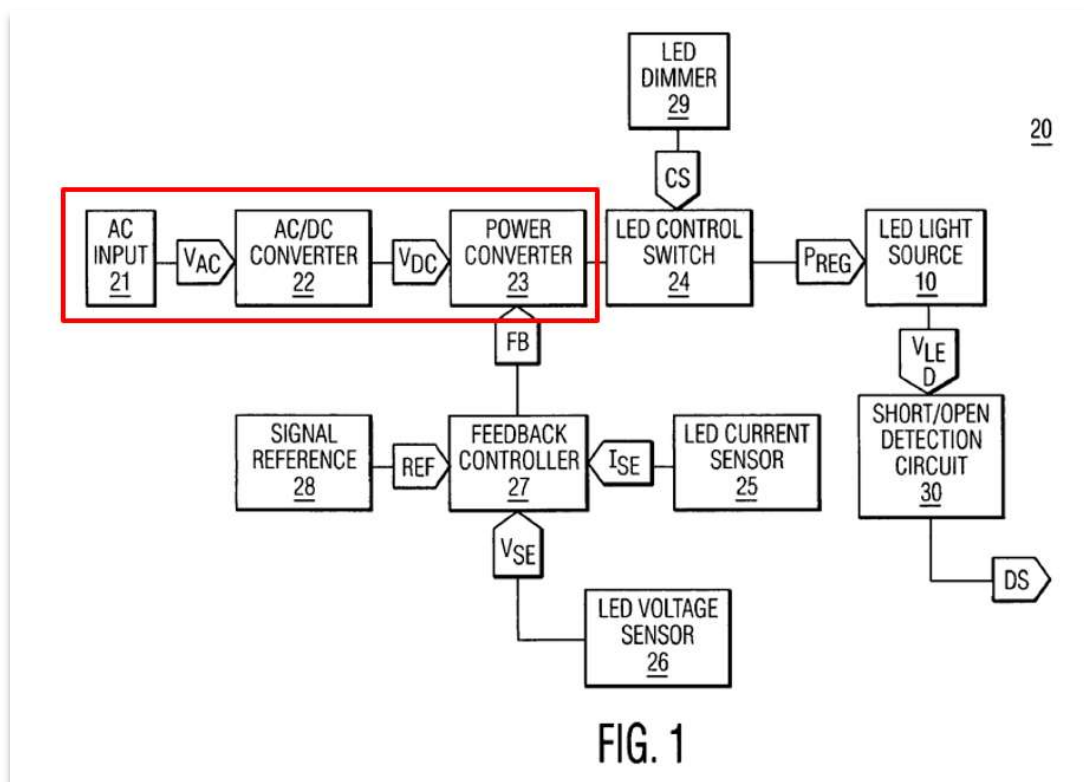
Ex. 1006, Fig. 2 (annotated). The semiconductor light source (LEDs) are driven by a current.

The power supply (20) for LEDs provides power to a LED light source (10) having a variable number of LEDs wired in series and/or in parallel. The power supply (20) uses current and voltage feedback to adjust power to the LEDs and provides protection to the LED light source (10).

Ex. 1006, Abstract; Ex. 1002, ¶192.

c. 1(b): “a voltage source that drives the semiconductor light source;”

Tripathi discloses this limitation. Tripathi discloses a voltage source (annotated red) that drives the LEDs.



Ex. 1006, Fig. 1 (annotated). Tripathi describes the voltage source in connection with the block diagram of Figure 1.

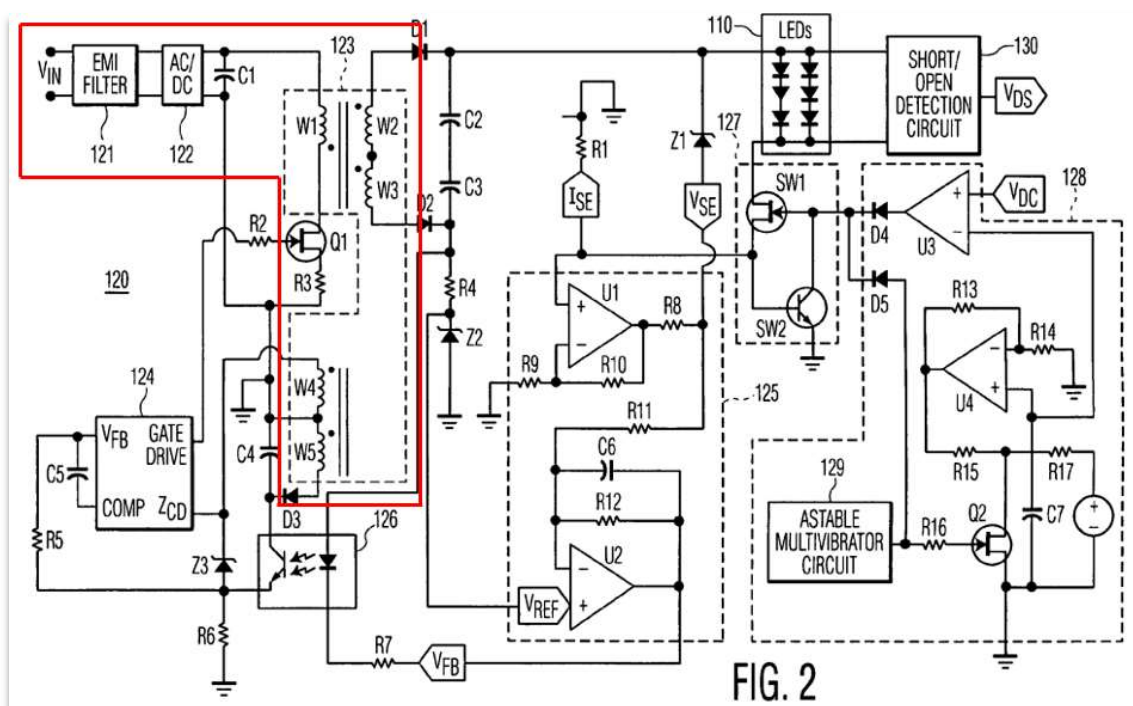
FIG. 1 illustrates a block diagram of a power supply 20 for powering an LED light source 10 including a variable number of LEDs wired in series and/or in parallel. A single-phase ac input 21 of power supply 20 provides a voltage V_{AC} to an AC/DC converter 22 of power supply 20 whereby AC/DC converter 22 converts voltage V_{AC} into a voltage V_{DC} . AC/DC converter 22 provides voltage V_{DC} to a power converter 23 of power supply 20 whereby power converter 23 generates a regulated power P_{REG} including a LED current and a LED voltage V_{LED} .

Ex. 1006, 2:18-27. Tripathi also describes the voltage source for driving the LEDs, in connection with the circuit-level diagram of Figure 2.

Voltage is supplied to power supply 120 at V_{IN} to EMI filter 121. The voltage can be an ac input and is typically 50/60 Hertz at 120/230

VRMS. EMI filter 121 blocks electromagnetic interference on the input. AC/DC 122 can be a bridge rectifier and converts the ac output of EMI filter 120 to dc. Transformer 123 includes a primary winding W1, W4 and W5, and a plurality of secondary windings W2 and W3. The windings W1/W2 constitute the flyback transformer to power the LED light source 110.

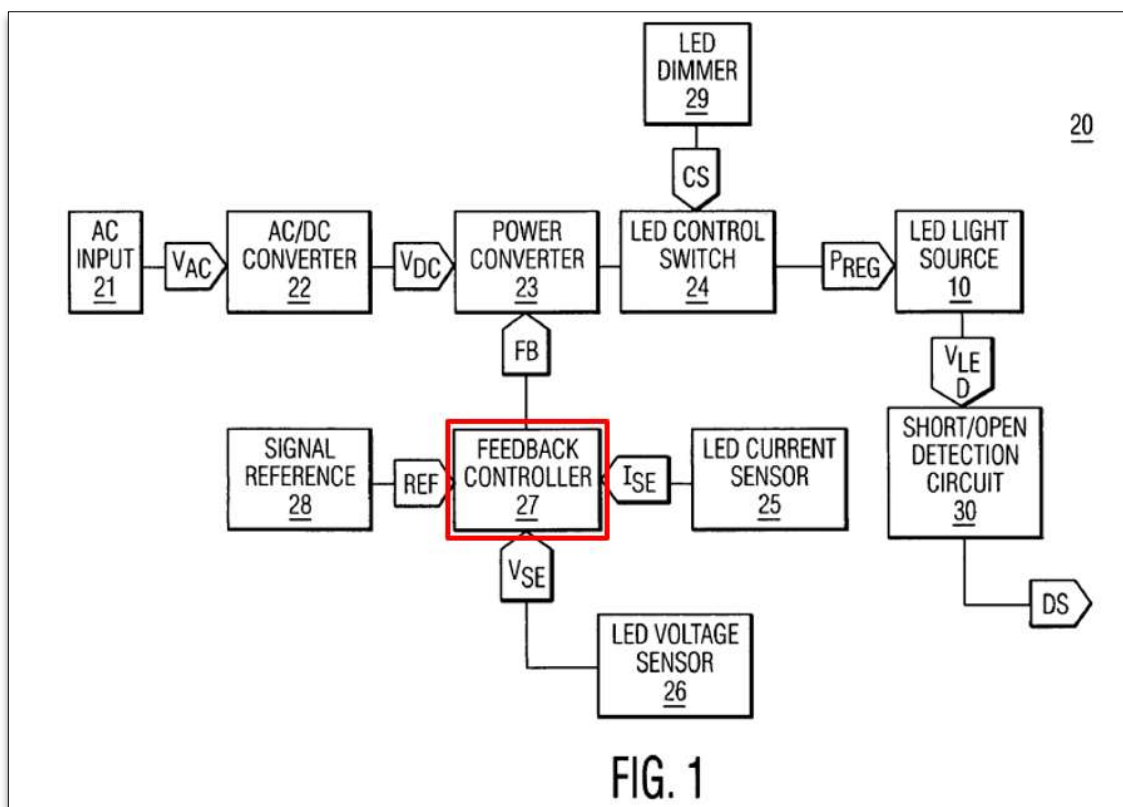
Ex. 1006, 3:12-23; *see* 3:24-26 (“The flyback transformer transfers power to LED light source **110** where the LED current and the LED voltage are controlled by feedback control.”). The voltage source is highlighted in Figure 2 below:



Ex. 1006, Fig. 2 (annotated); Ex. 1002, ¶193.

- 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;”

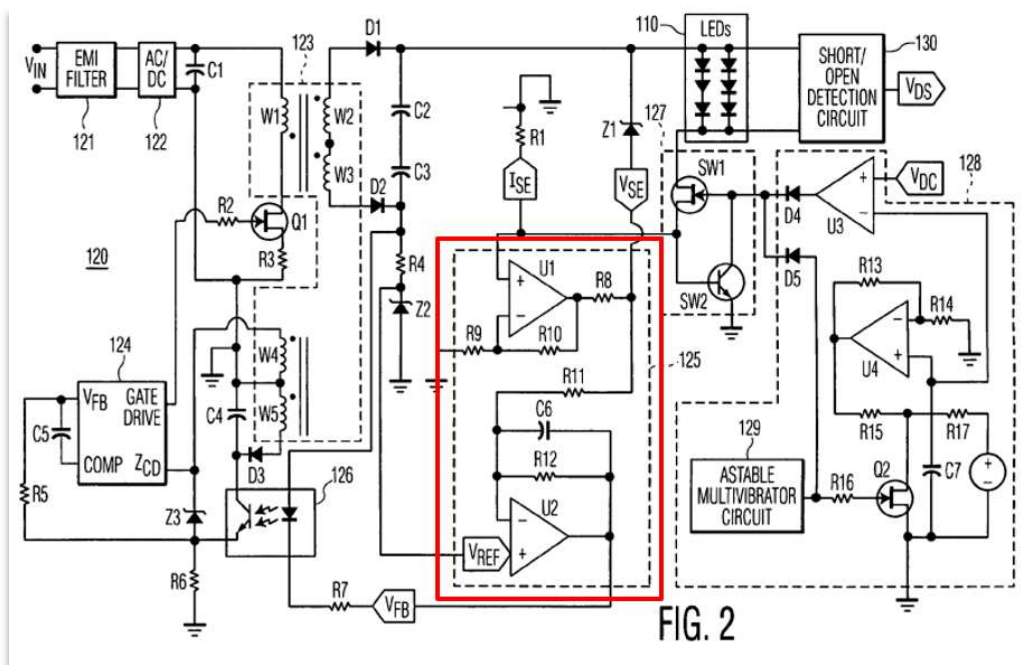
Tripathi discloses this limitation. For example, Tripathi discloses a “feedback controller,” which is an example of the claimed “output voltage controlling section.” The feedback controller (annotated red) is item 27 in Figure 1 and item 125 in Figure 2.



Ex. 1006, Fig. 1 (annotated). The feedback controller “provides a feedback signal FB to power converter 23,” and based on the feedback signal FB, the power

converter “provides regulated power P_{REG} to LED light source 10.” Ex. 1006, 2:28-42; Ex. 1002, ¶194.

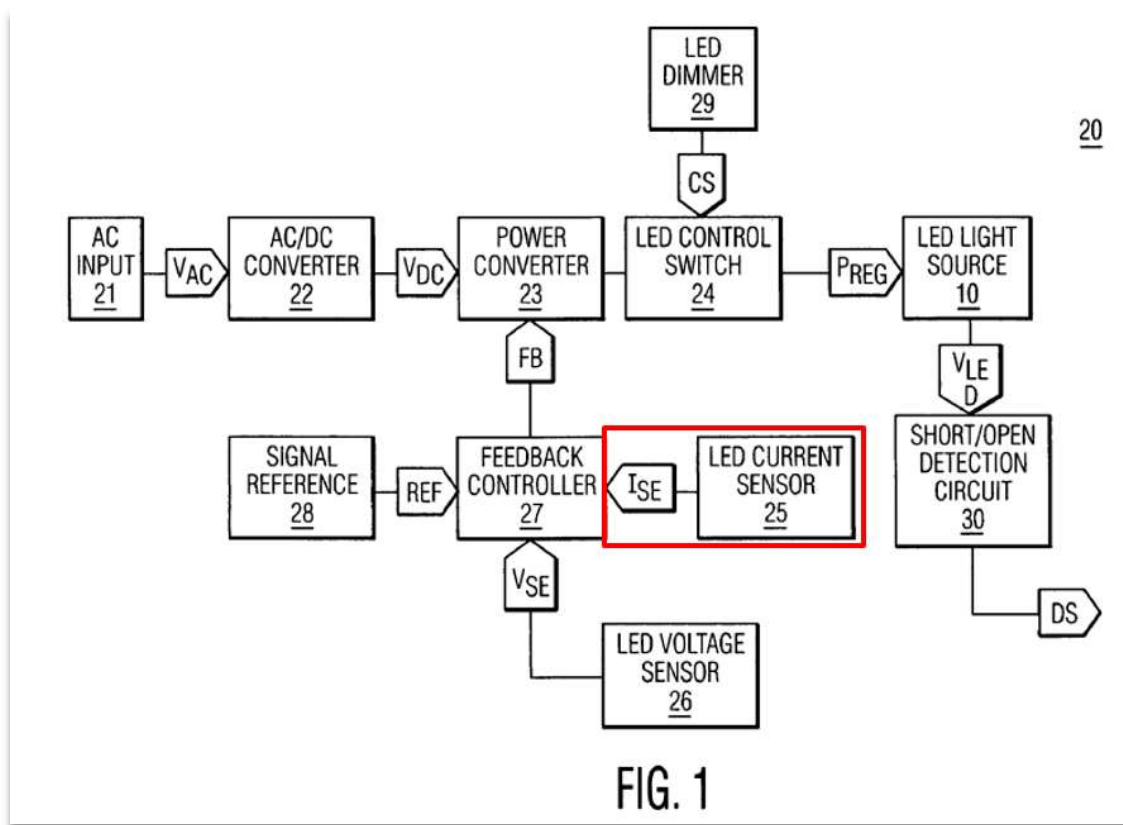
Tripathi also describes the feedback controller in connection with Figure 2. “Feedback controller 125 maintains an accurate voltage feedback V_{FB} to thereby avoid large errors in LED current flowing through LED light source 110” and provides “voltage feedback V_{FB} .” The voltage feedback “drives “an optocoupler 126,” which “supplies a gate drive signal to MOSFET Q1” to “adjust[] the current flow through winding W1 of transformer 123 to match the LED light source.” Ex. 1006, 3:40-4:5.



Ex. 1006, Fig. 2 (annotated); Ex. 1002, ¶¶195-96.

e. **1(d): “an output current detecting section that detects an output current of the semiconductor light source;”**

Tripathi discloses this limitation. For example, Tripathi discloses that a current sensor (annotated red) detects the current flowing through the LEDs. “A LED current sensor 25 of power supply 20 provides a sensed current I_{SE} indicative of a magnitude of the LED current flowing through the LED light source 10.” Ex. 1006, 2:31-33.

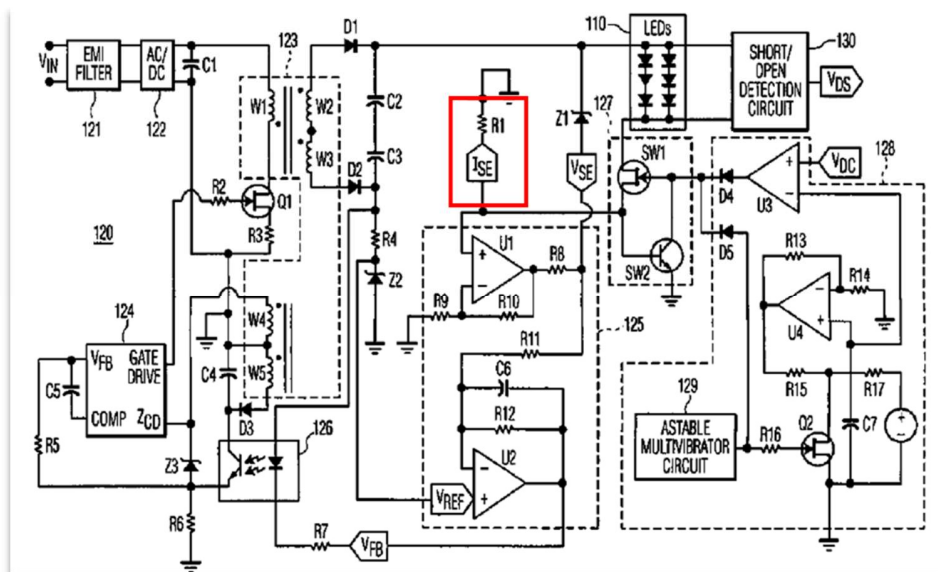


Ex. 1006, Fig. 1 (annotated); Ex. 1002, ¶197.

Tripathi also describes the components of the LED current sensor 25 in connection with the circuit-level diagram of Figure 2.

A sensed LED current I_{SE} flow through resistor R1, which is in series with the LED light source 110 via LED control switch 127. A voltage representative of sensed LED current I_{SE} is applied to a non-inverting input of a comparator U1.

Ex. 1006, 3:40-44. I_{SE} is an “output current of the semiconductor light source” LEDs 110 because it is “in series with the LED light source 110” and is measured after the current passes through LEDs 110 “via LED control switch 127.” Ex. 1006, 3:40-44; Fig. 2 (showing the current I_{SE} coming off LED control switch 127 after passing through LEDs 110).

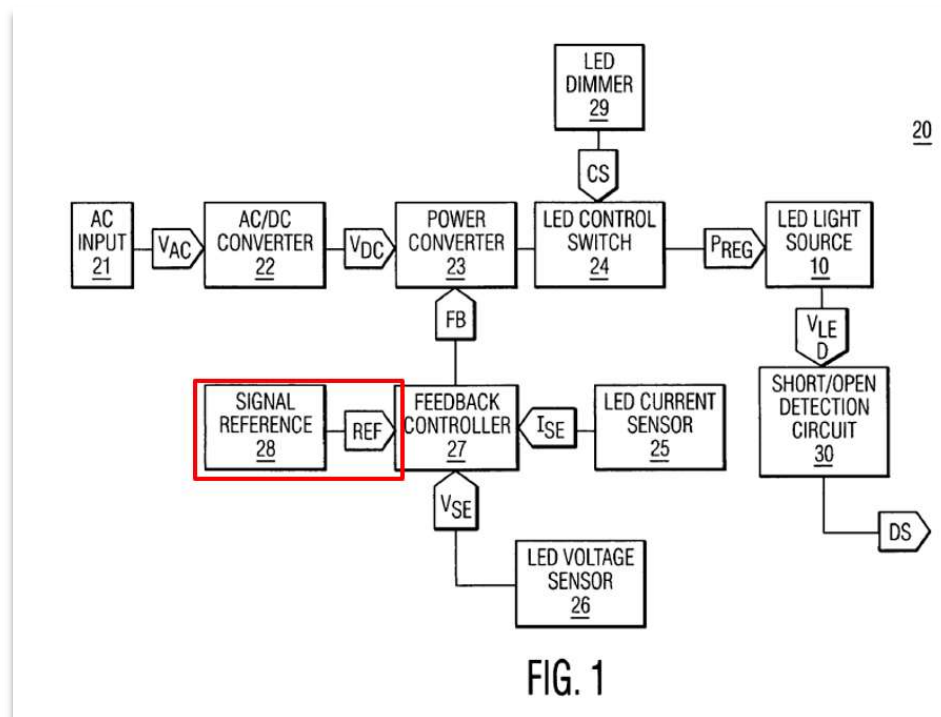


Ex. 1006, Fig. 2 (annotated); Ex. 1002, ¶197.

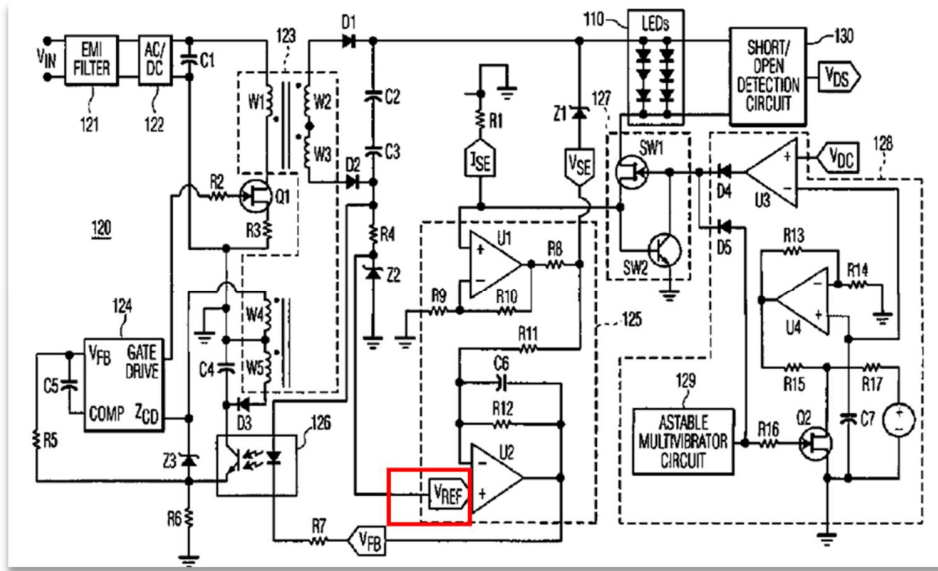
- f. 1(e): “a current command section that specifies a reference value of a drive current which is applied to the semiconductor light source;”

Tripathi discloses this limitation. The “reference current signal” (“REF” of Figure 1 and “ V_{REF} ” of Figure 2) specifies a “reference current” and is an example

of the claimed “current command section that specifies a reference value of a drive current which is applied to the semiconductor light source.” Tripathi discloses that “a reference current signal is generated between a series resistor R4 and a Zener Z2” that is shown in Figure 2 as “ V_{REF} ” input into comparator U2. Ex. 1006, 3:26-29, Fig. 2 (“ V_{REF} ” as the “reference current signal” that is “generated between a series resistor R4 and a Zener Z2”). The “ V_{REF} ” (“reference current signal”) is measured after resistor R4 and specifies a reference value of the drive current applied to LEDs 110. The “ V_{REF} ” “reference current signal” of Figure 2 is shown in Figure 1 as “REF” from “signal reference 28.” Ex. 1006, Figure 1. The “current command” portion of Tripathi is annotated in Figures 1 and 2 below:



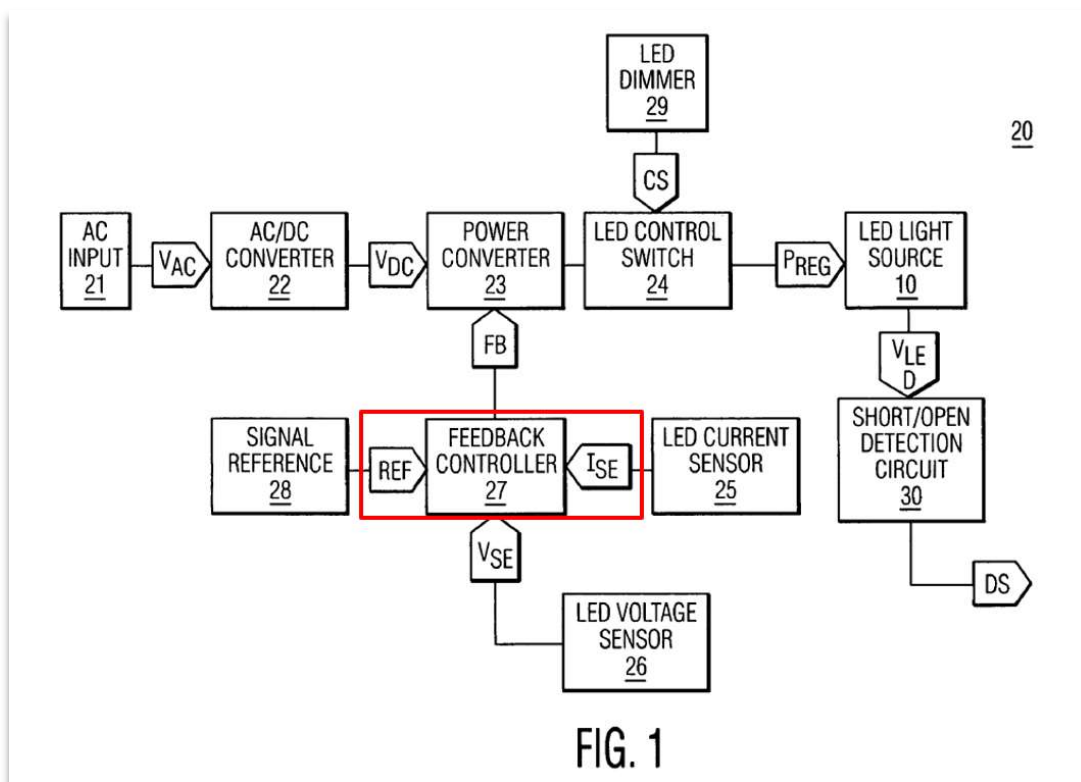
Ex. 1006, Fig. 1 (annotated).



Ex. 1006, Fig. 2 (annotated); Ex. 1002, ¶198.

- 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 this limitation. The feedback controller (annotated red) is an example of a current comparing section.



Ex. 1006, Fig. 1 (annotated). As can be seen, two of the inputs include “REF” (reference value specified by current command section) and “I_{SE}” (output current), and the feedback controller compares them:

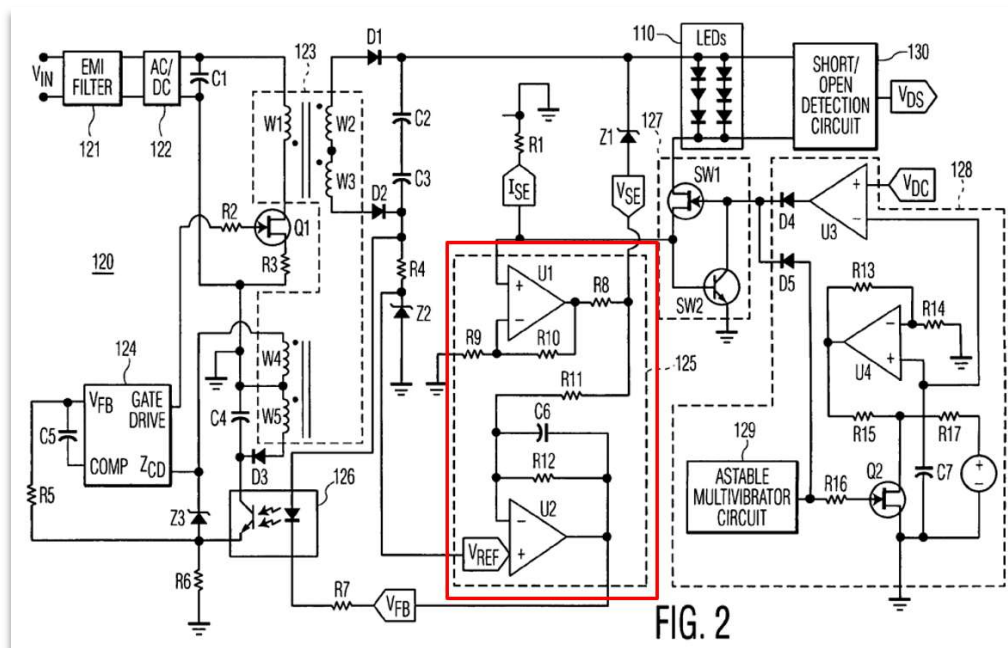
A feedback controller (27) compares sensed current [I_{SE}] and sensed voltage to a reference signal [REF] and generates a feedback signal, which is processed by a power factor corrector (124) to adjust the current flow through the transformer supplying current to the LEDs.

Ex. 1006, Abstract; Fig. 1 (below). Tripathi provides a similar explanation regarding the comparison, regarding Figure 2:

Sensed LED current I_{SE} and sensed LED voltage V_{SE} as well as a voltage reference V_{REF} are fed to feedback controller 125, whereby a voltage feedback V_{FB} from feedback controller 125 drives an optocoupler 126 via resistor R7. In generating voltage feedback V_{FB},

feedback controller 125 employs a pair of comparators U1 and U2, resistors R8-R12, and a capacitor C6 as illustrated in FIG. 2.

Ex. 1006, 3:40-52. The voltage feedback V_{FB} from feedback controller 125 drives an optocoupler 126, which “supplies a gate drive signal to MOSFET Q1” that “adjusts the current flow through winding W1 of transformer 123 to match the LED light source 110 power demand.” Ex. 1006, 3:60-64.



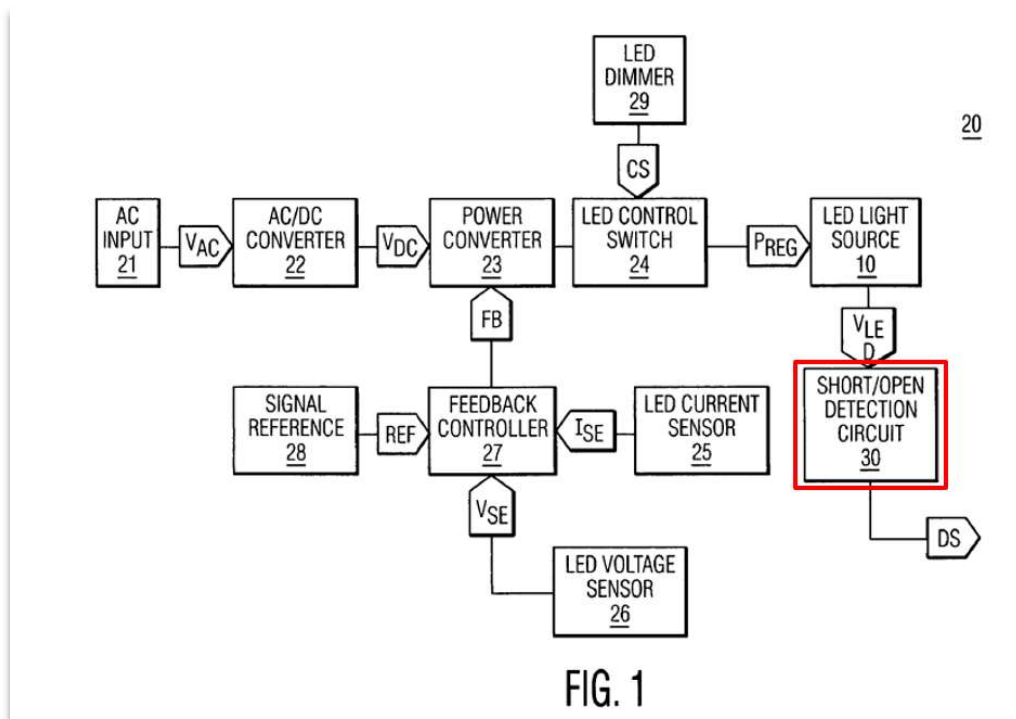
Ex. 1006, Fig. 2 (annotated); Ex. 1002, ¶¶199-201.

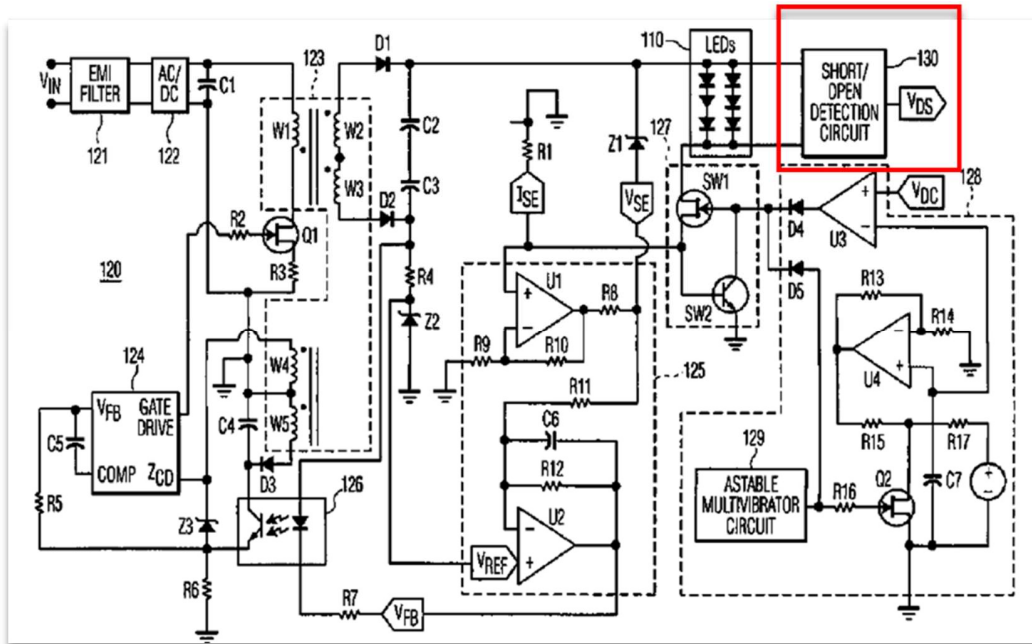
h. 1(g): “an impedance detecting section that detects an impedance of the semiconductor light source,”

Tripathi discloses this limitation, or at least renders it obvious. Tripathi discloses a short/open detection circuit 130, where short is a low impedance state and open circuit is a high impedance state of the LED light source:

FIG. 4 illustrates one embodiment of short/open detection circuit 130. A LED voltage drop V_{LD} across the LED light source 110 applied between a node N1 and a node N2, and an input voltage V_{IN} is applied between node N2 and a common reference. The LED voltage drop V_{LD} approximates zero (0) volts when LED light source 110 (FIG. 2) is shorted, and approximates the LED voltage V_{LED} of regulated power P_{REG} (FIG. 1) when LED light source 110 is an open circuit.

Ex. 1006, 5:41-59; Fig. 4. "The detection signal has a first level representative of a load condition of the LED light source. The detection signal has a second level representative of a short condition or an open condition indicative of the LED light source." Ex. 1006, 1:53-57. The open/short detection circuit is annotated red.





Ex. 1006, Figs. 1-2 (annotated); Ex. 1002, ¶¶202-203.

A POSITA would have understood that detecting an LED voltage drop of zero volts (short condition) detects an impedance of approximately zero, and a voltage drop of the entire LED voltage (open circuit condition) approximates a detection of infinite (complete) impedance of the semiconductor light source to the current. The output of the “short / open detection” circuit is referred to as “a detection signal V_{DS} [that] at a high level ... indicate[s] a ‘LED outage’ condition of LED light source **110** and at a low level ... indicate[s] a normal operation of LED light source **110**. The ‘LED outage’ condition is either indicative of a short or open of LED light source **110**.” Ex. 1006, 5:44-49. To the extent this limitation is not disclosed by Tripathi, it would have been obvious to a POSITA that the “short or open of LED

light source **110**” represented an impedance of the LEDs and therefore rendered obvious the claimed “impedance detecting section.” *Id.*; Ex. 1002, ¶204.

- 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 renders obvious this limitation. As discussed in Claim Limitation 1(c) and 1(f), Tripathi discloses controlling the output voltage of the voltage source. The voltage feedback V_{FB} from feedback controller 125 drives an optocoupler 126, which “supplies a gate drive signal to MOSFET Q1” that “adjusts the current flow through winding W1 of transformer 123 to match the LED light source 110 power demand.” Ex. 1006, 3:60-64. As further described in limitation 1(g), Tripathi discloses, or at least renders obvious, impedance detection in the form of a short/open detection circuit **130**. Ex. 1002, ¶¶205-06.

Tripathi teaches that voltage control is used to prevent damage to the circuit. Ex. 1006, 1:44-48 (“The LED control switch further operates to clamp a peak of the LED current during an initial loading stage of the LED light source” which “prevents damage to the LED light source”); 2:43-45 (“LED control switch 24 further operates to clamp a peak of LED current flowing through LED light source 10 to thereby protect the LED light source 10 from electrical damage.”). Based on the disclosure of Tripathi, it would have been obvious to a POSITA to use the output of

this detection V_{DS} as part of the feedback voltage control of the LEDs, for example, to prevent damage to the circuit or the LEDs, for example, by reducing or cutting power to the LEDs. In such as coupling, a POSITA would understand that the feedback controller 27 provides a feedback signal FB to power converter 23 based on sensed current I_{SE} , sensed voltage V_{SE} , reference signal REF, and V_{DS} (detection signal of a short or open impedance condition). *See Error! Reference source not found.*1 modified to include detection signal DS as part of the feedback control.

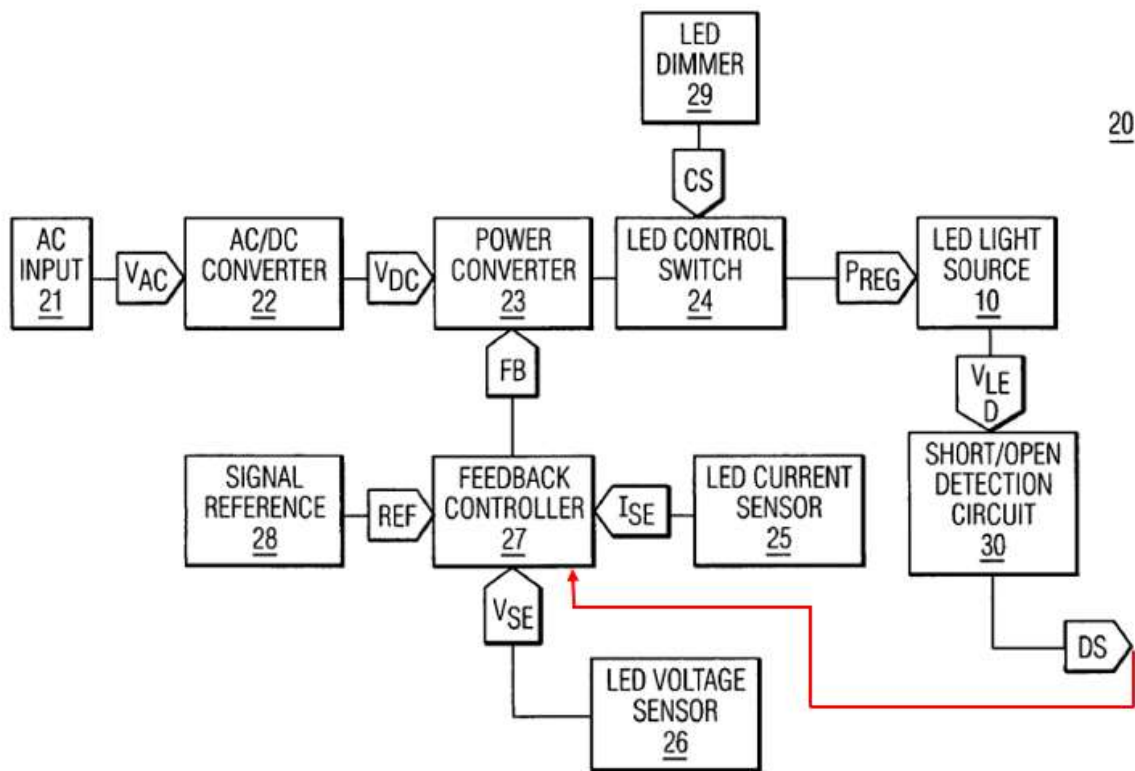


FIG. 1

Ex. 1006, Fig. 1 (annotated). A POSITA would understand to use the detection signal V_{DS} in feedback controller 27 to adjust the power, for example, by reducing or cutting the voltage to the LED light source 10 in the event of an short or open condition due to the “LED outage” to, for example, prevent damage to the circuit and/or circuit components as recognized by Tripathi. Ex. 1002, ¶¶207-208.

B. CLAIM 5

As discussed above, the limitations of claim 5 are subsumed within claim 1. *See supra* §IV(C); Ex. 1002, ¶47 (table correlating claim 5 with claim 1). Claim 5 is rendered obvious by Tripathi for the same reasons as described above regarding Ground 3 Claim 1. Ex. 1002, ¶¶209-216.

X. GROUND 4: TRIPATHI IN VIEW OF NISHIMURA

Claims 1, 2, and 5 would have been obvious over Tripathi (Ex. 1006) in view of Nishimura (Ex. 1005). Elements and claims not mentioned below are not affected by the combination with Nishimura, and are disclosed or rendered obvious for the same reasons stated above in Ground 3, which is incorporated by reference into Ground 4. Ex. 1002, ¶¶217-18.

As discussed for Claim Limitation 1(g) and Limitation 1(h) of Ground 3, Tripathi discloses that the output voltage controlling section controls the output voltage of the voltage source based on an output of the current comparing section. Ex. 1002, ¶219.

Tripathi recognizes that “[t]he electrical characteristics of LEDs are such that small changes in the voltage applied to the LED lamp will cause appreciable current changes” and that “ambient temperature changes will also result in LED current changes by changing the forward drop across the LEDs.” Ex. 1006, 1:22-26. A POSITA would understand Tripathi to be describing the dynamic impedance characteristics of the LEDs. Tripathi teaches that “the lumen output of LEDs depends on the LED current” and therefore there is a need to “precisely regulate the LED current to prevent luminous intensity variations due to input ac voltage variations and ambient temperature[.]” Ex. 1006, 1:26-31; Ex. 1002, ¶220.

Nishimura also recognizes the dynamic impedance characteristics of LEDs and teaches to measure the impedance of the LEDs and use the measured impedance in voltage control. Ex. 1005, 2:64-3:5 and Claims 18 and 24. In view of Nishimura, it would have been obvious to perform a direct measurement of the impedance of the LEDs (as disclosed in Nishimura) and use it in the voltage control circuit of Tripathi to “precisely regulate the LED current to prevent luminous intensity variations due to input ac voltage variations and ambient temperature[.]” Ex. 1006, 1:26-31. Nishimura discloses directly measuring the impedance of the semiconductor light source, and using that impedance measurement to control output voltage. The subsections below discuss the why a POSITA would have been

motivated with a reasonable expectation of success to combine Nishimura with Tripathi, followed by the disclosure of the combination. Ex. 1002, ¶221.

A. REASONS TO COMBINE

A POSITA would have been motivated to combine Tripathi (Ex. 1006) and Nishimura (Ex. 1005) for several reasons. Ex. 1002, ¶222.

a. Interrelated teachings between Tripathi and Nishimura

Nishimura is in in the same field of technology as Tripathi and both disclose circuits for driving LEDs. Ex. 1006, 1:9-10 (“The technical field of this disclosure is power supplies, particularly, a power supply for LEDs.”); Ex. 1005, 1:27-31 (“[A]n operating current of an LED is varied and, at one or more values of the operating current, a corresponding voltage of the LED is measured. The measured voltages are then used as feed-forward variables to set the light intensity of the LED.”); Ex. 1002, ¶¶223-225.

Both Tripathi and Nishimura address a similar problem of the dynamic impedance characteristics of LEDs. For example, Tripathi discloses that “[t]he electrical characteristics of LEDs are such that small changes in the voltage applied to the LED lamp will cause appreciable current changes” and, “[i]n addition, ambient temperature changes will also result in LED current changes by changing the forward drop across the LEDs.” Ex. 1006, 1:22-26. Similarly, Nishimura states:

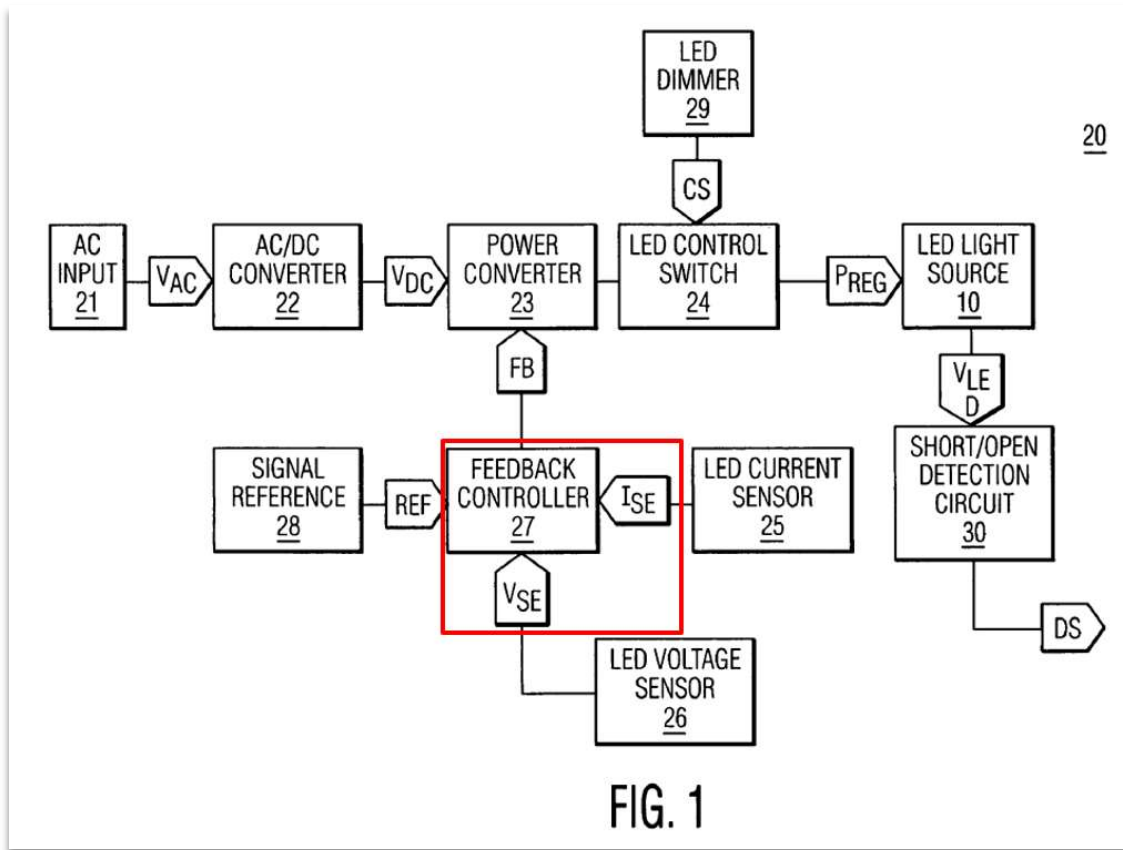
Temperature, aging and other factors can lead to a shift in the intensity of light emitted by a light emitting diode (LED).

A shift in the intensity of light emitted by an LED may be precipitated by factors such as a change in temperature of the LED's junction, or aging effects.

It 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. The LEDs turn-on voltage and/or dynamic impedance may therefore be used to closely predict the intensity of light emitted by an LED as a function of its operating current.

Ex. 1005, 1:7-9, 2:7-9, 2:22-28; Ex. 1002, ¶226.

Both Tripathi and Nishimura detect output signals (e.g., current, voltage, and/or impedance) of the LEDs, and use these signals to control the current supplied to the LEDs. This can be seen in annotated Figure 1 of Tripathi:



Ex. 1006, Fig. 1 (annotated). The feedback controller 27 in the block diagram of Figure 1 of Tripathi relies on measured LED voltage (V_{SE}), measured current (I_{SE}), and a signal reference (REF) to perform voltage feedback control to set the drive current for the LEDs. *Id.*, 3:44-47. Similarly, Nishimura describes detecting output signals and then controlling the current supplied to LEDs:

In one embodiment, an operating current of an LED is varied and, at one or more values of the operating current, a corresponding voltage of the LED is measured. The measured voltages are then used as feed-forward variables to set the light intensity of the LED.

Second and third voltage measurements may be taken at operating current values representing first and second predetermined fractions of the LED's nominal operating current. These second and third voltage

measurements may be used to estimate the dynamic impedance of the LED (e.g., $\Delta V/\Delta I=R$; 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.)

Ex. 1005, 1:27-31, 2:67-3:9; Ex. 1002, ¶227-28.

b. Applying a known technique to a known device ready for improvement to yield predictable results

A POSITA would have understood the combination of Tripathi and Nishimura to be a use of a known technique (divider to directly detect impedance of the LEDs) to a known device (the LED drive circuit using feedback control of Tripathi) ready for improvement (Tripathi already measured LED current and voltage—the quantities input into the impedance calculation of Nishimura—and already used them in feedback control) to obtain predictable results (feedback control of current supplied to LEDs based on measured impedance). Ex. 1002, ¶¶ 229-32.

c. Reasonable expectation of success

A POSITA would have had a reasonable expectation of success in combining Tripathi with Nishimura. Tripathi discloses a robust control system, in which adaptations can be made to the circuit to allow for different degrees of control depending on the specific application. Ex. 1006, 4:23-26 (“In alternate embodiments, either Zener diode Z1 or Zener diode Z3, or both Zener diode Z1 and Zener diode Z3 can be omitted depending on the degree of control protection

required for a particular application.”). A POSITA would understand that the direct impedance calculation of Nishimura could be implemented in Tripathi by adding a divider that receives as inputs the voltage supplied to the LEDs and the output current from the LEDs as taught by Nishimura (and Ohm’s Law). A POSITA would further understand that the “feedback controller 27” of Tripathi would be modified to receive the impedance determination of Nishimura to perform “feedback control” and adjust the LED supply voltage supplied to compensate for the gain from the dynamic impedance of the LEDs. Ex. 1002, ¶¶233-34.

B. CLAIM 1

- a. **1(g): “an impedance detecting section that detects an impedance of the semiconductor light source,”**

Nishimura discloses this limitation for the reasons discussed above in Ground 2, Claim Limitation 1(g). Ex. 1002, ¶¶235-41.

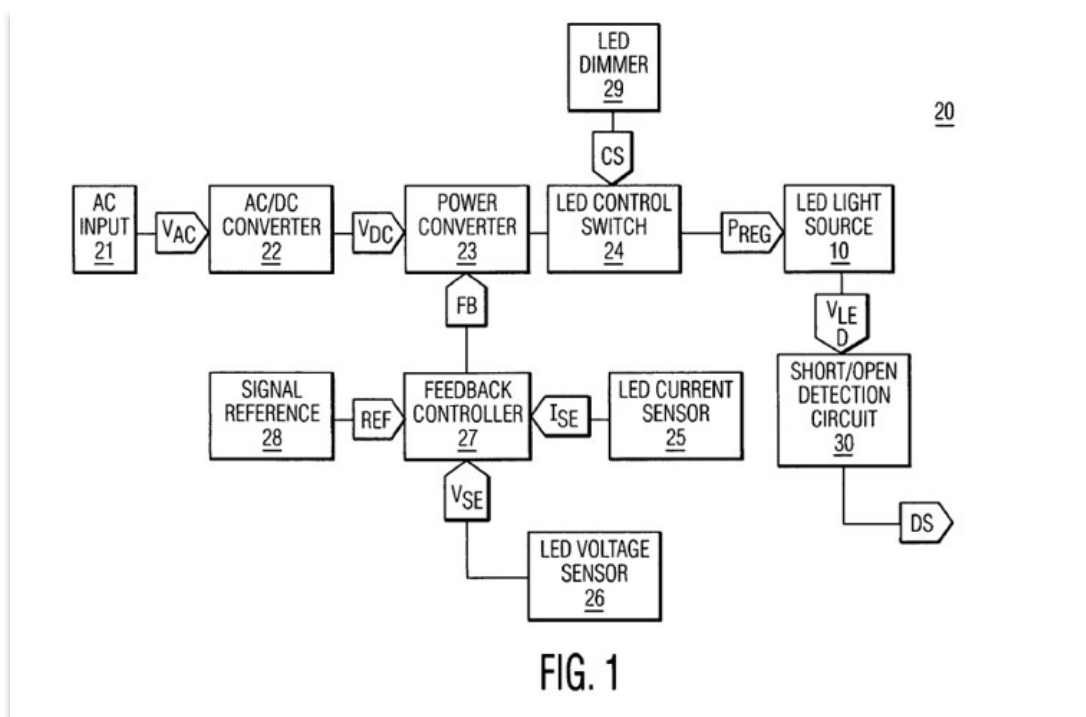
- b. **1(h): “wherein the output voltage controlling section controls the output voltage of the voltage source based on an output of the current comparing section and an output of the impedance detecting section.”**

The Tripathi-Nishimura combination renders this limitation obvious. As discussed above in Ground 3 for Claim Limitation 1(h), Tripathi discloses “wherein the output voltage controlling section controls the output voltage of the voltage source based on an output of the current comparing section.” Nishimura further discloses and/or renders obvious “wherein the voltage controlling section controls

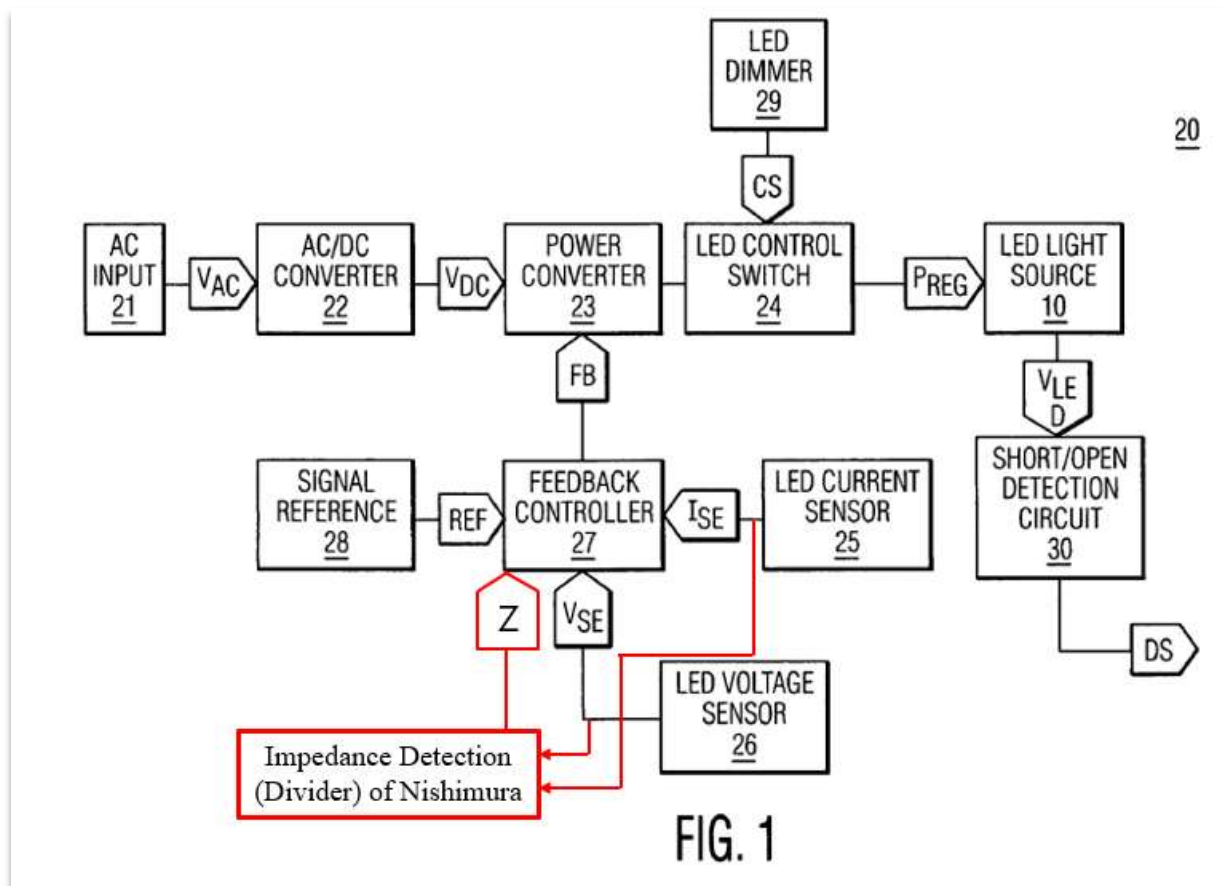
the output voltage of the voltage source based on ... an output of the impedance detection section” for the reasons discussed above in Ground 2, Claim Limitation 1(h). Ex. 1002, ¶242.

A POSITA would further understand that the measured dynamic impedance of Nishimura would be useful in the feedback controller 27 of Tripathi to compensate for the dynamic impedance of the LEDs. A POSITA would recognize that there are many ways to use the detected impedance of Nishimura in closed-loop voltage control. For example, a POSITA would know to simply multiply the impedance value by the current using analog circuitry ($V=Z \times I$) 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 know that the impedance and current values could be stored in a register or memory and compared to themselves to identify changes over time ($\Delta Z/t$, $\Delta I/t$) and these changes could be used to modify the gain to increment the output voltage either up or down to maintain constant LED current. These modifications would allow for control over the LED current based on dynamic impedance of the LEDs. A POSITA would further understand that voltage adjustment of the LEDs would only need to be done in the circuit of Tripathi if the measured LED current (“ I_{SE} ”) was different from the reference current “REF” and accordingly the voltage needed to be adjusted to correct the LED current back to the reference current. Ex. 1002, ¶243.

The figures below show an embodiment of how a POSITA would understand to modify Tripathi to obtain the direct impedance calculation of Nishimura. Figure 1 of Tripathi is shown below.



In the annotated figure below, the divider of Nishimura has been added to Figure 1 of Tripathi.



Ex. 1006, Fig. 1 (modified in red); Ex. 1002, ¶244.

A POSITA would be motivated to implement the impedance detection of Nishimura in Tripathi. A POSITA would recognize that the impedance of Nishimura could be determined from the existing sensed voltage V_{SE} and current I_{SE} of Tripathi and that the dynamic impedance of Nishimura would allow Tripathi to further account for the dynamic impedance of the LEDs, as taught by Nishimura, in voltage control and allow Tripathi to provide a more stable supply current to the LEDs. This would improve the functionality of Tripathi. Ex. 1002, ¶¶245-46.

C. CLAIM 2

- a. 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.

The Tripathi-Nishimura combination disclose and/or render obvious this limitation. Nishimura further discloses and/or renders obvious claim 2 for the same reasons discussed in Ground 2, Claim Limitation 2. Ex. 1002, ¶¶247-54.

D. CLAIM 5

As discussed above, the limitations of claim 5 are subsumed within claim 1. *See supra* §IV(C); Ex. 1002, ¶47 (table correlating claim 5 with claim 1). Claim 5 is rendered obvious by the Tripathi-Nishimura combination for the same reasons as described above regarding Ground 4 Claim 1. Ex. 1002, ¶¶255-56.

XI. SECONDARY CONSIDERATIONS

Petitioner is aware of no evidence of secondary considerations that would meaningfully rebut a finding of obviousness. Ex. 1002, ¶257.

XII. CONCLUSION

Petitioner respectfully requests institution and that the Challenged Claims be cancelled.

Respectfully submitted,

BAKER BOTTS L.L.P.

Date: January 31, 2022

/s/ Eliot D. Williams
Eliot D. Williams (Reg. No. 50,822)
Lead Attorney for Petitioner

CERTIFICATE OF COMPLIANCE

Pursuant to 37 C.F.R. §42.24(d), the undersigned hereby certifies that the word count under §42.24(a)(1) for the foregoing Petition for *Inter Partes* Review totals 13,813 words, within the 14,000 word limit allowed under § 42.24(a).

Respectfully submitted,

BAKER BOTTS L.L.P.

Date: January 31, 2022

/s/ Eliot D. Williams
Eliot D. Williams (Reg. No. 50,822)
Lead Attorney for Petitioner

CERTIFICATE OF SERVICE

In accordance with 37 C.F.R. §§42.6(e) and 42.105, the undersigned certifies that on the 31st day of January, 2022, a complete and entire copy of the PETITION FOR *INTER PARTES* REVIEW (“petition”), Petitioner’s power of attorney, and related Exhibits were served on Patent Owner at the correspondence address of record for the subject patent,

HAMRE, SCHUMANN, MUELLER & LARSON P.C.
45 South Seventh Street
Suite 2700
MINNEAPOLIS MN 55402-1683

via Express Mail or by means at least as fast and reliable as Express Mail, and a courtesy copy is also being forwarded to Patent Owner’s Litigation Counsel via electronic mail to:

T. William Kennedy Jr.
Jon Rastegar
Ryan Griffin
Nelson Bumgardner Conroy PC
2727 North Harwood Street
Suite 250
Dallas, TX 75201
Tel: (817) 377-9111
pat@nelbum.com
justin@nelbum.com
bill@nelbum.com
jon@nelbum.com
ryan@nelbum.com

John P. Murphy
Nelson Bumgardner Conroy PC

3131 W 7th St
Suite 300
Fort Worth, TX 76107
Tel: (817) 806-3808
murphy@nelbum.com

Respectfully submitted,

BAKER BOTTS L.L.P.

Date: January 31, 2022

/s/ Eliot D. Williams
Eliot D. Williams (Reg. No. 50,822)
Lead Attorney for Petitioner