UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HISENSE USA CORP.,
Petitioner,

v.

LIGHT GUIDE INNOVATIONS LLC,
Patent Owner.

U.S. Patent No. 7,936,415

Case No.: IPR2025-01537

PETITION FOR *INTER PARTES* REVIEW OF CLAIMS 1-18 OF U.S. PATENT 7,936,415

TABLE OF CONTENTS

TABLE OF EXHIBITS

Exhibit	Description
1001	U.S. Patent No. 7,936,415 ("the '415 patent")
1002	File history of U.S. Patent No. 7,936,415 ("'415-FH")
1003	Declaration of Michael Krames, Ph.D.
1004	U.S. Patent Application Publication No. 2007/0247414 ("Roberts")
1005	U.S. Patent Application Publication No. 2006/0187660 ("Liu")
1006	U.S. Patent Application Publication No. 2003/0193789 ("Karlicek")
1007	Certified English Translation of Korean Patent Application No. 10-2006-0080215
1008	U.S. Patent Application Publication No. 2007/0115671 to Roberts et al. ("Roberts-671").
1009	Certified English translation of International Patent Application Publication No. WO2006/028073A1 ("Nishida")
1010	U.S. Patent No. 4,851,862 to Newman et al. ("Newman")
1011	U.S. Patent No. 7,178,951 to Hsiao et al. ("Hsiao")
1012	Certificate of translation for Korean Patent Application No. 10-2006-0080215
1013	Original Korean language version of Korean Patent Application No. 10-2006-0080215
1014	Certificate of translation for International Patent Application Publication No. WO2006/028073A1
1015	Original Japanese language version of International Patent Application Publication No. WO2006/028073A1
1016	U.S. Patent Application Publication No. 2006/0012991 ("Weaver")
1017	U.S. Patent No. 6,404,131 to Kawano et al. ("Kawano")
1018	U.S. Patent No. 5,139,890 to Cowie et al. ("Cowie")
1100	Confidential list of potentially relevant suppliers of Petitioner

CLAIMS LISTING

Claims
1. [1-PRE] A light source apparatus comprising:
[1a] at least one module substrate comprising connecting terminals at both side ends thereof;
[1b] a light emitting diode on the module substrate; and
[1c] a plurality of connecting substrates connected to the connecting terminals of the module substrate, wherein the connecting substrate comprises a termination connecting substrate, by which the connecting terminal provided at one end of a final module substrate of the module substrates is prepared as a closed loop circuit.
2. The light source apparatus as claimed in claim 1, wherein the connecting substrate comprises an intermediate connecting substrate connecting the connecting terminals of adjacent module substrates to each other.
3. The light source apparatus as claimed in claim 1, [3a] wherein the connecting substrate comprises an external connecting substrate which is disposed at a first end of a first module substrate of the module substrates, and
[3b] an intermediate connecting substrate which connects the connecting terminal of the first module substrate with the external connecting substrate and/or between the connecting terminal of the module substrates.
4. The light source apparatus as claimed in claim 3, wherein the connecting substrate comprises a connecting terminal, which corresponds to at least one of connecting terminals provided at both side ends of the module substrate.
5. The light source apparatus as claimed in claim 3, wherein the external connecting substrate comprises an external connector to which a light emitting diode driver is connected.
6. The light source apparatus as claimed in claim 4, [6a] wherein the connecting terminal is formed on the module substrate or under the module substrate, and
[6b] the intermediate connecting substrate is mounted on the external connecting substrate and on the connecting terminals between plural module substrates.
7. The light source apparatus as claimed in claim 1, wherein the light emitting diode comprises at least one LED chip having at least one color.
8. The light source apparatus as claimed in claim 1, wherein the module substrate comprises a single-layer printed circuit board or a multi-layer printed circuit board.
9. The light source apparatus as claimed in claim 1, wherein the module substrate comprises a multi-copper layer and a via hole formed in the module substrate, and a silver plating layer formed on a bottom surface of the module substrate.

10. The light source apparatus as claimed in claim 7, wherein the module substrate includes a test pad terminal for testing the LED chip.
11. The light source apparatus as claimed in claim 1, wherein the module substrate comprises white ink coated on the module substrate, except for a region where the LED chip is mounted.
12. [12-PRE] A light source apparatus comprising:
[12a] a housing comprising a receiving groove;
[12b] at least one module substrate which is received in the housing and has connecting terminals mounted at both side ends of the module substrate;
[12c] a light emitting diode on the module substrate; and
[12d] a connecting substrate connected to the connecting terminal of the module substrate, wherein the connecting substrate comprises a termination connecting substrate, which allows a connecting terminal provided at one end of a final module substrate of the module substrates to be feedback in a form of a closed loop.
13. The light source apparatus as claimed in claim 12, wherein the connecting substrate comprises an external connecting substrate, which is provided at one end of a first module substrate of the module substrates to supply a driving power.
14. The light source apparatus as claimed in claim 13, wherein the connecting substrate comprises a plurality of intermediate connecting substrates which connect both connecting terminals of a plurality of module substrates and/or between the external connecting substrate and the first connecting terminal of the first module substrate.
15. The light source apparatus as claimed in claim 12, comprising at least one LED bar, on which the module substrates are connected to each other in series by the connecting substrate.
16. [16-PRE] A liquid crystal display comprising:
[16a] a liquid crystal panel; and a light unit disposed below the liquid crystal panel,
[16b] wherein the light unit comprises a housing comprising a receiving groove,
[16c] at least one module substrate which is received in the housing and has a first connecting terminal and a second connecting terminal at both end portions of the module substrate,
[16d] a light emitting diode on the module substrate, and
[16e] a connecting substrate which is connected to the first connecting terminal of a first end of the module substrate or the second connecting terminal of a second end of the module substrate, wherein the connecting substrate comprises a termination connecting substrate which comprises a closed loop pattern for

forming a second connecting terminal of a second end of a final module substrate as a closed loop circuit.
17. The liquid crystal display as claimed in claim 16, [17a] wherein the connecting substrate comprises: an external connecting substrate for external connection; and
[17b] at least one intermediate connecting substrate comprising a third connecting terminal which connects the external connecting substrate with the first connecting terminal of the first module substrate and/or between the connecting terminals of module substrates.
18. The liquid crystal display as claimed in claim 17, wherein one of the module substrate, the external connecting substrate, the intermediate substrate and the termination substrate comprises a flexible substrate.

I. INTRODUCTION

Hisense USA Corp. ("Hisense" or "Petitioner") hereby seek *inter partes* review and cancellation of claims 1-18 ("the Challenged Claims") of U.S. Patent No. 7,936,415 ("the '415 patent").

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

A. Real Party-In-Interest

The real parties-in-interest are: Hisense USA Corp., Hisense Company Ltd., Hisense Visual Technology Co. Ltd., Hisense International Co. Ltd., Hisense International (Hong Kong) America Investments Co. Ltd., Hisense International (HK) Co. Ltd., Guiyang Hisense Electronics Co., Ltd., Hisense Electronics Manufacturing Company of America Corp., and Hisense Electronica Mexico S.A. de C.V.

Although Petitioner does not believe any of its relevant suppliers are RPIs, out of an abundance of caution, Petitioner has included a list of relevant suppliers in Confidential Exhibit 1100. A Motion to Seal Confidential Exhibit 1100 accompanies this Petition.

B. Related Matters

The following pending federal district court litigation may affect or be affected by a decision in this proceeding:

- *Light Guide Innovations LLC v. Hisense Company Ltd. et al EDTX-2-25-cv-00051*. ("the Litigation").

Petitioner further notes that it has filed, or intends to file, *inter partes* reviews against the following additional patents owned by Patent Owner, which patents are also the subject of the Litigation:

- *Inter Partes* Review No. 2025-01526 challenging U.S. Patent No. 8,408,778; and
- *Inter Partes* Review No. 2025-01538 challenging U.S. Patent No. 8,267,537.

The undersigned is unaware of any other judicial or administrative matter that would affect, or be affected by, a decision in this proceeding.

C. Lead and Back-up Counsel and Service Information

Petitioner designates the following lead and backup counsel:

Lead Counsel	**Back-up Counsel**
Heath J. Briggs (Reg. No. 54,919) Greenberg Traurig, LLP 1144 15th St. Suite 3300 Denver, CO 80202 Telephone: 303-685-7418 Facsimile: 720-904-6118 BriggsH@gtlaw.com	Trenton Ward (Reg. No. 59,157) Greenberg Traurig, LLP Terminus 200 3333 Piedmont Road NE, Suite 2500 Atlanta, GA 30305 Telephone: 678-553-2100 Facsimile: 678-553-2212 Trenton.Ward@gtlaw.com

Back-up Counsel	**Back-up Counsel**
Benjamin P. Gilford (Reg. No. 72,072) Greenberg Traurig, LLP 90 South Seventh Street, Suite 3500 Minneapolis, MN 55402 Telephone: 612-259-9683 Facsimile: 312-873-4694 GilfordB@gtlaw.com	Stephen M. Ullmer (*pro hac vice* to be filed) Greenberg Traurig, LLP 0260 SW Greenburg Road, Suite 400 Portland, OR 97223 Tel: 303-572-6579 UllmerS@gtlaw.com

Service on Petitioner may be made by mail or hand delivery to: Greenberg Traurig, LLP, 1144 15th St., Suite 3300, Denver, CO 80202. Petitioner consents to and prefers electronic service by emailing GT-Hisense-IPRs@gtlaw.com and counsel of record (shown above).

III. CERTIFICATION OF WORD COUNT UNDER 37 C.F.R. §42.24(d)

Petitioner certifies that the word count in this Petition is 13,293 words, as counted by the word-processing program (Microsoft Word for Microsoft 365 MSO) used to generate this Petition, where such word count excludes the claims listing, table of contents, mandatory notices, certificate of service, appendix of exhibits, and this certificate of word count. This Petition is in compliance with the 14,000 word limit set forth in 37 C.F.R. §42.24(a)(1)(i).

IV. STIPULATION

Petitioner hereby stipulates that, if the PTAB institutes review in this proceeding, Petitioner will not pursue any grounds raised in this Petition, or any grounds Petitioner could have reasonably raised in this Petition, in the Litigation or any parallel proceeding. *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 at 12-13 (PTAB Dec. 1, 2020) (precedential). Petitioner further stipulates that, if the PTAB institutes review in this proceeding, it will not rely in the Litigation on any product or system that is "based on the same evidence presented" in this IPR and will not advance a theory of obviousness based on the combination of prior art that is asserted in any ground presented in the Petition with any other prior art, including product or system prior art, against the challenged claims. *Cf. SAP America, Inc. v. Cyandia, Inc.*, IPR2024-01496, Paper 13 at 9 (PTAB Apr. 7, 2025).

V. GROUNDS FOR STANDING UNDER 37 C.F.R. §42.104

Petitioner certifies that the '415 patent is available for IPR and Petitioner is not barred/estopped from requesting cancellation of the Challenged Claims per the below Grounds:

Ground	'415 Patent Claims	Basis for Obviousness
Ground 1	1-2, 7-8, 11	Obvious over Roberts (Ex-1004)
Ground 2	12, 15	Obvious over Roberts in view of Liu (Ex-1005)
Ground 3	1-8, 11	Obvious over Roberts in view of Karlicek (Ex-1006)
Ground 4	12-15	Obvious over Roberts in view of Liu and Karlicek

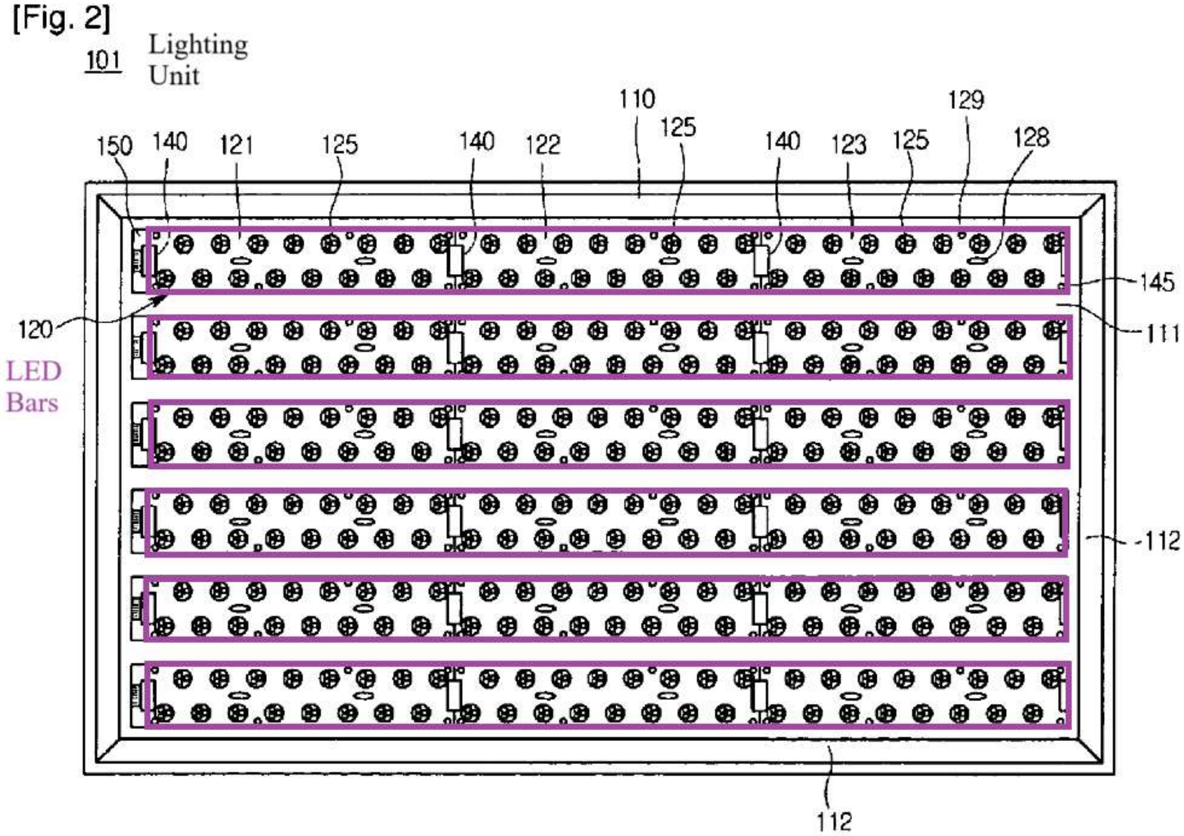
Ground	’415 Patent Claims	Basis for Obviousness
Ground 5	9	Obvious over Roberts in view of Nishida (Ex-1009), optionally in view of Karlicek
Ground 6	10	Obvious over Roberts in view of Newman (Ex-1010), optionally in view of Karlicek
Ground 7	16-18	Obvious over Roberts in view of Liu, Karlicek, and Hsiao (Ex-1011)

VI. <u>OVERVIEW OF THE ’415 PATENT</u>

A. The ’415 Patent and the Challenged Claims

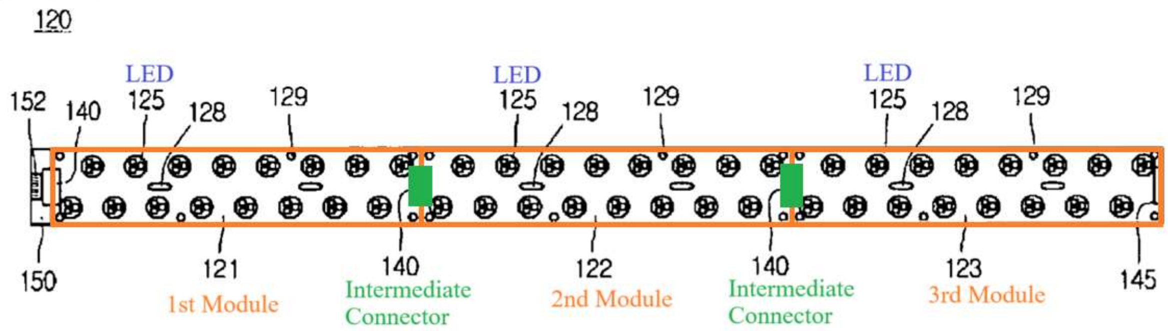
The ’415 patent discloses a “light source apparatus and a liquid crystal display [LCD] having the same.” (Ex-1001 at Abstract.) The LCD (100) includes a housing (110) and a lighting unit (101) having a plurality of ***LED bars*** 120:

[Fig. 2]



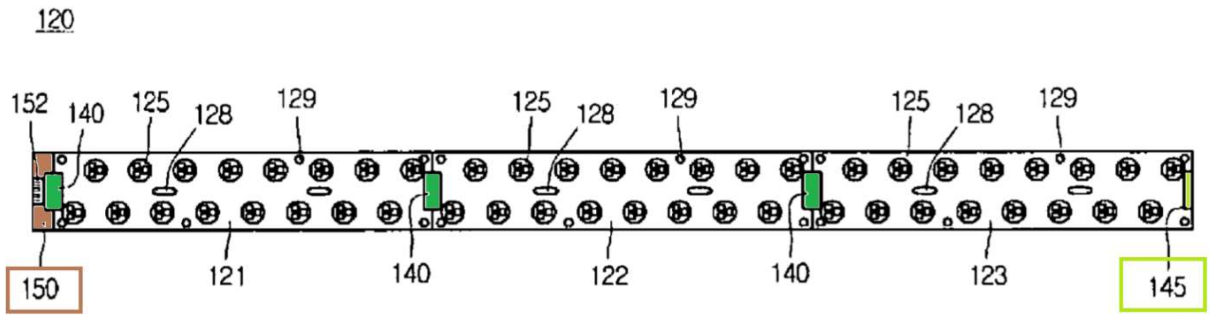
(*Id.* at FIG. 2, 2:48-63; *see also id.* at FIG. 1, 2:40-43.) As illustrated in Figure 5, each ***LED bar*** (120) includes a plurality of ***module substrates*** (121, 122, 123) interconnected via ***intermediate connecting substrate*** 140.

[Fig. 5]



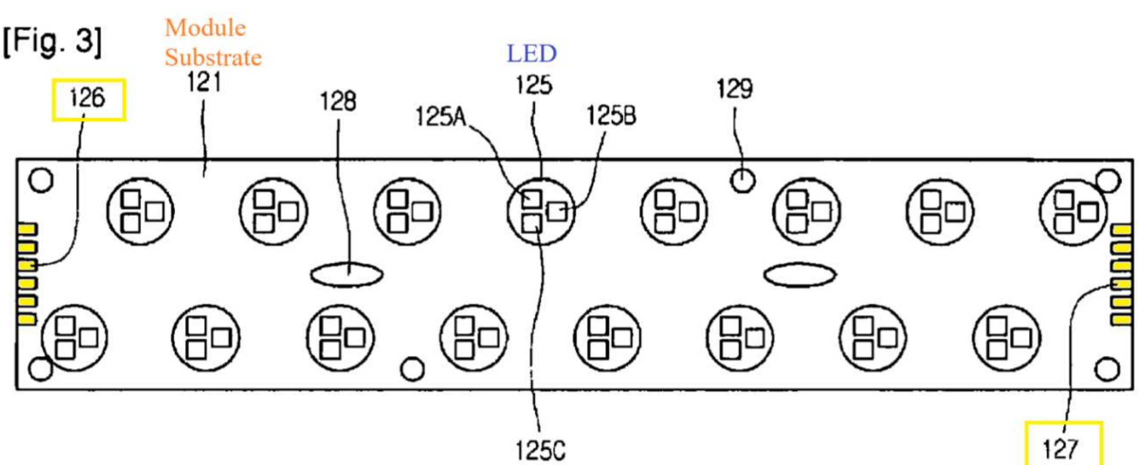
(*Id.* at FIG. 5, 3:19-23, 3:31-37.) One end of each ***LED bar*** (120) includes a ***terminating connecting substrate*** (145) "so that the end portion of the third module substrate 123 is provided as a closed loop." (*Id.* at 3:39-40.) The other end of each ***LED bar*** (120) is connected to ***external connecting substrate*** (150) for connection to "an external LED driver." (*Id.* at 3:40-44.)

[Fig. 5]



(*Id.* at FIG. 5.) ***Connecting terminals (126, 127)*** are provided at both ends of a ***module substrate*** for mating with connecting substrates:

[Fig. 3]



(*Id.* at FIG. 3, 4:4-50.)

B. Priority Date

The ’415 patent claims priority to Korean Application No. 10-2006-0080215 (“KR’215”), filed August 24, 2006. (Ex-1001 at [30].) At least claims 12-18 of the ’415 patent are unsupported by KR’215 because KR’215 fails to disclose a “housing comprising a receiving groove,” which is recited in, or required by, each of those claims.

The only disclosures of a “housing comprising a receiving groove” in the ’415 patent are the following:

- Abstract
- Col. 1, lines 43-60
- Col. 2, lines 48-53
- FIG. 1 (showing receiving groove 111).

None of these disclosures are present in KR’215. (Ex-1002 at 52-78 (original Korean language version of KR’215); *see also* Ex-1013; Ex-1007 (certified translation of KR’215).) Accordingly, at least claims 12-18 have a priority date of August 7, 2008, *i.e.*, the date the PCT application that resulted in the ’415 patent was filed.[1] *Dynamic Drinkware, LLC v. National Graphics, Inc.*, 800 F.3d 1375, 1378-

[1] The prior art applied herein is effective irrespective of whether the ’415 patent may properly claim priority to KR’215.

79 (Fed. Cir. 2015); *Ariad Pharm., Inc. v. Eli Lilly & Co.*, 598 F. 3d 1336, 1351 (Fed. Cir. 2010) (*en banc*).

C. Prosecution History

The ’415 patent underwent minimal prosecution. A first action rejected various claims based on US2003/0053307 to Talamo, with a few claims being rejected based on Talamo in view of US2007/0115671 to Roberts et al. (“Roberts-671”). (Ex-1002 at 29-34.) Other claims were found allowable because Roberts-671 allegedly did not disclose a closed loop circuit. (*Id.* at 34.) The applicant amended the claims to require a closed loop circuit, after which the application was allowed. (*Id.* at 7-10, 17-24.)

The Examiner erred in allowing the claims over Roberts-671 because Roberts-671 <u>*does*</u> disclose a closed loop circuit. (Ex-1003-Krames at ¶¶48-51; Ex-1008-Roberts-671 at FIG. 4, 0074-75.) Further, had the Examiner conducted proper searching, the Examiner would have realized Roberts-671 is just one of several different patent applications to Mr. John. K. Roberts of Grand Rapids, Michigan, disclosing similar embodiments, and the Examiner would have identified U.S. Patent Application Publication No. 2007/0247414, also to John K. Roberts, of Grand Rapids, Michigan, which includes additional material disclosures beyond Roberts-671, as shown herein. Indeed, Roberts (Ex-1004) alone renders obvious many claims of the ’415 patent.

D. Person of Ordinary Skill in the Art ("POSITA")

A POSITA would have had 2 or 3 years of experience in LED-based lighting device design and fabrication as well as at least a bachelor's degree in a relevant field (*e.g.*, mechanical engineering), or alternatively would have an equivalent combination of advanced education and practical experience, such as an advanced degree that is based on work involving LED-based lighting device design and fabrication. (Ex-1003-Krames at ¶53.) A POSITA would have been knowledgeable regarding backlighting devices that use LEDs. (*Id.* at ¶54.)

E. Claim Construction

Petitioner does not believe any specific constructions are required at this time, and, therefore, applies the plain and ordinary meanings ("plain meanings") to the Challenged Claims. Petitioner reserves the right to propose specific constructions if appropriate/necessary during these proceedings.[2]

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[2] To be clear, Petitioner's application of the prior art herein does not indicate Petitioner agrees the '415 patent is compliant with 35 U.S.C. § 112. The '415 patent's claims may lack written description support and/or be indefinite, among other things.

VII. OVERVIEW OF THE PRIOR ART

A. Roberts (Ex-1004)

Roberts is US2007/0247414, filed April 21, 2006, and is at least pre-AIA §102(e) prior art. (Ex-1004-Roberts at [22].) Roberts is analogous art to the '415 patent, relating to a "light source apparatus and a liquid crystal display having the same." (Ex-1001 at 1:6-7; Ex-1004-Roberts at 0001, 0003; Ex-1003-Krames at ¶65.)

Roberts discloses a lighting panel (40) having a plurality of ***light bar assemblies (30)***, each assembly comprising a plurality of ***solid state lighting tiles (10)***[3]:

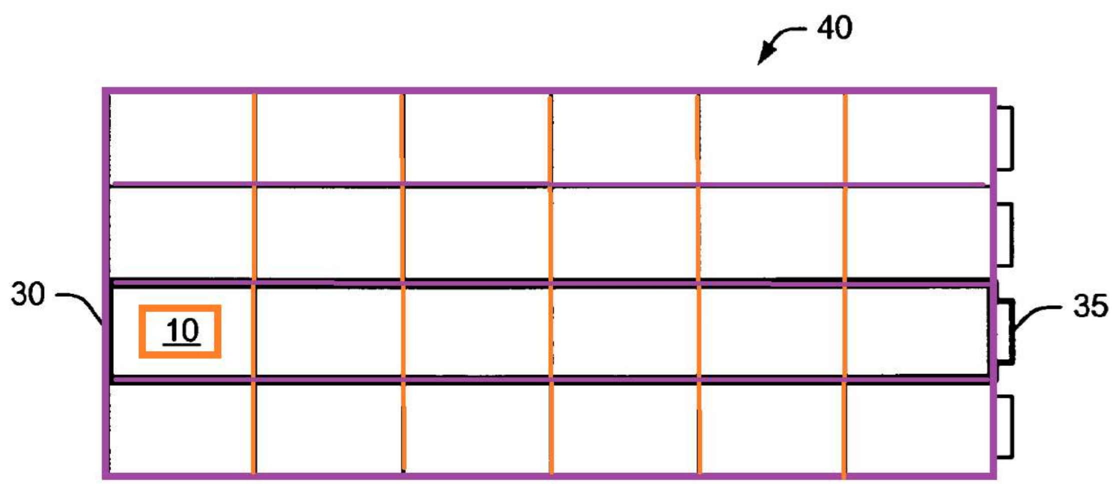


FIGURE 4B

[3] Roberts also refers to the lighting tiles as "LED modules." (Ex-1004-Roberts at 0013.)

(Ex-1004-Roberts at FIG. 4B, 0071.)

Each ***lighting tile (10)*** is a "functional building block to create a large area planar light source" and includes ***lighting elements (12)***, such as ***LEDs***, and ***contacts (14)*** for facilitating interconnection among ***lighting tiles (10)***:

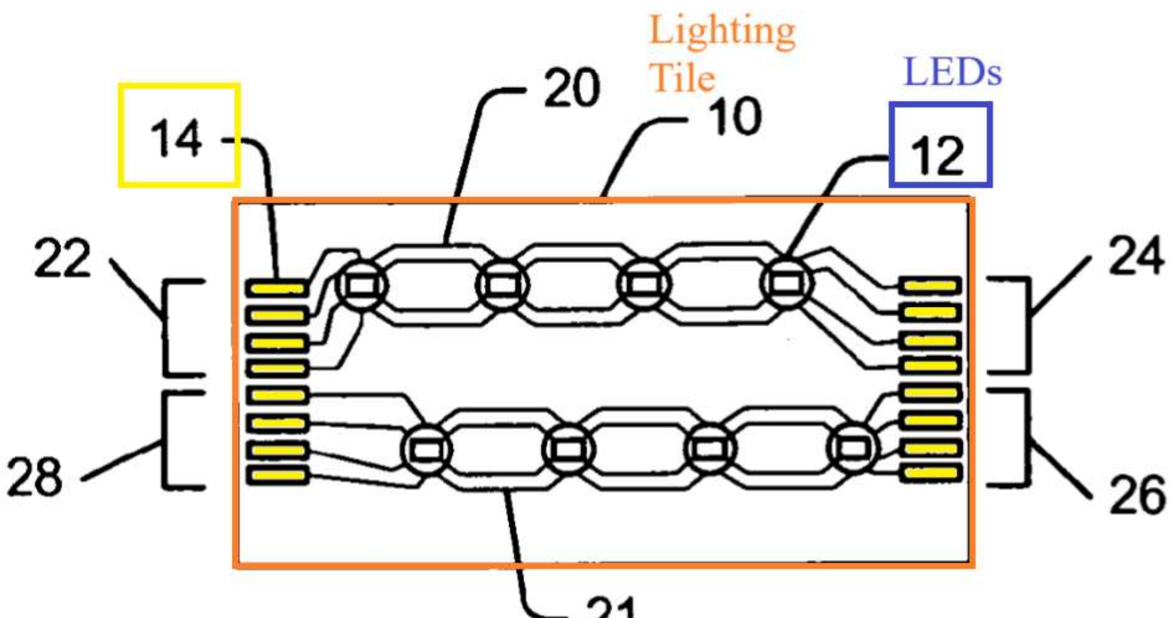


FIGURE 1

(*Id.* at FIG. 1, 0060-62.)

An ***edge connector (13)*** may be used to mechanically and/or electrically interconnect the many ***lighting tiles (10)*** of each ***light bar assembly (30)***:

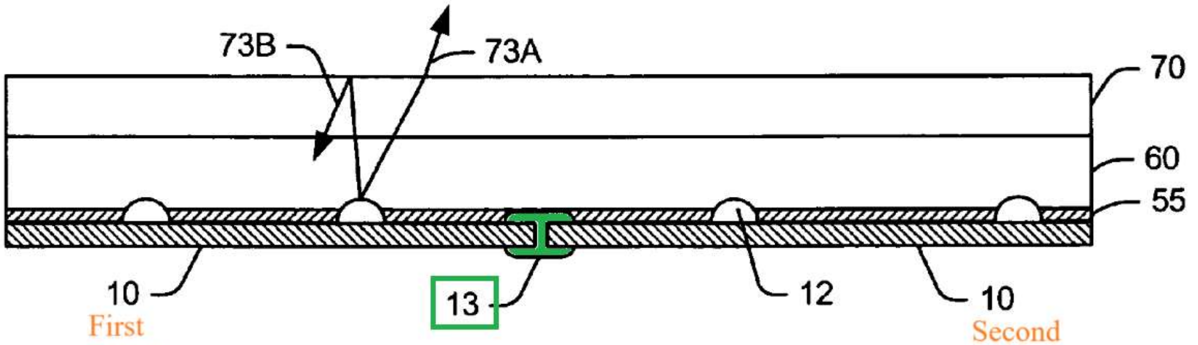


FIGURE 5B

(*Id.* at FIG. 5B, 0082.)

Further, a ***loopback connector (35)*** may be included at one end of each ***light bar assembly (30)*** to provide a closed-loop circuit:

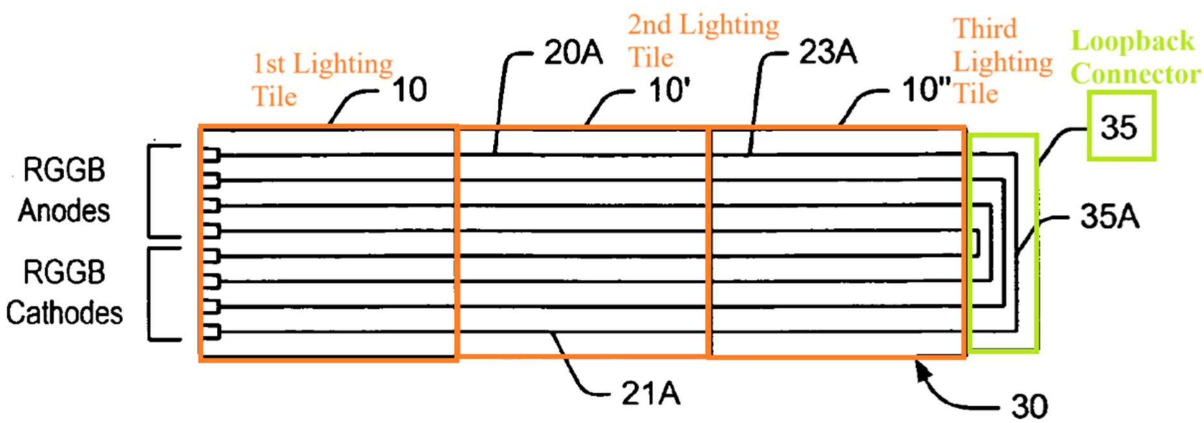


FIGURE 4A

(*Id.* at FIG. 4A, 0020, 0072.)

"The ***loopback connector*** 35 may include an edge connector, a flexible wiring board, or any other suitable connector. In addition, the loop connector may include printed traces formed on/in the tile 10." (*Id.* at 0073.) A controller (230) and current driver (220) are used to individually power and control each LED string of the lighting panel:

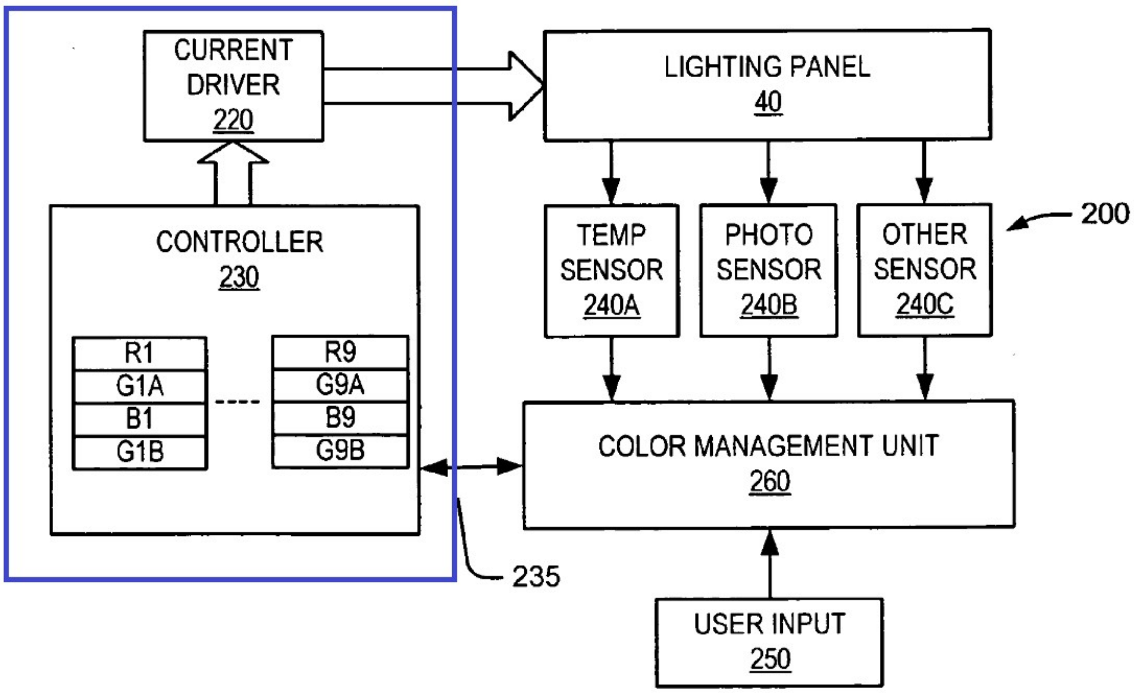


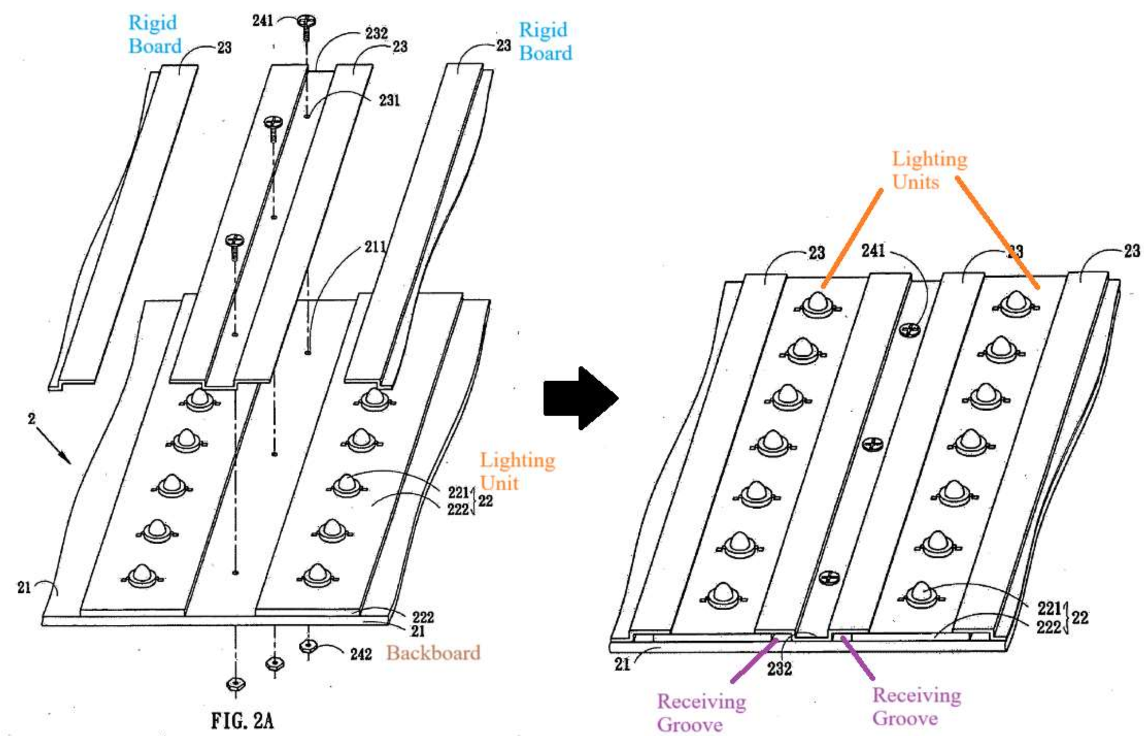
FIGURE 8

(*Id*. at FIG. 8, 0095, 0097.)

B. Liu (Ex-1005)

Liu is US2006/0187660, filed July 15, 2005, and is at least pre-AIA §102(e) prior art. (Ex-1005-Liu at [22].) Liu is analogous art to the '415 patent. (*Id.* at Abstract, 0002, 0007-8; Ex-1003-Krames at ¶68.)

Liu discloses a simple manner of securing lighting boards to a housing using receiving grooves:

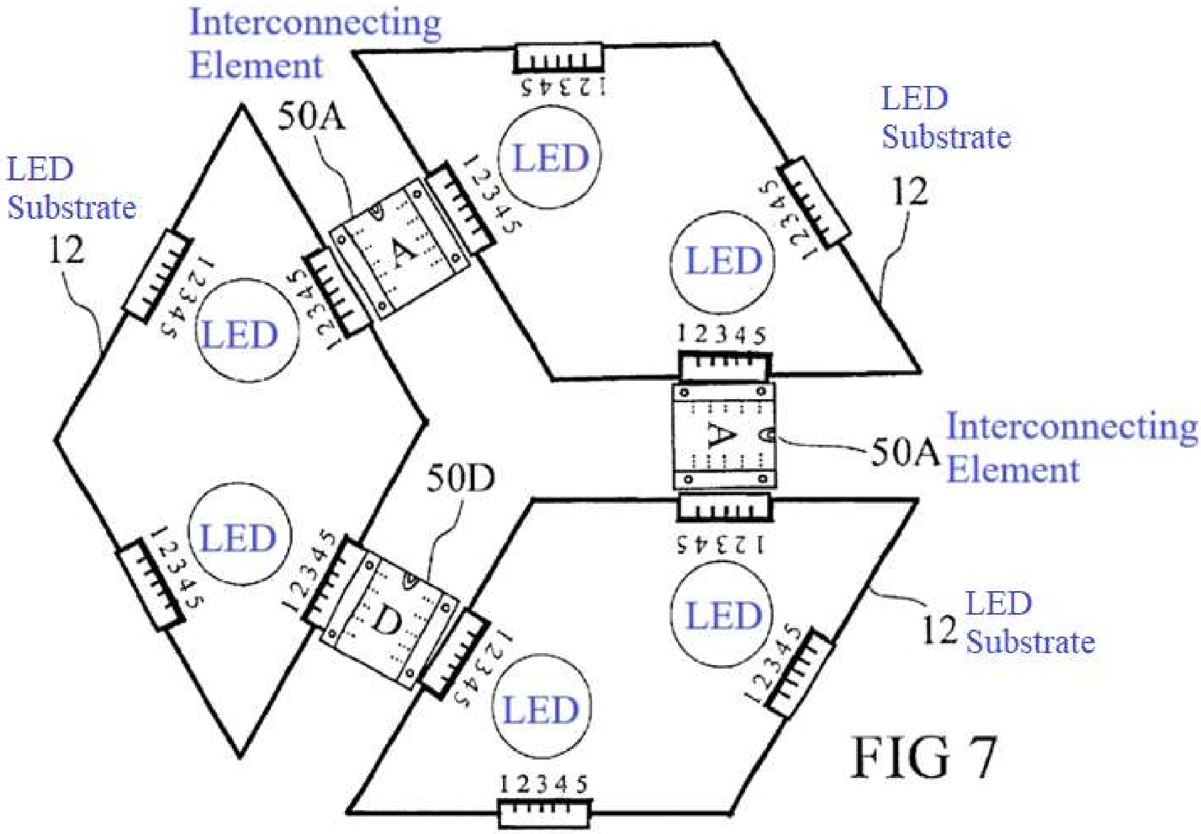


(Ex-1005-Liu at FIGS. 2A-2B, 0017-19.)

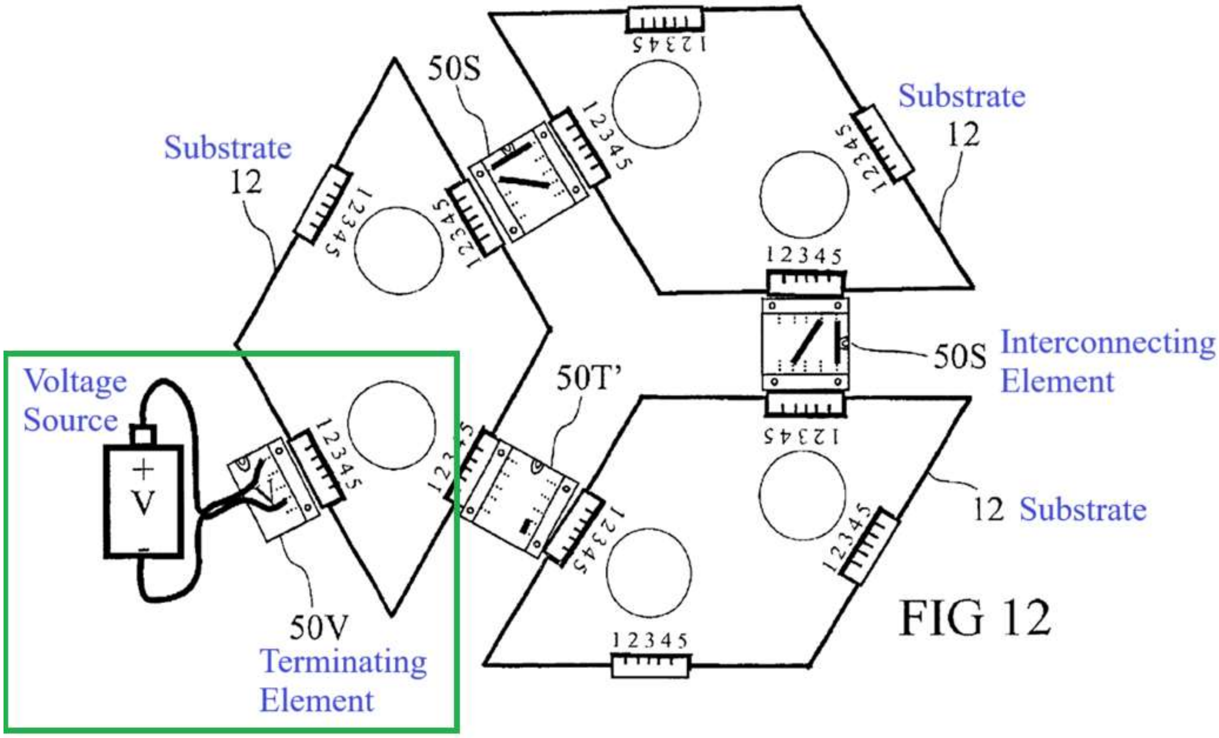
C. Karlicek (Ex-1006)

Karlicek is U.S. Patent Publication No. 2003/0193789, published October 16, 2003, and is at least pre-AIA 102(b) prior art. (Ex-1006-Karlicek at [43].) Karlicek is analogous art to the '415 patent. (*Id.* at Abstract, 0001, 0046; Ex-1003-Krames at ¶71.)

Karlicek discloses various manners of connecting a plurality of LED substrates in series (or parallel) using interconnecting and terminating elements (substrates):



(Ex-1006-Karlicek at FIG. 7, 0055.)



(*Id.* at FIG. 12, 0061.)

D. Nishida (Ex-1009)

Nishida is an English language translation of WO2006/028073A1, which published March 16, 2006, and is at least pre-AIA 102(a) prior art. (Ex-1009-Nishida at (43).) Nishida is analogous art to the '415 patent. (*Id.* at 0001, 0032, 0034-36; Ex-1003-Krames at ¶74.)

Nishida discloses conventional features of multi-layer PCB boards, such as multiple copper layers and a silver plating layer. (Ex-1009-Nishida at 0018-20, 0024, 0027, 0029-30.)

E. Newman (Ex-1010)

Newman is U.S. Patent No. 4,851,862, issued July 25, 1989, and is at least pre-AIA 102(b) prior art. (Ex-1010-Newman at [45].) Newman is analogous art to the '415 patent. (*Id.* at Abstract, 1:6-18, 3:36-62; Ex-1003-Krames at ¶77.)

Newman discloses a plurality of LED array modules, each of which comprises an ***LED array chip (16)*** and ***test pads (50)*** for testing the ***LED array chip (16)***. (Ex-1010-Newman at FIGS. 3-4, 2:61-66, 4:43-46, 5:39-44.)

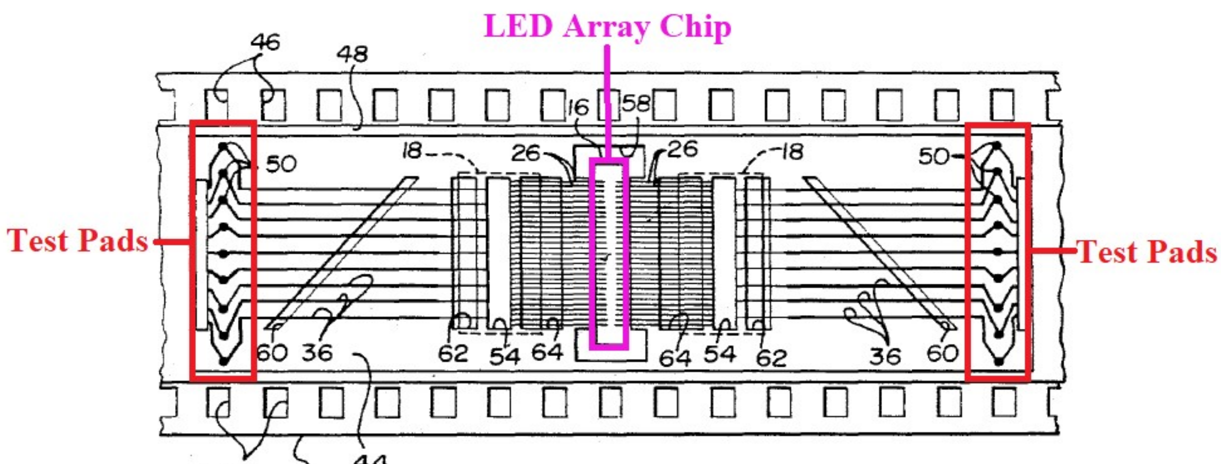


FIG. 4

(*Id*. at FIG. 4.)

F. Hsiao (Ex-1011)

Hsiao is U.S. Patent No. 7,178,951, filed April 4, 2006, and is at least pre-AIA 102(e) prior art. (Ex-1011-Hsiao at [22].) Hsiao is analogous art to the '415 patent. (*Id*. at 1:12-17, FIGS. 1-2; Ex-1003-Krames at ¶80.)

Hsiao discloses the configuration of a "conventional LCD," including a light unit disposed below a liquid crystal panel. (Ex-1011-Hsiao at FIG. 1, 1:19-60.)

VIII. SPECIFIC GROUNDS FOR PETITION

A. GROUND 1: Roberts Renders Obvious Claims 1-2, 7-8, and 11.

1. The Challenged Claims

Claim 1. [1-PRE] A light source apparatus comprising:

Irrespective of whether the preamble is limiting, Roberts teaches it. Specifically, Roberts discloses a ***lighting panel (40)*** which serves as a light source for a display.

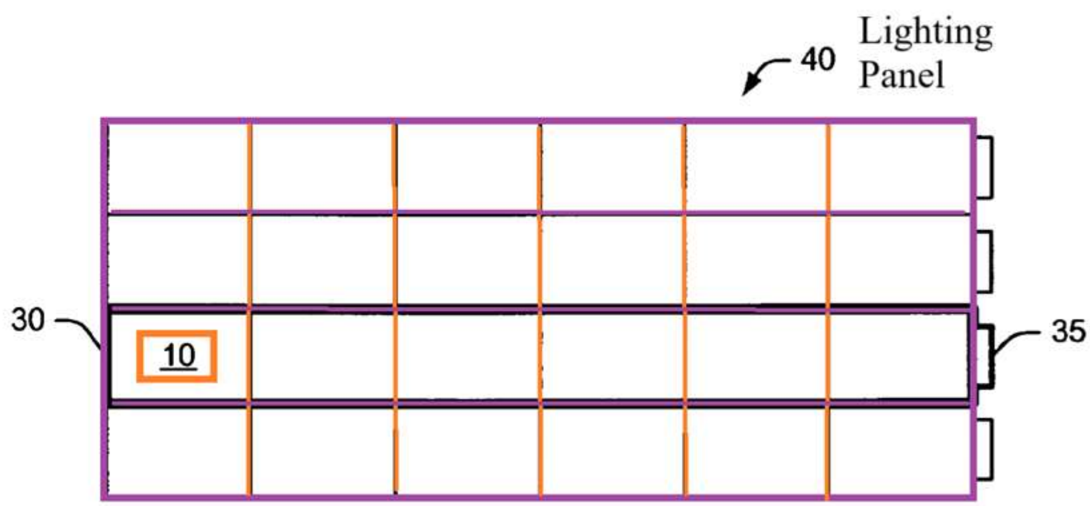


FIGURE 4B

(Ex-1004-Roberts at FIG. 4B, 0013, 0019, 0075-77.)

Thus, Roberts teaches limitation [1-PRE]. (Ex-1003-Krames at ¶¶81-83.)

[1a] at least one module substrate comprising connecting terminals at both side ends thereof;

Roberts teaches limitation [1a].

Roberts' lighting panel (40) includes a ***plurality of light bar assemblies (30)***, each of which includes a plurality of ***lighting tiles (10)*** (module substrates):

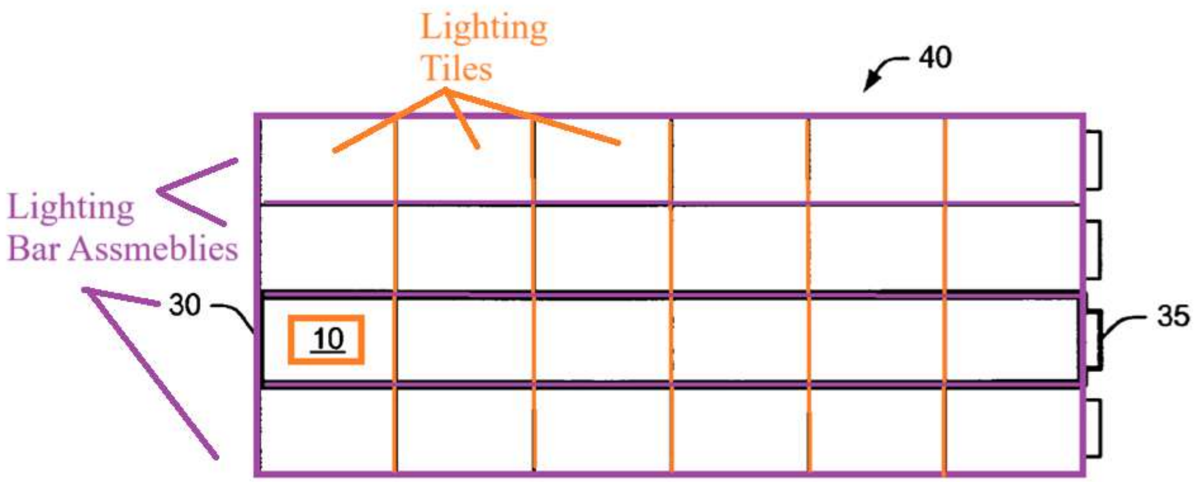


FIGURE 4B

(Ex-1004-Roberts at FIG. 4B, 0075.)

Each ***lighting tile (10)*** includes ***connecting terminals (contacts 22, 24, 26, 28)*** at both side ends thereof:

> "In the embodiments illustrated in FIG. 1, the lighting elements 12 are multi-chip clusters of four solid state emitting devices per cluster. In the tile 10, four lighting elements 12 are serially arranged in a first path 20, while four lighting elements 12 are serially arranged in a second path 21. The lighting elements 12 of the first path 20 are connected, for example via printed circuits, to *a set of four anode contacts 22 arranged at a first end of the tile 10, and a set of four cathode contacts 24 arranged at a second end of the tile 10*. The lighting elements 12 of the second path 21 are connected to *a set of four anode contacts 26*

<u>arranged at the second end of the tile 10, and a set of four cathode contacts 28 arranged at the first end of the tile 10</u>."

(*Id.* at 0061.)

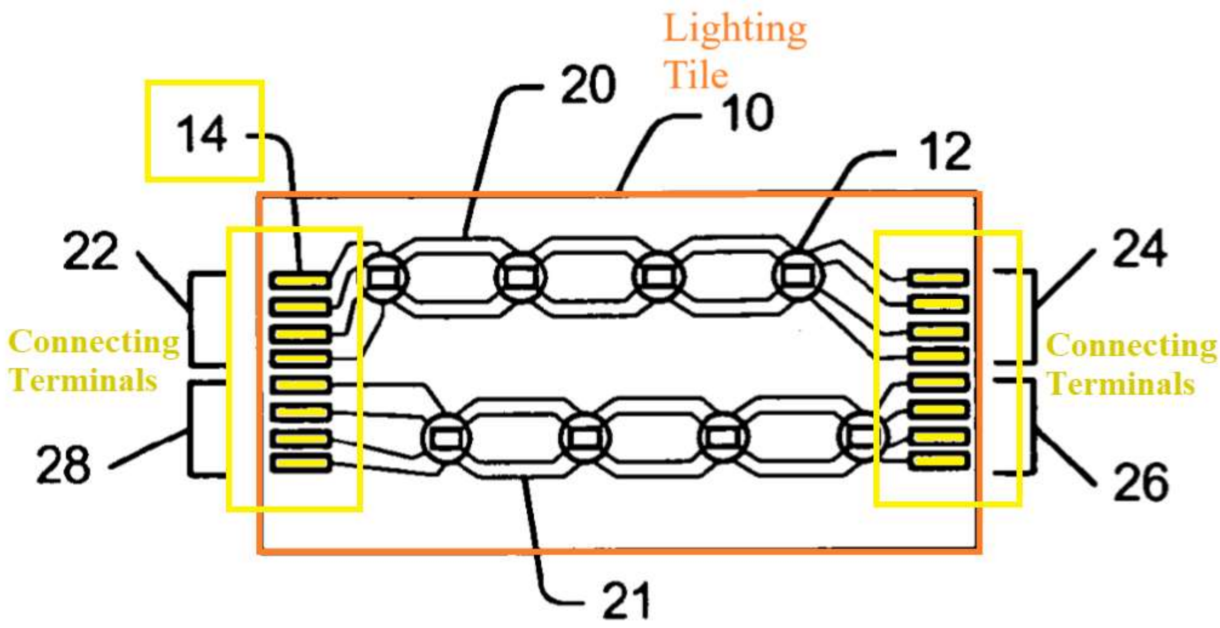


FIGURE 1

(*Id.* at FIG. 1.)

Thus, Roberts teaches limitation [1a]. (Ex-1003-Krames at ¶¶84-87.)

<u>[1b] a light emitting diode on the module substrate; and</u>

Roberts teaches limitation [1b].

Roberts discloses that each ***lighting tile (10)*** (module substrate) includes ***lighting elements (12)*** thereon, which may be ***LEDs*** (light emitting diodes):

"A solid state lighting tile 10 may include *<u>thereon</u>* a number of *<u>solid state lighting elements 12</u>* arranged in a regular and/or irregular one- or two-dimensional array."

(Ex-1004-Roberts at 0060.)

> "In some embodiments of the invention, ***the lighting elements 12 are chip-on-board clusters including*** ***one or more LEDs*** configured to emit in the *blue* or UV spectrum. A wavelength conversion material is arranged to receive light emitted by the LEDs and to responsively emit a longer wavelength light, such as a *red, green, blue and/or yellow light*."

(*Id.* at 0062.)

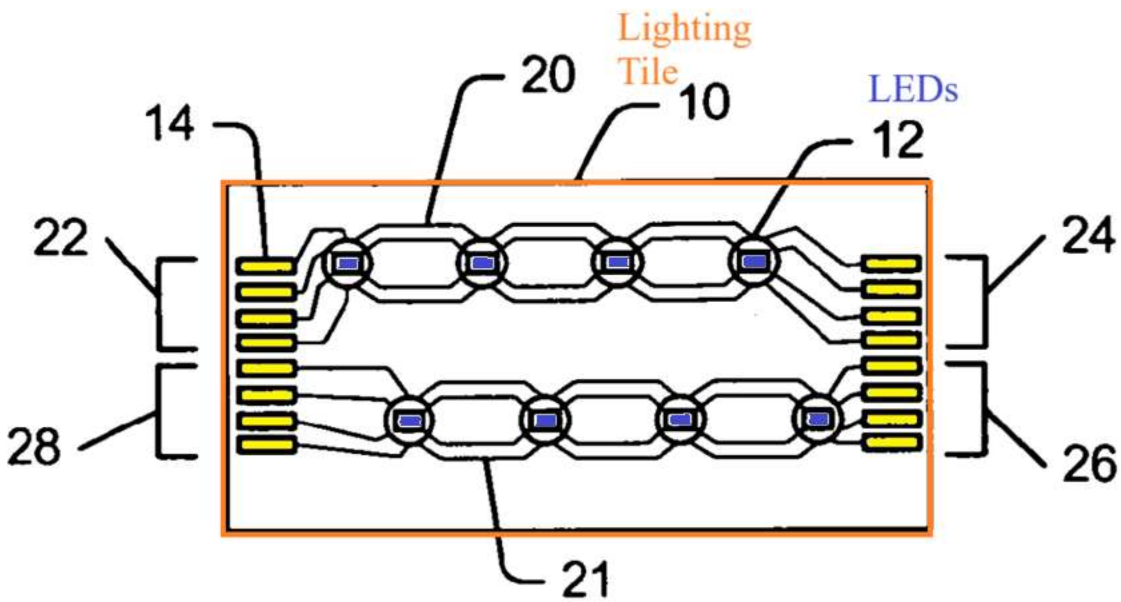


FIGURE 1

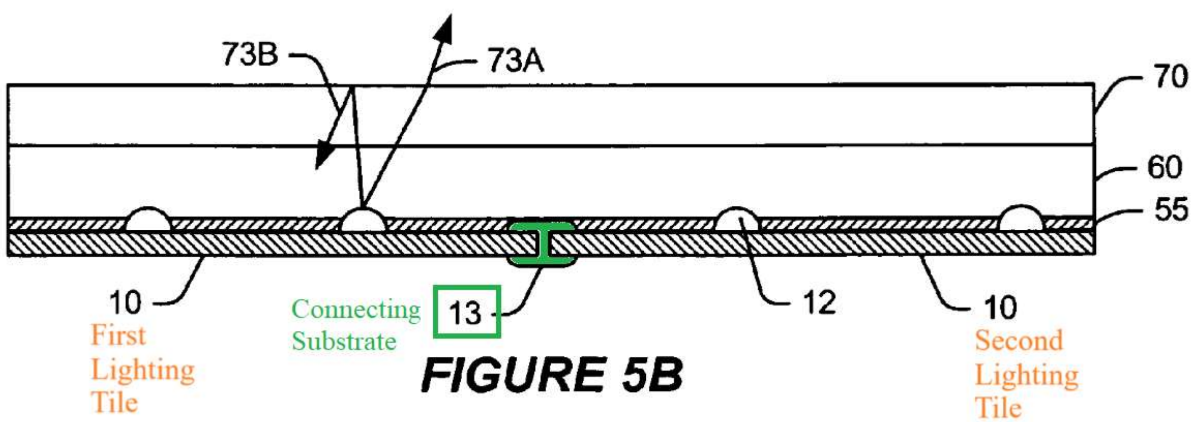
(*Id.* at FIG. 1; *see also id.* at 0013.)

Thus, Roberts teaches limitation [1b]. (Ex-1003-Krames at ¶¶88-90.)

[1c] a plurality of connecting substrates connected to the connecting terminals of the module substrate, wherein the connecting substrate comprises a termination connecting substrate, by which the connecting terminal provided at one end of a final module substrate of the module substrates is prepared as a closed loop circuit.

Roberts teaches and suggests limitation [1c].

Specifically, Roberts discloses that its ***lighting tiles (10)*** (module substrates) may be "*connected at respective opposing edges by an **edge connector 13** [connecting substrate], which may provide an **electrical** and/or mechanical connection between adjacent **tiles 10***." (Ex-1004-Roberts at 0082.)



(Ex-1004-Roberts at FIG. 5B.)

Roberts does not expressly disclose that its ***edge connectors 13*** (connecting substrates) are "connected to the connecting terminals of the module substrate." However, Roberts teaches and suggests, and a POSITA would have found it obvious, that Roberts' ***edge connectors 13*** are "connected to the connecting terminals of the module substrate." (Ex-1003-Krames at ¶93; Ex-1004-Roberts at 0082.) Roberts expressly discloses that its lighting tiles are electrically connected in series using the connecting terminals (e.g., anodes 22, 26 and cathodes 24, 28) and that the ***edge connectors 13*** provide the electrical connection between adjacent ***lighting tiles 10***. (*Id.* at 0071-74, 0082, FIG. 4A.) Thus, Roberts teaches and suggests, and a POSITA would have expected and would have found it obvious, that Roberts' ***edge connectors 13*** are "connected to the connecting terminals of the module substrate" to provide the electrical connection between adjacent tiles 10 (e.g., the electrical connection between the cathode contacts 24 and anode contacts 26 of a first tile 10 and the anode contacts 22 and cathode contacts 28, respectively, of a second tile 10′). (Ex-1003-Krames at ¶94.)

Roberts further discloses that its connecting substrates may include ***a loopback connector 35*** (termination connecting substrate). According to Roberts, each ***lighting bar assembly (30)*** may terminate at one end with ***a loopback connector 35***:

> "Furthermore, the cathode contacts 24 of the first path 20 of the rightmost tile 10" may be electrically connected to the anode contacts 26 of the second path 21 of the rightmost tile 10" ***by a loopback connector 35***. For example, ***the loopback connector 35 may electrically connect the cathode 24A of the string 20A of blue LED chips 16A of the first path 20 of the rightmost tile 10" with the anode 26A of the string 21A of blue LED chips of the second path 21 of the rightmost tile 10"***. In this manner, the string 20A of the first path 20 may be connected in series with the string 21A of the second path 21

> by a conductor 35A of the loopback connector 35 to form a single string 23A of blue LED chips 16. The other strings of the paths 20, 21 of the tiles 10, 10', 10" may be connected in a similar manner."

(Ex-1004-Roberts at 0072.)

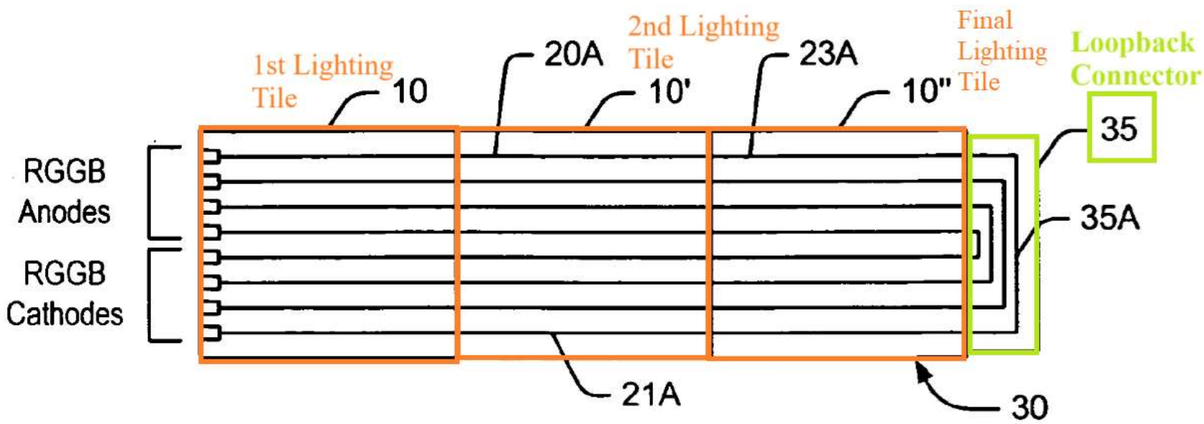


FIGURE 4A

(*Id.* at FIG. 4A.)

As Roberts illustrates, each cathode contact 24 at the rightmost end of the final lighting tile 10" is electrically connected to a corresponding anode contact 26 at the rightmost end of the final lighting tile 10" via a conductor 35A of ***the loopback connector 35*** in order to form a single string of individually colored LEDs (e.g., a first blue LED string, a second green LED string, etc.). (*Id.* at 0062, 0072; Ex-1003-Krames at ¶96.) In this way, the connecting terminal at the rightmost end of the final lighting tile 10" (the connecting terminal provided at one end of a final module substrate of the module substrates) is prepared, using Roberts' ***loopback connector***

35, as a "closed loop circuit" wherein each LED string is individually powered and controllable. (Ex-1003-Krames at ¶96.)

As Roberts explains:

> "***A current driver 220*** *provides independent current control for each of the LED strings 23* of the lighting panel 40. For example, the current driver 220 may provide *independent current control for 36 separate LED strings in the lighting panel 40*. The current driver 220 may provide a constant current source for each of the 36 separate LED strings of the lighting panel 40 under the control of a controller 230."

(Ex-1004-Roberts at 0097.)

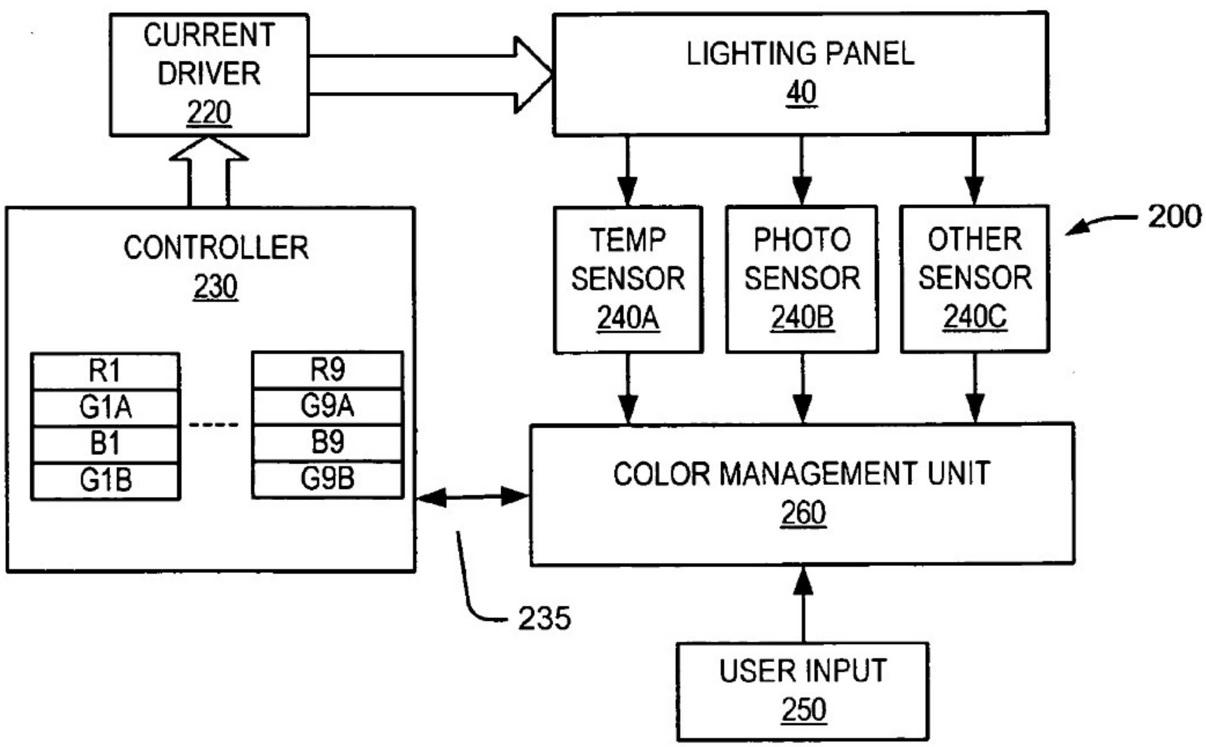


FIGURE 8

(*Id*. at FIG. 8.)

Indeed, Roberts seeks independent current control of each string in a ***lighting bar assembly***, which a POSITA would have known is facilitated using a closed-loop lighting circuit:

> "In order to allow consistent, controllable light output characteristics for a lighting panel, some embodiments of the invention provide *a lighting panel having two or more serial strings of LED chips. An independent current control circuit is provided for each of the strings of LED chips*. Furthermore, current to each of the strings may be individually controlled, for example, by means of pulse width modulation (PWM) and/or pulse frequency modulation (PFM). The width of pulses applied to a particular string in a PWM scheme (or the frequency of pulses in a PFM scheme) may be based on a pre-stored pulse width (frequency) value that may be modified during operation based, for example, on a user input and/or a sensor input."

(*Id.* at 0094; Ex-1003-Krames at ¶¶98-99.)

An embodiment of Roberts' closed-loop circuit as it relates to the blue LED string (20A, 21A) is illustrated below:

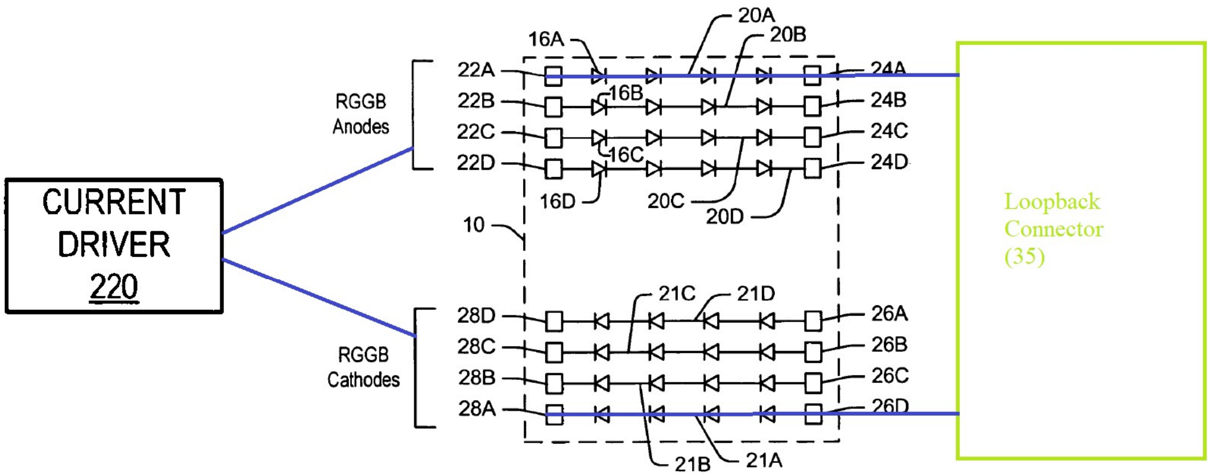


FIGURE 3

(Ex-1004-Roberts at FIG. 3; *see also id*. at 0067-69, 0072, FIGS. 5A and 8.)

Accordingly, Roberts teaches "wherein the connecting substrate comprises a termination connecting substrate, by which the connecting terminal provided at one end of a final module substrate of the module substrates is prepared as a closed loop circuit." (Ex-1003-Krames at ¶¶91-101.)

A POSITA would have understood that Roberts' ***edge connectors 13*** and ***loopback connectors 35*** are "connecting substrates" within the meaning of the Challenged Claims at least because they are physical structures/platforms upon which electrical interconnections between adjacent anode and cathode contacts are built or made. (Ex-1004-Roberts at FIGS. 4A and 5B, 0071-73, 0075, 0082; Ex-1003-Krames at ¶102.)

Thus, Roberts teaches and suggests limitation [1c]. (Ex-1003-Krames at ¶103.) Accordingly, Roberts teaches and renders obvious Claim 1. (*Id*. at ¶104.)

Claim 2. The light source apparatus as claimed in claim 1, wherein the connecting substrate comprises an intermediate connecting substrate connecting the connecting terminals of adjacent module substrates to each other.

Roberts teaches Claim 2.

Specifically, as explained above relative to limitation [1c], Roberts' ***edge connectors 13*** disclose, teach, and suggest "an intermediate connecting substrate connecting the connecting terminals of adjacent module substrates (***lighting tiles***) to each other." (Ex-1004-Roberts at FIGS. 4A and 5B, 0071-72, 0082.)

Accordingly, Roberts teaches and renders obvious Claim 2. (Ex-1003-Krames at ¶¶105-107.)

Claim 7. The light source apparatus as claimed in claim 1, wherein the light emitting diode comprises at least one LED chip having at least one color.

Roberts teaches Claim 7.

Specifically, Roberts teaches that the LEDs may comprise at least one LED chip that emits blue, red, green, and/or yellow light. (Ex-1004-Roberts at 0061-62, 0064, 0067.)

Thus, Roberts teaches and renders obvious Claim 7. (Ex-1003-Krames at ¶¶108-110.)

<u>Claim 8. The light source apparatus as claimed in claim 1, wherein the module substrate comprises a single-layer printed circuit board or a multi-layer printed circuit board.</u>

Preliminarily, it is noted that Claim 8 claims all possible versions of printed circuit boards ("PCBs"): single-layer or multi-layer. Thus, a disclosure of a module substrate comprising a PCB teaches Claim 8. (Ex-1003-Krames at ¶112.)

Roberts teaches Claim 8. Specifically, Roberts teaches that its ***lighting tiles (10)*** (module substrates) may comprise "a printed circuit board (PCB) on which one or more circuit elements, such as discrete light emitting components, may be mounted," such as "a metal core PCB (MCPCB)." (Ex-1004-Roberts at 0060.)

Thus, Roberts teaches and renders obvious Claim 8. (Ex-1003-Krames at ¶¶113-114.)

<u>Claim 11. The light source apparatus as claimed in claim 1, wherein the module substrate comprises white ink coated on the module substrate, except for a region where the LED chip is mounted.</u>

Roberts teaches Claim 11.

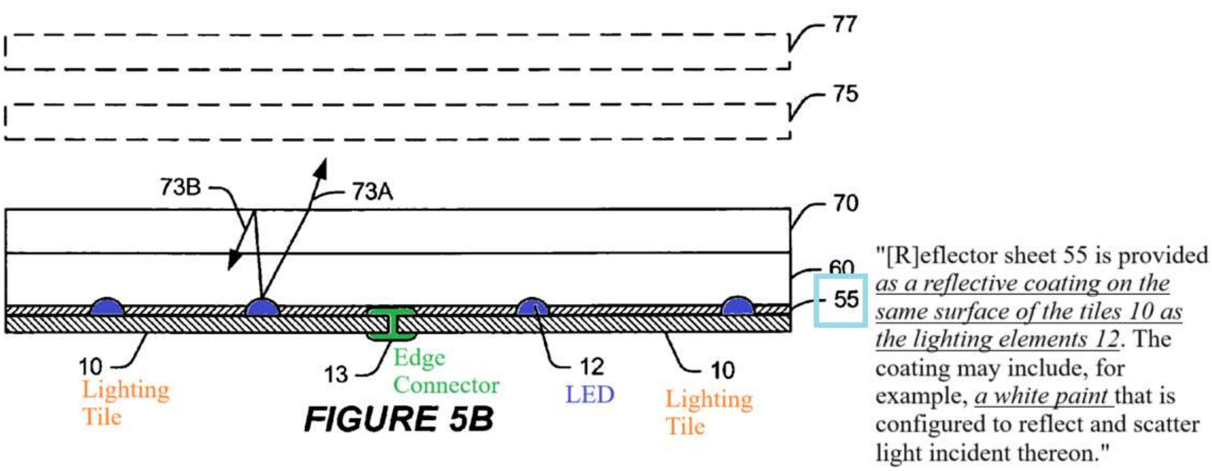
Specifically, Roberts teaches that a reflective coating, such as a "white paint," may share the "same surface" of the ***lighting tiles 10*** with the LEDs:

> "Additional embodiments of the invention are illustrated in FIG. 5B, in which a pair of tiles 10 are shown. The panels 10 may be connected at respective opposing edges by an edge connector 13, which may provide an electrical and/or mechanical connection between adjacent tiles 10. In the embodiments of FIG. 5B, ***a reflector sheet 55*** is <u>*provided as a reflective coating **on the same surface** of the tiles 10 as the lighting*</u>

> *elements 12*. The coating may include, for example, ***a white paint*** that is configured to reflect and scatter light incident thereon. A diffuser sheet 60 is provided on the reflector sheet 55."

(Ex-1004-Roberts at 0082.)

As shown in FIG. 5B, the reflector sheet 55 (white paint) is coated on the ***lighting tile 10*** (module substrate) except in regions where the ***LED chips (12)*** are mounted:



(*Id*. at FIG. 5B.) A POSITA would have known that "white paint" teaches and suggests "white ink" in this context, as the terms "white paint" and "white ink" were used interchangeably in the field to describe layers reflective to visible light. (Ex-1003-Krames at ¶118; Ex-1016-Weaver at 0004; Ex-1017-Kawano at 2:62-67, 13:1-7.)

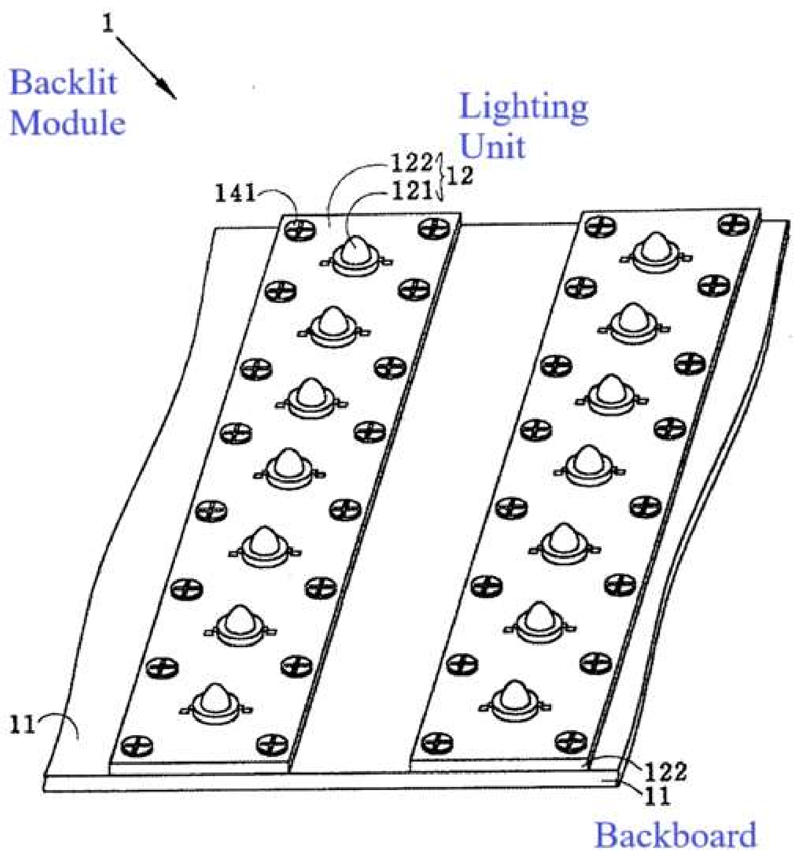
Thus, Roberts teaches and renders obvious Claim 11. (Ex-1003-Krames at ¶¶115-119.)

B. GROUND 2: Roberts in View of Liu Renders Obvious Claims 12 and 15.

1. Scope, Content and Motivation to Combine

For Ground 2, the prior art is Roberts (Ex-1004) and Liu (Ex-1005). As shown herein, Roberts teaches all limitations of the Ground 2 claims except "a housing comprising a receiving groove." Liu discloses this conventional feature.

As Liu explains, conventional LCDs at the time of Liu included "a backboard 11 and a plurality of lighting units 12 arranged in equal space and in parallel on the backboard 11." (Ex-1005-Liu at 0004.)

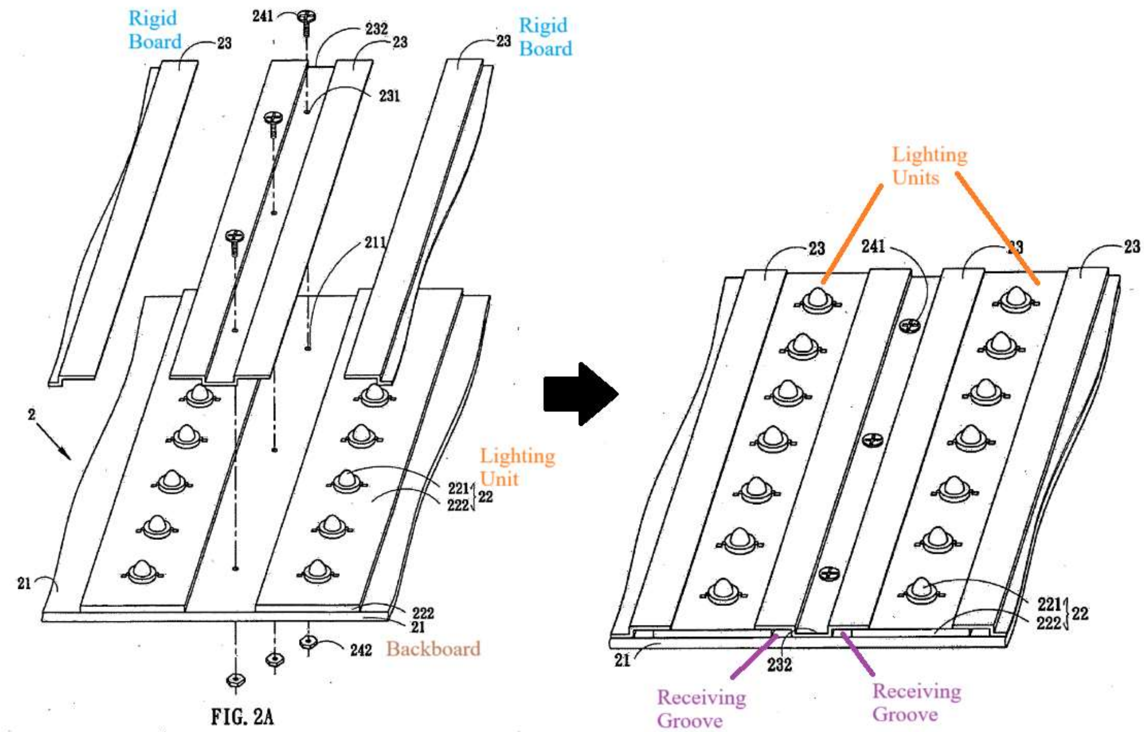


(*Id*. at FIG. 1, 0004-6.)

> "Each of the lighting units 12 includes a plurality of lighting elements 121 and an aluminum board 122 carrying the lighting elements 121, wherein the lighting elements 121 are soldered above the aluminum board 122 and connected with the conductive trace (not shown). And, the heat generated by operating the lighting units 12 is dissipated to the backboard 11 through the aluminum board 122."

(*Id.* at 0004.)

As Liu explains, the issue with this arrangement is that "since the material of the aluminum board 122 is not hard enough such that <u>*it is inevitable to have some voids between the aluminum board 122 and the backboard 11 to block [hinder] the thermal dissipation*</u>." (*Id.* at 0006.) Accordingly, Liu seeks "to firmly fasten the lighting units unto the backboard of the backlight module so that the assembling is simplified and the required amount of the nuts and bolts is greatly reduced." (*Id.* at 0007.) Liu therefore proposes a housing (backboard) and rigid board arrangement that securely holds lighting units to the housing, eliminating gaps/voids between the lighting units and the housing. (*Id.* at 0008.) The housing's rigid boards include a groove for receiving the lighting units and securing them to the housing:



(*Id*. at FIGS. 2A-2B.) This arrangement simplifies assembly while decreasing "the amount of the nuts and bolts required," and improving "thermal dissipation between the lighting units and the backboard." (*Id.* at 0009.)

A POSITA would have been motivated to apply Liu's teachings to Roberts. (Ex-1003-Krames at ¶125.) Roberts discloses a lighting display having a plurality of LED bars / lighting tiles that may be used as an LCD backlight. (Ex-1004-Roberts at 0095, 0134.) Roberts does not specifically disclose how to physically mount its lighting tiles / LED bars to a housing in the preparation of a backlit display. Liu does, explaining that mounting lighting boards (e.g., Roberts' lighting tiles / LED bars) for backlit applications is easier, uses less hardware, and facilitates improved heat transfer when using a rigid board to secure the lighting boards to the housing.

(Ex-1003-Krames at ¶125.) A POSITA would have found it obvious and beneficial to apply Liu's teachings to Roberts to ensure Roberts' lighting tiles / LED bars were securely mounted to a housing in a cost-effective manner. (*Id.*) Roberts, like Liu, seeks effective heat transfer from the back of its lighting tiles. (Ex-1004-Roberts at 0017, 0066, 0087-88.) Accordingly, a POSITA would have been motivated to apply Liu's light board mounting teachings to Roberts, wherein Liu's rigid boards are used to secure Roberts' lighting tiles / LED lighting bars to a housing. (Ex-1003-Krames at ¶125.)

A POSITA also would have had a reasonable expectation of successfully applying Liu's teachings to Roberts. It would have been straightforward to a POSITA to secure Roberts' lighting tiles / LED bars to a housing using Liu's rigid board teachings in the preparation of Roberts' backlit devices, merely requiring the use of conventional materials (e.g., conventional fasteners, Liu's rigid boards) to secure Roberts' lighting tiles / LED bars to a housing. (Ex-1003-Krames at ¶126.)

2. The Challenged Claims

Claim 12. [12-PRE] A light source apparatus comprising:

Roberts teaches limitation [12-PRE] for the same reasons as provided above relative to Ground 1, limitation [1-PRE]. (Ex-1003-Krames at ¶127.)

[12a] a housing comprising a receiving groove;

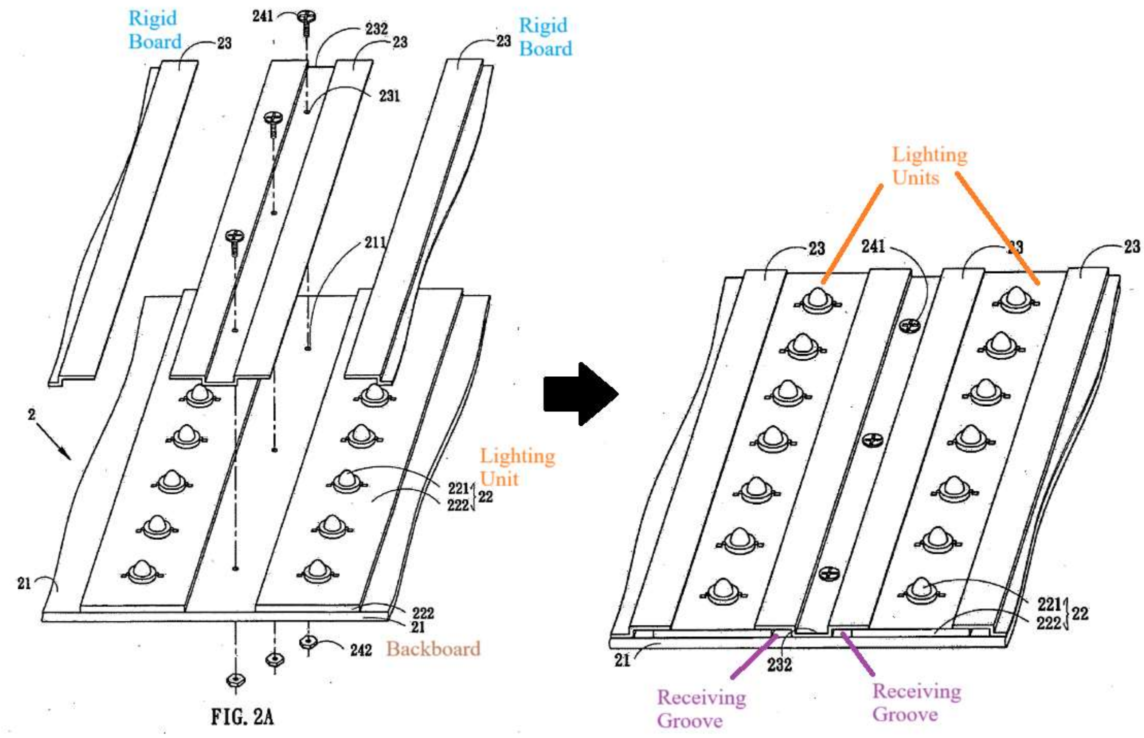
Roberts in view of Liu teaches limitation [12a].

Specifically, Liu teaches a backboard (housing) having a rigid board for securing lighting boards thereto:

> "According to the object described above, the present invention discloses a fastening device <u>*utilized in a backlight module*</u> to fasten the lighting units and the resultant backlight module. <u>*A rigid board partially laps over the adjacent lighting unit or units. The rigid board and the backboard have holes respectively such that bolts are passed through the holes and locked on nuts*</u>. Accordingly the rigid board exerts a compressing strength to fasten the adjacent lighting unit or units onto the backboard. In addition to the simplification of the assembling and the decrease of the amount of the nuts and bolts required, the efficiency of thermal dissipation between the lighting units and the backboard is further improved."

(Ex-1005-Liu at 0008.)

As shown by, for instance, FIGS. 2A-2B, Liu's housing (21) and rigid board (23) arrangement defines a groove for receiving a lighting board (22):



(Ex-1005-Liu at FIGS. 2A-2B; 0017-19.)

As explained above relative to §VIII.B.1, a POSITA would have been motivated to combine the teachings of Roberts and Liu with a reasonable expectation of success wherein Roberts' lighting tiles / LED bars are secured to a housing using Liu's rigid boards with a receiving groove. Applying Liu's teaching to Roberts would thus result in a "housing comprising a receiving groove." (Ex-1003-Krames at ¶131.)

Thus, Roberts in view of Liu teaches limitation [12a]. (*Id*. at ¶¶128-132.)

[12b] at least one module substrate which is received in the housing and has connecting terminals mounted at both side ends of the module substrate;

For the reasons explained in Ground 1, limitation [1a], Roberts teaches "at least one module substrate" having "connecting terminals mounted at both side ends of the module substrate." (Ex-1003-Krames at ¶133.)

Roberts in view of Liu teaches that Robert's lighting tiles (module substrates) are "receiv[ed] in the housing." Specifically, as explained above relative to §VIII.B.1, a POSITA would have been motivated to combine the teachings of Roberts and Liu with a reasonable expectation of success wherein Roberts' lighting tiles / LED bars are secured to a housing using Liu's rigid boards. Applying Liu's teaching to Roberts would thus result in Roberts' lighting tiles being "receiv[ed] in the housing." (*Id*. at ¶134.)

Thus, Roberts in view of Liu teaches limitation [12b]. (*Id*. at ¶135.)

[12c] a light emitting diode on the module substrate; and

Roberts teaches limitation [12c] for the same reasons as provided above relative to Ground 1, limitation [1b]. (Ex-1003-Krames at ¶136.)

[12d] a connecting substrate connected to the connecting terminal of the module substrate, wherein the connecting substrate comprises a termination connecting substrate, which allows a connecting terminal provided at one end of a final module substrate of the module substrates to be feedback in a form of a closed loop.

Roberts teaches and suggests limitation [12d] for the same reasons as provided above relative to Ground 1, limitation [1c]. (Ex-1003-Krames at ¶137.)

Specifically, as shown below, there are no material differences between limitations [1c] and [12d]:

Limitation [1c]	Limitation [12d]
a plurality of connecting substrates connected to the connecting terminals of the module substrate,	***a*** connecting substrate connected to the connecting terminal of the module substrate,
wherein the connecting substrate comprises a termination connecting substrate,	wherein the connecting substrate comprises a termination connecting substrate,
by which the connecting terminal provided at one end of a final module substrate of the module substrates ***is prepared as a closed loop circuit***.	***which allows a*** connecting terminal provided at one end of a final module substrate of the module substrates <u>***to be feedback in a form of a closed loop***</u>.

As shown, since Roberts discloses "a plurality of connecting substrates" [1c] it also discloses "a connecting substrate" [12d]. Similarly, because Roberts discloses a "connecting terminal provided at one end of a final module substrate of the module substrates is prepared as a closed loop circuit," [1c] Roberts also discloses "a connecting terminal provided at one end of a final module substrate of the module substrates to be feedback in a form of a closed loop" [12d]. Indeed, Challenged Claim 12 itself defines the claimed "feedback" to be in the "form of a closed loop" (*id.*), and Roberts teaches "closed loop" feedback for the same reasons discussed above. (Ex-1003-Krames at ¶138; Ex-1004-Roberts at FIG. 4A, 0072 (teaching a closed loop); *see also id.* at FIG. 8, 0025, 0033, 0094, 0097, 0099, 0126, 0134, 0136 (teaching closed loop feedback).)

Thus, Roberts in view of Liu renders obvious Claim 12. (Ex-1003-Krames at ¶¶139-140.)

Claim 15. The light source apparatus as claimed in claim 12, comprising at least one LED bar, on which the module substrates are connected to each other in series by the connecting substrate.

Roberts teaches Claim 15.

As explained above in Ground 1, limitation [1a], Roberts discloses a ***lighting panel (40)*** having a ***plurality of light bar assemblies (30)*** (LED bars), each comprising multiple ***lighting tiles 10*** (module substrates) that are "connected to each other":

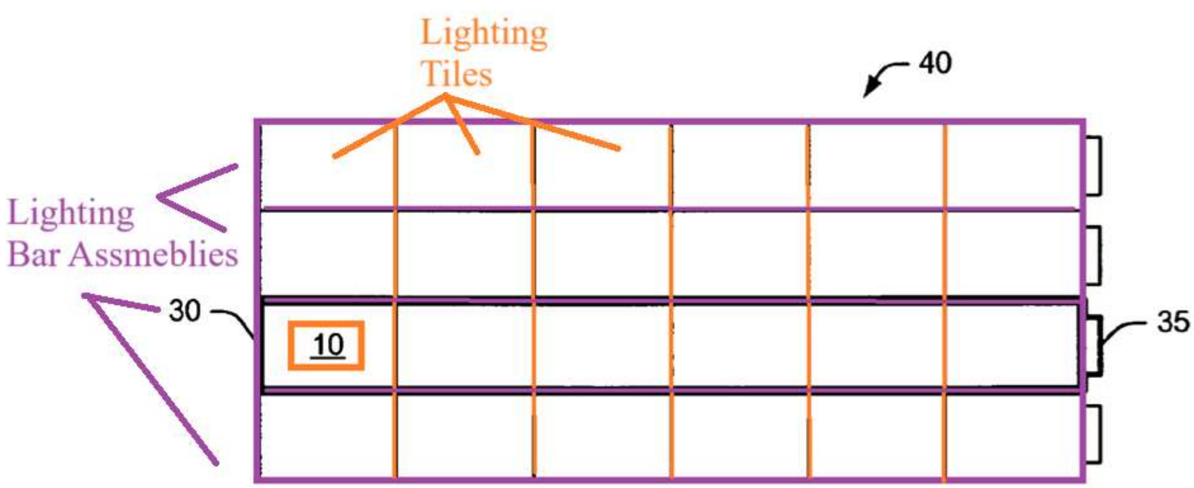


FIGURE 4B

(Ex-1004-Roberts at FIG. 4B, 0075.)

> "*Multiple tiles 10* may be assembled to form a larger *lighting bar assembly 30* as illustrated in FIG. 4A. As shown therein, a bar assembly 30 may include two or more tiles 10, 10', 10" *connected end-to-end*.

(*Id*. at 0071.)

Roberts further discloses that the lighting tiles (module substrates) are connected to each other in series:

> "In this manner, the string 20A of the first path 20 may be connected ***in series*** with the string 21A of the second path 21 by a conductor 35A of the loopback connector 35 to form a single string 23A of blue LED chips 16. The other strings of the paths 20, 21 of the tiles 10, 10', 10" may be connected in a similar manner."

(*Id.* at 0072; *see also id*. at 0067.)

Thus, Roberts teaches a "light source apparatus … comprising at least one LED bar, on which the module substrates are connected to each other in series." (Ex-1003-Krames at ¶¶142-144.)

Roberts also teaches that the module substrates are "connected to each other in series by the connecting substrate." (*Id*. at ¶145.) As explained in Ground 1, limitation [1c], the lighting tiles (module substrates) "are connected to each other in series by" "*an **edge connector 13** [connecting substrate], which may provide an **electrical** and/or mechanical connection between adjacent **tiles 10***." (Ex-1004-Roberts at 0082.)

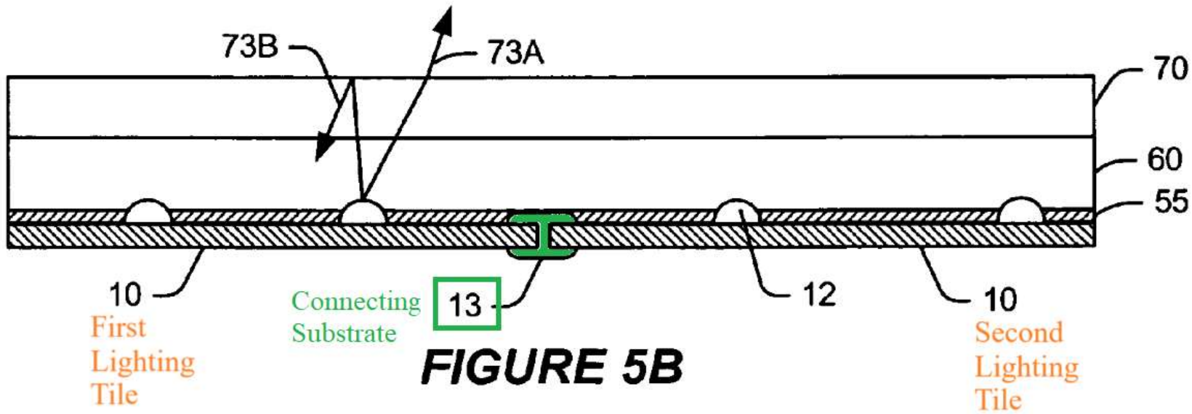


FIGURE 5B

(*Id.* at FIG. 5B.)

Thus, Roberts teaches Claim 15, and Roberts in view of Liu renders obvious Claim 15. (Ex-1003-Krames at ¶146.)

C. <u>GROUND 3</u>: Roberts in View of Karlicek Renders Obvious Claims 1-8 and 11.

1. Scope, Content and Motivation to Combine

For Ground 3, the art is Roberts in view of Karlicek, wherein Karlicek's "terminating element 50V" is used in addition to or in lieu of Roberts' ***edge connector 13*** to connect Roberts' lighting bar assemblies to an external power/voltage source. Also, for Ground 3, Karlicek's "interconnecting element 50A" is optionally used in lieu of or in addition to Roberts' ***edge connector 13*** to connect adjacent ***lighting tiles 10*** to one another.

As shown in Ground 1, Roberts discloses intermediate connecting substrates (***edge connector 13***) and termination connecting substrates (***loopback connector 35***) for connecting its lighting tiles:

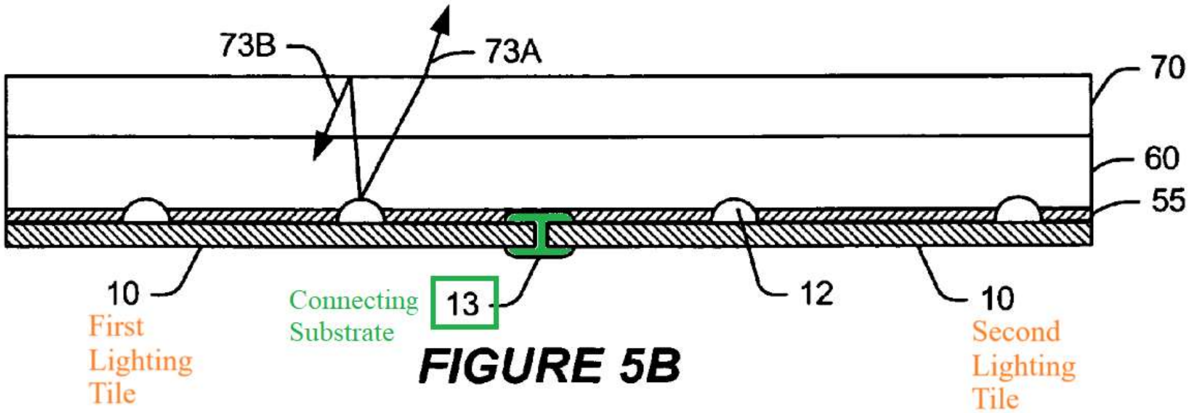


FIGURE 5B

(Ex-1004-Roberts at FIG. 5B.)

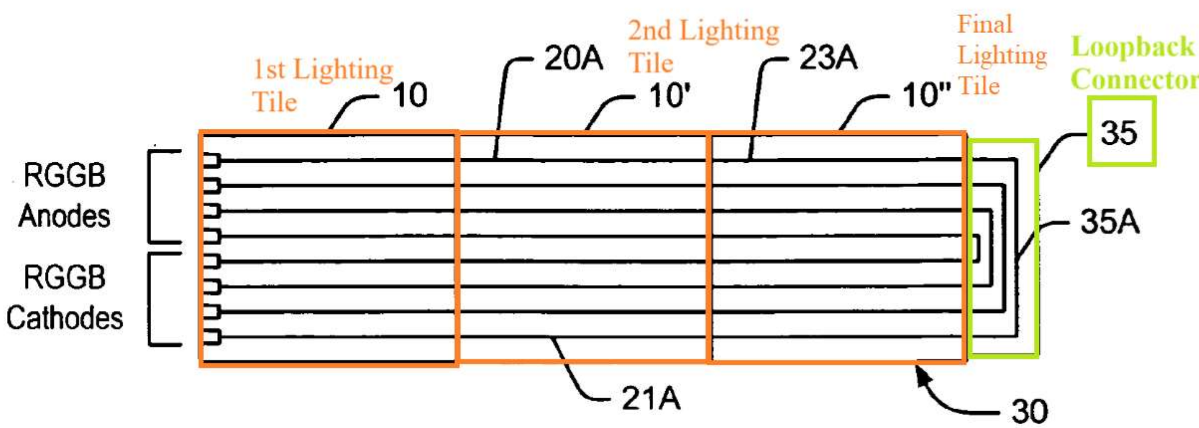


FIGURE 4A

(*Id.* at FIG. 4A.)

Roberts also discloses powering and individually controlling each LED string using an external current driver and controller:

> "*A current driver 220 provides independent current control for each of the LED strings 23 of the lighting panel 40*. For example, the current driver 220 may provide independent current control for 36 separate LED strings in the lighting panel 40. *The current driver 220 may*

<u>*provide a constant current source for each of the 36 separate LED strings of the lighting panel 40 under the control of a controller 230*</u>. In some embodiments, the controller 230 may be implemented using an 8-bit microcontroller such as a PIC18F8722 from Microchip Technology Inc., which may be programmed to provide pulse width modulation (PWM) control of 36 separate current supply blocks within the driver 220 for the 36 LED strings 23."

(*Id.* at 0097.)

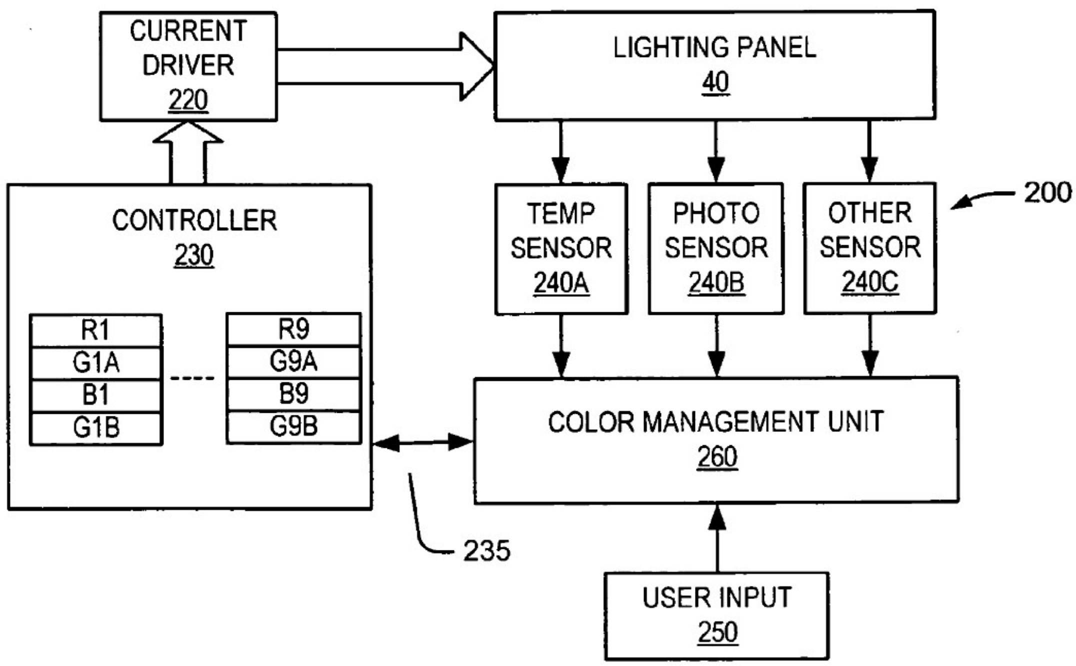
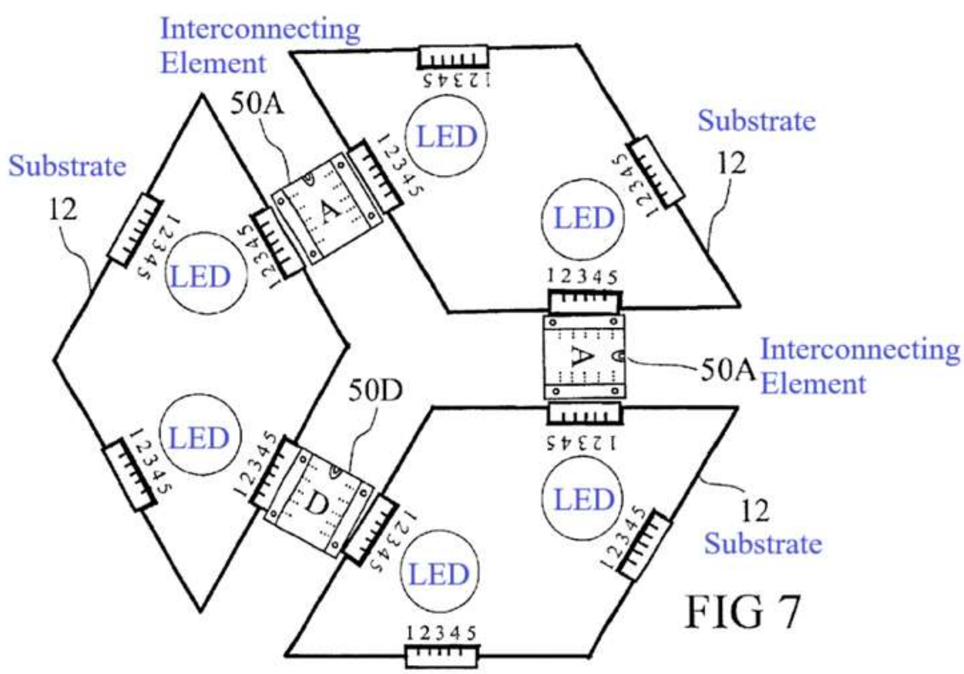


FIGURE 8

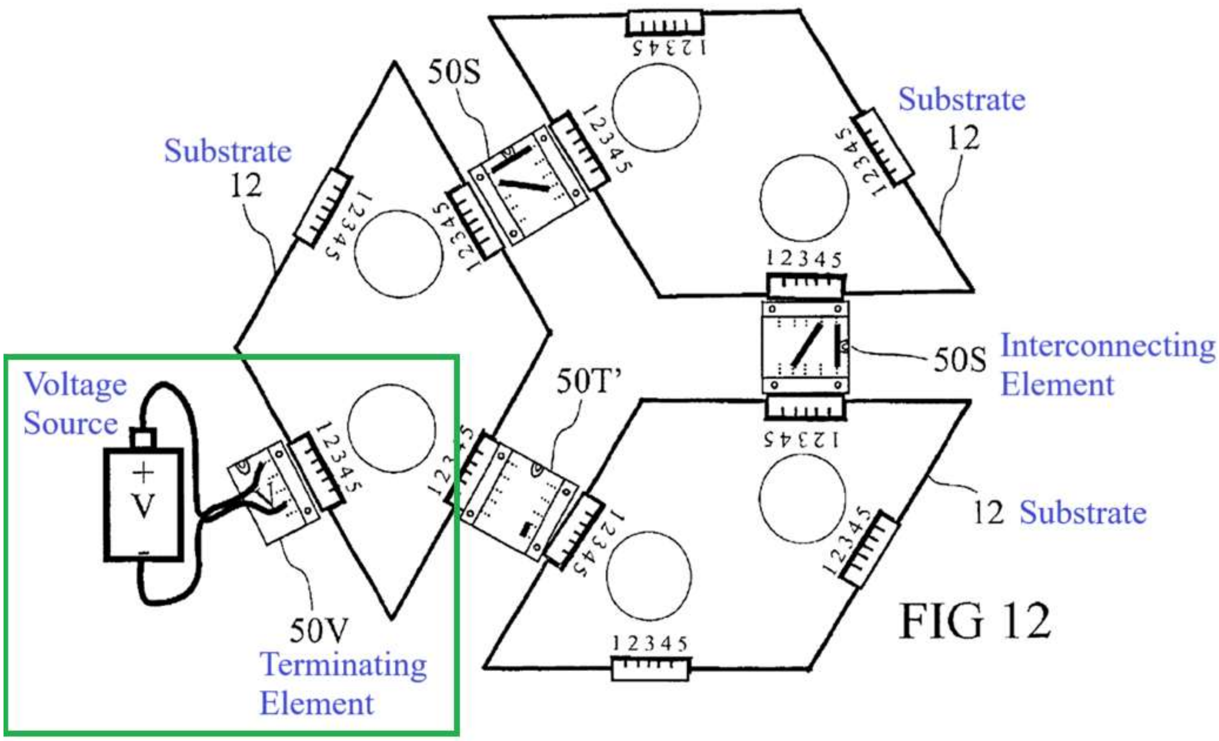
(*Id.* at FIG. 8.)

Like Roberts, Karlicek discloses a "plurality of substrates 12 each have one or more components 14 arranged thereon," such as "LED components." (Ex-1006-Karlicek at 0046.) Like Roberts, "each substrate 12 includes one or more connectors 16 that effectuate interconnection of the substrates 12" and "to effectuate electrical interconnection of the components 14 across the boundaries of paired substrates 12." (*Id.* at 0049.) Similar to Roberts' ***edge connector 13***, Karlicek employs an "interconnecting element 50A" that "operatively connects to a pair of connectors 16 at mating ports 52 and 54 of the interconnecting element 50A. … The interconnecting element 50A also has a pre-selected electrical configuration that effectuates a desired electrical arrangement of the components of the connected substrates 12, such as a series connection arrangement, parallel connection arrangement, or the like." (*Id.* at 0055.)



(*Id.* at FIG. 7.)

Karlicek further describes and illustrates a convenient manner of connecting an end of a plurality of substrates 12 to a voltage source (V) using a terminating element 50V:



(*Id.* at FIG. 12; 0061.)

A POSITA would have been motivated to apply Karlicek's substrate interconnection teachings to Roberts. (Ex-1003-Krames at ¶153.) Like Roberts, Karlicek seeks to connect multiple LED substrates (tiles) in series using connectors to power LEDs:

> "A plurality of PC board traces connect the LEDs 14a, 14b to the connectors 16 and optionally also connect the LEDs 14a, 14b to each another. For example, *a trace 40 can be used to interconnect the LED's*

> *14a, 14b electrically in series*. … In one embodiment, *the connectors 16 are formed into the edges of the PC board 24 so that the traces advantageously directly connect to the electrical conductor members comprising the connectors 16, and the connectors 16 are readily accessible at the edges of the substrate 12*. … In the illustrated exemplary embodiment of FIG. 5, the LEDs 14a, 14b are connected in series on the substrate 12."

(Ex-1006-Karlicek at 0053.)

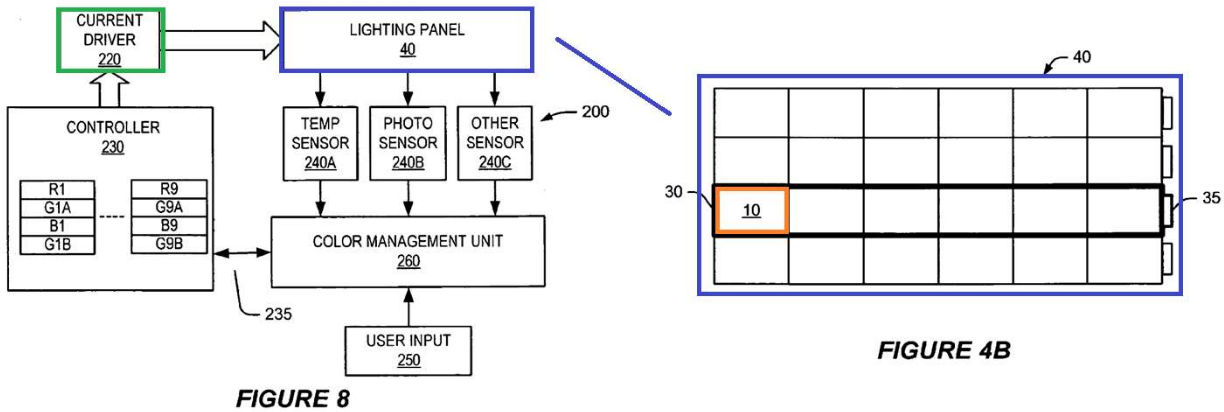
Also like Roberts, Karlicek employs intermediate edge connectors to facilitate electrical and mechanical interconnections among the plurality of LED substrates:

> "With reference now to FIGS. 6 and 7, an approach for effectuating the interconnection of pairs of connectors 16 is described. An interconnecting element 50A of a type "A" operatively connects to a pair of connectors 16 at mating ports 52 and 54 of the interconnecting element 50A. The interconnecting element 50A mechanically connects to the two substrates 12 that have the pair of connectors 16 to effectuate structural interconnection between the two substrates 12. The mechanical connection can be by a frictional fit (not shown) or by fastenings 56 which can be screws, rivets, or the like. The interconnecting element 50A also has a pre-selected electrical configuration that effectuates a desired electrical arrangement of the components of the connected substrates 12, such as a series connection arrangement, parallel connection arrangement, or the like."

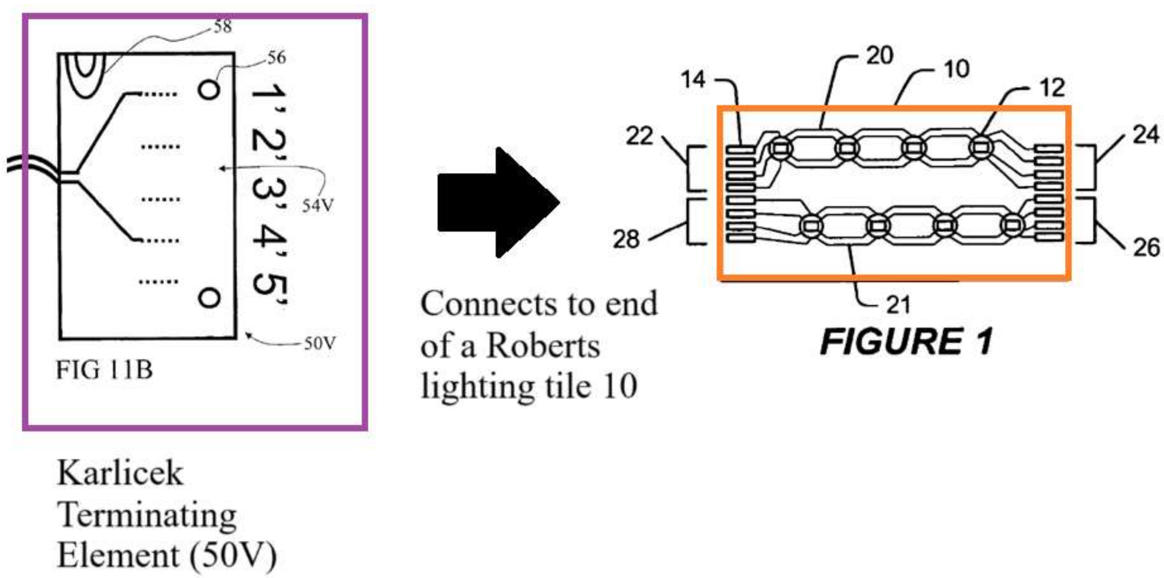
(*Id.* at 0055 (explaining intermediate edge connectors); *see also id*. at FIGS. 6-7.)

Roberts does not expressly disclose how its lighting bars are connected to the external current driver (220) / controller (230), and does not provide specific implementation details for its edge connectors 13. However, a POSITA would have recognized that Karlicek's terminating element (50V) and interconnecting elements (50A) would have been useful in connecting an end of Roberts' LED bar (30) to Roberts' current driver (220) / controller (230) and for implementing Roberts' edge connectors 13, respectively. (Ex-1003-Krames at ¶155.)

Karlicek provides a simple, modular solution for connecting a series of LED tiles to each other and to a power source, which aligns with Roberts' modular approach to preparing a lighting panel having multiple LED bars with any suitable number of lighting tiles. (Ex-1006-Karlicek at 0062-63, 0065-66.) Karlicek's terminating element (50V) would have provided an easy and straightforward manner of connecting Roberts' LED bars to Roberts' current driver (220) / controller (230), merely requiring a properly configured Karlicek terminating element (50V) to be employed with the anode and cathode contacts (22, 24, 26, 28) of a lighting tile 10 located at an end of Roberts' lighting bar 30. (Ex-1003-Krames at ¶156.) Karlicek's interconnecting elements (50A) would have similarly provided an easy and straightforward manner of implementing Roberts' edge connectors 13, merely requiring properly configured Karlicek interconnecting elements (50A) to be employed with the anode and cathode contacts (22, 24, 26, 28) of adjacent lighting tiles 10. (*Id*.)



(Ex-1004-Roberts at FIGS. 8, 4B (showing Roberts' current driver (220) is connected to each LED bar (30) of Roberts' lighting panel (40) via a leftmost lighting tile (10).)



(Ex-1006-Karlicek at FIG. 11B; Ex-1004-Roberts at FIG. 1.)

As desired by Roberts, Karlicek's terminating element (50V) and interconnecting elements (50A) facilitate independent control of different colored LED strings:

> "With reference now to FIGS. 13 and 14, another embodiment of the modular mounting assembly is described. A substrate 12RGB has six LED components arranged thereon: <u>*a first red LED component 14aR*</u>, <u>*a first green LED component 14aG, and a first blue LED component 14aB*</u> arranged in a first receiving well 22a; and <u>*a second red LED component 14bR, a second green LED component 14bG, and a second blue LED component 14bB*</u> arranged in a second receiving well 22b, as shown. <u>*The first and second LED component of each color is connected in series by PC board traces 40R, 40G, and 40G. In order to accommodate the greater number of anode and cathode terminals in this tri-color substrate 12RGB, connectors 16RGB having seven conductor members each is used. As shown in the electrical schematic of FIG. 14, each of the three colors is independently addressable*</u>: conductor members 1 and 4 connect to the red LED series; conductor members 2 and 5 connect to the green LED series; and conductor members 3 and 6 connect to the blue LED series. The conductor member 1 serves as circuit ground in the substrate 12RGB. For substrates having more complex interconnections such as those shown in FIGS. 13 and 14, two-level or even more complex PC boards can be used to accommodate the larger number of traces involved."

(Ex-1006-Karlicek at 0066.)

Karlicek also teaches that its terminating element (50V) and interconnecting elements (50A) are advantageously "standardized," which beneficially allows highly complex modular assemblies to be created in a relatively simple manner:

> "However, it will be appreciated that highly complex modular assemblies including dozens, hundreds, or even greater numbers of LED components having complex spatial arrangements, electrical interconnections, electrical sub-circuits, and the like can be created by appropriate selection and arrangement of a standardized set of substrates, interconnecting elements, and terminating elements. Another advantage of the present invention is that replacement of a failed LED component is greatly simplified, and requires only replacement of the substrate on which the failed LED component is disposed."

(*Id*. at 0065; *see also id*. at 0004-5, 0062.)

Additionally, a POSITA would have appreciated that Karlicek's interconnecting elements (50A) are substantially flat and may be located on a single side of an LED tile (e.g., a top side of an LED tile). (*Compare* Ex-1004-Roberts at FIG. 5B *with* Ex-1006-Karlicek at FIGS. 6-7.) A POSITA would have recognized that using Karlicek's substantially flat interconnecting elements (50A) to implement Roberts' edge connectors 13 would have beneficially provided an even bottom surface of Roberts' module substrates, which would have facilitated easy mounting of Roberts' module substrates on a housing (e.g., the housing of an LCD backlight assembly). (Ex-1003-Krames at ¶159.) Karlicek's interconnecting elements (50A) also provide for a more compact LED bar design as the volume between adjacent tiles is reduced and/or eliminated since the interconnecting substrate (50A) is entirely located on upper surfaces of Roberts' adjacent tiles. (*Id.*)

A POSITA also would have had a reasonable expectation of applying Karlicek's substrate interconnection teachings to Roberts. (Ex-1003-Krames at ¶160.) Like Roberts, Karlicek teaches individual power/control of each LED string (blue, red, etc.):

> "In order to accommodate the greater number of anode and cathode terminals in this tri-color substrate 12RGB, connectors 16RGB having seven conductor members each is used. *As shown in the electrical schematic of FIG. 14, each of the three colors is independently addressable*: conductor members 1 and 4 connect to the red LED series; conductor members 2 and 5 connect to the green LED series; and conductor members 3 and 6 connect to the blue LED series."

(Ex-1006-Karlicek at 0066; Ex-1004-Roberts at 0094, 0097.) Further, like Roberts, Karlicek teaches connecting each LED string in series. (Ex-1006-Karlicek at 0053-54, 0058; Ex-1004-Roberts at 0067, 0072.) Implementing Karlicek's terminating element (50V) and interconnecting elements (50A) with Roberts would have been straightforward to a POSITA, merely requiring implementing Karlicek's terminating element (50V) and interconnecting elements (50A) in a form factor and with a wiring scheme that matched Roberts' LED bar requirements. (Ex-1003-Krames at ¶161.)

2. The Challenged Claims

<u>Claims 1-2, 7-8, and 11</u>

As discussed above with respect to Ground 1, Roberts renders obvious Claims 1-2, 7-8, and 11, with Roberts' edge connectors 13 disclosing, teaching, and suggesting the claimed "connecting substrates." To the extent the term "connecting substrate" is improperly and narrowly construed to require a substantially flat substrate, Roberts in view of Karlicek renders obvious Claims 1-2, 7-8, and 11.

Karlicek discloses substantially flat interconnecting elements (50A) that provide an electrical and mechanical connection between adjacent module substrates 12. (Ex-1006-Karlicek at FIGS. 6-7, 0055-56.) A POSITA would have understood that Karlicek's interconnecting elements (50A) are "connecting substrates" within the meaning of the Challenged Claims at least because they are physical structures/platforms upon which electrical interconnections between the conductors of adjacent module substrates are built or made. (Ex-1006-Karlicek at FIGS. 8A-B and 9A-B, 0058-59; Ex-1003-Krames at ¶164.) As explained in §VIII.C.1, a POSITA would have been motivated to implement Roberts' edge connectors 13 using Karlicek's interconnecting elements (50A) with a reasonable expectation of success. (Ex-1003-Krames at ¶164.)

Accordingly, even if the term "connecting substrate" is improperly and narrowly construed to require a substantially flat substrate, Roberts in view of

Karlicek renders obvious Claims 1-2, 7-8, and 11 for the reasons provided above in Ground 1, wherein Karlicek's substantially flat interconnecting elements (50A) are used with Roberts' ***lighting bar assemblies 30*** to electrical and mechanically connect adjacent Roberts ***lighting tiles 10***. (Ex-1003-Krames at ¶165.)

Claim 3. The light source apparatus as claimed in claim 1, [3a] wherein the connecting substrate comprises an external connecting substrate which is disposed at a first end of a first module substrate of the module substrates, and

Roberts in view of Karlicek teaches limitation [3a].

As explained in Ground 1, Claim 1, Roberts teaches ***lighting tiles 10*** (module substrates) having ***contacts (22, 24, 26, 28)*** (connecting terminals) at each end of the tile, and that a series of lighting tiles makes up an individual ***lighting bar assembly 30***:

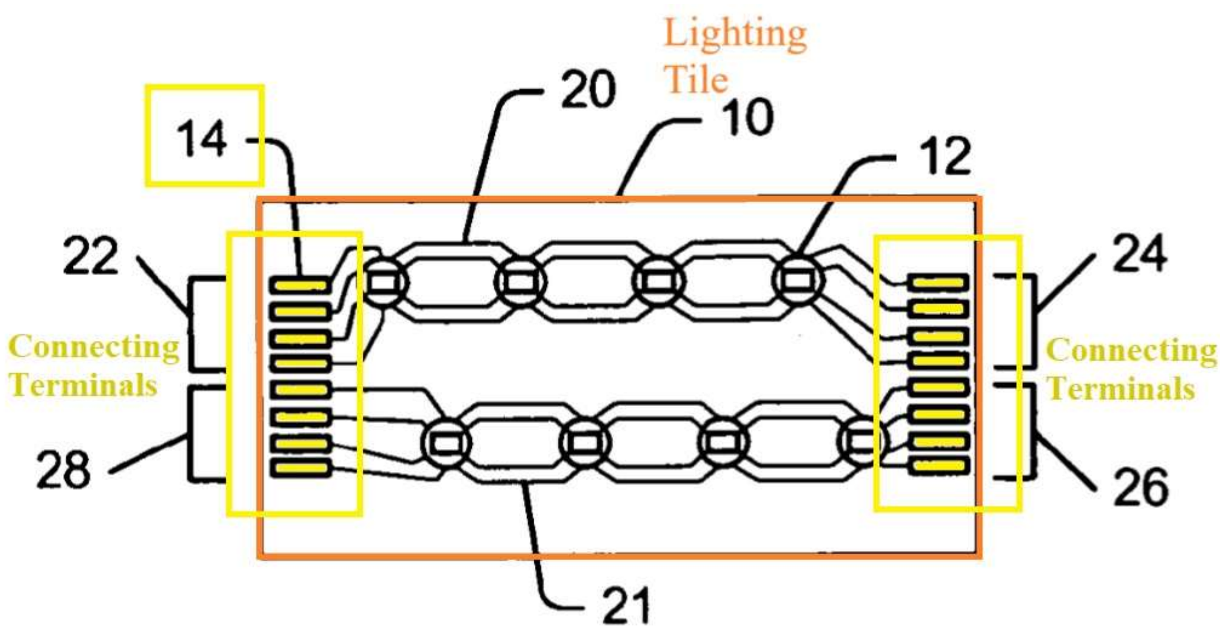


FIGURE 1

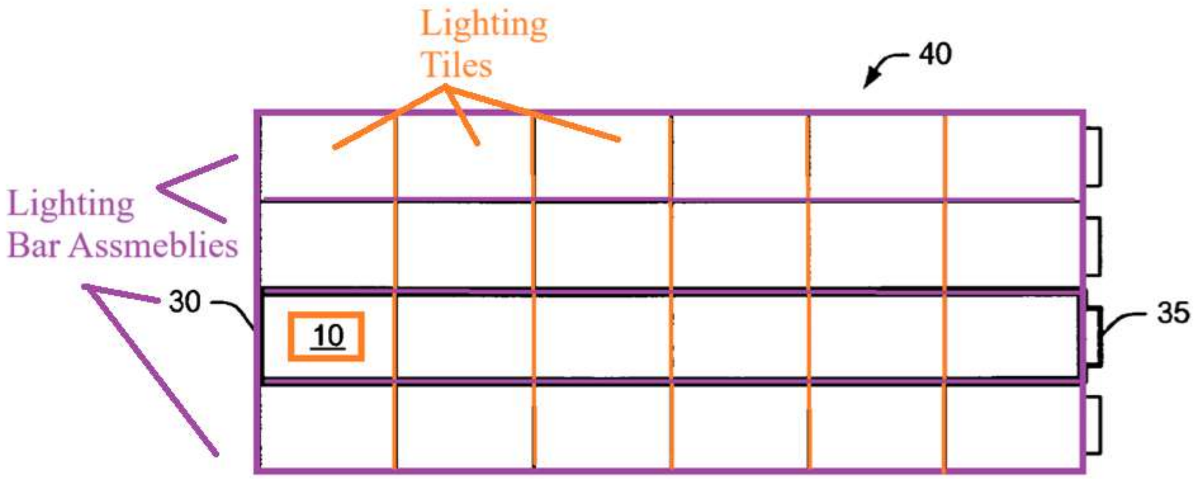


FIGURE 4B

(Ex-1004-Roberts at FIGS. 1, 4B.)

As explained in §VIII.C.1, *supra*, Roberts teaches that each of its lighting bars should be connected to an external current driver, but does not provide conventional implementation details for doing so. Karlicek does.

Specifically, Karlicek teaches the use of a terminating element 50V (external connecting substrate) that connects a first end of the first of a series of lighting tiles (module substrates) to an external voltage source (current driver):

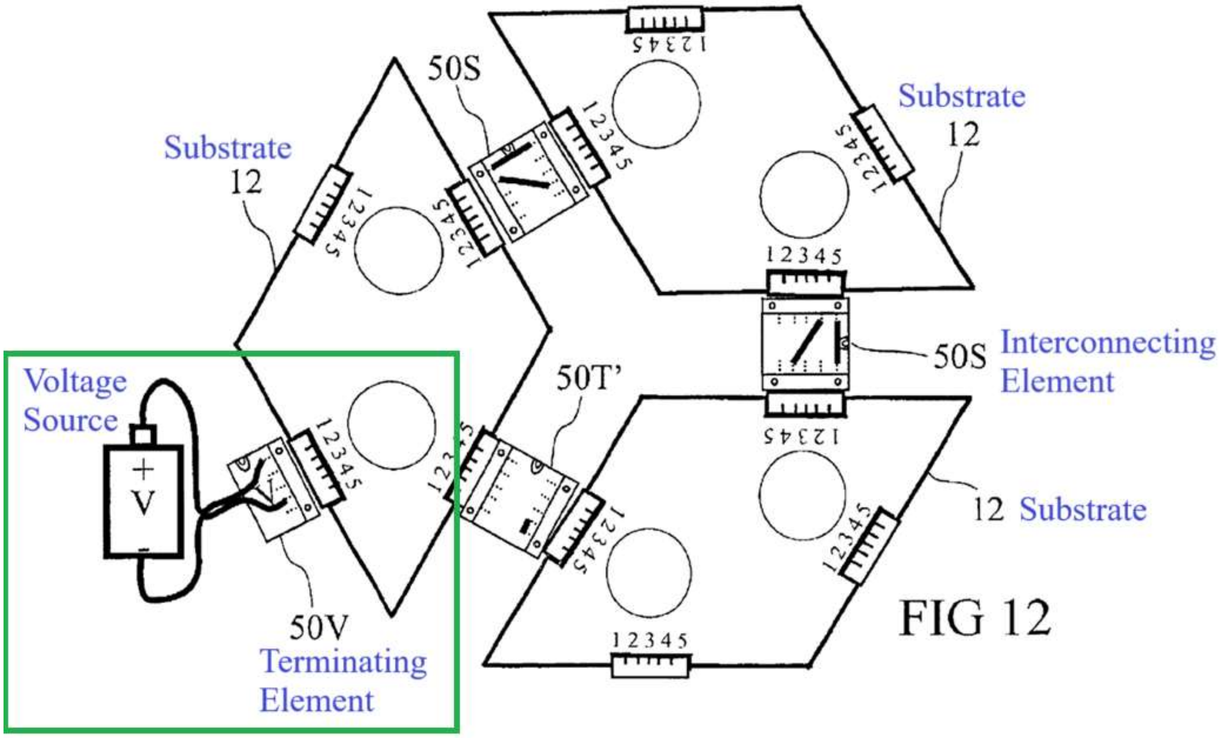


FIG 12

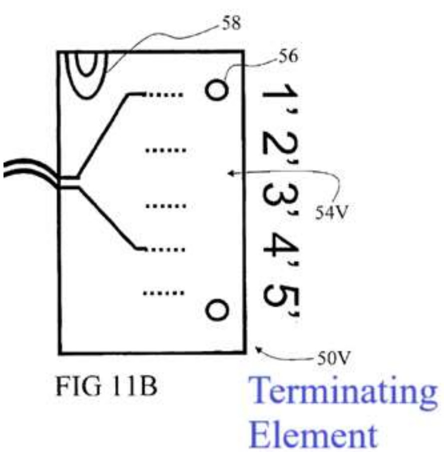
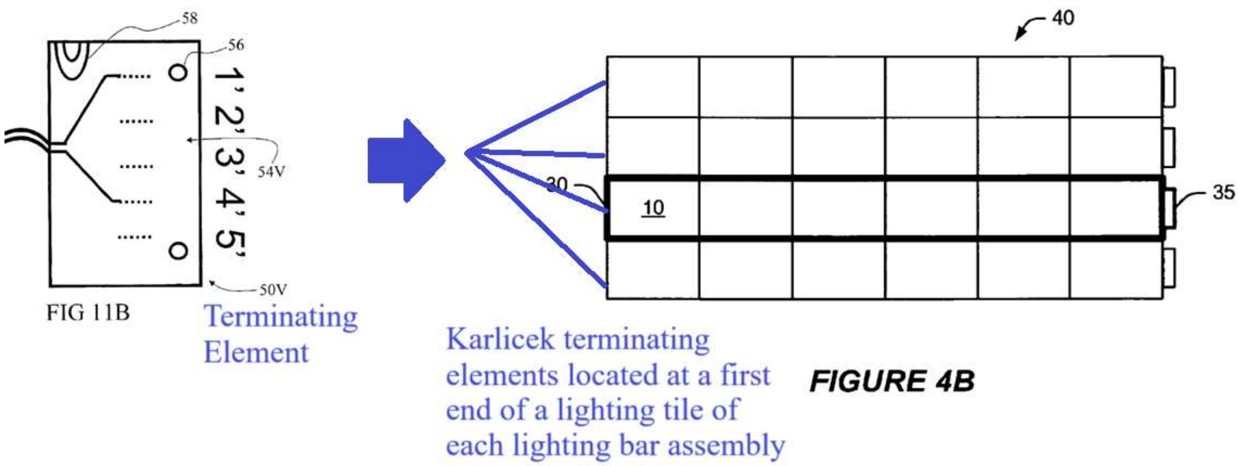


FIG 11B

(Ex-1006-Karlicek at FIGS. 12, 11B, 0061.) As shown and described, Karlicek's terminating element 50V is configured as a substrate. (*Id.* at FIGS. 11B, 12; 0055, 0061.)

As explained in §VIII.C.1, a POSITA would have been motivated to apply Karlicek's terminating element teachings to Roberts and with a reasonable expectation of success, wherein each of Roberts' lighting bar assemblies is connected to Roberts' current driver (220) / controller (230) via Karlicek's terminating element (50V) (external connecting substrate), which is disposed at a first end of a first lighting tile (module substrate) of each lighting bar assembly:



(Ex-1006-Karlicek at FIG. 11B, 0061; Ex-1004-Roberts at FIG. 4B, 0075.)

Thus, Roberts in view of Karlicek teaches limitation [3a]. (Ex-1003-Krames at ¶¶166-172.)

<u>[3b] an intermediate connecting substrate which connects the connecting terminal of the first module substrate with the external connecting substrate and/or between the connecting terminal of the module substrates.</u>

Because of its use of "and/or," limitation [3b] has two options. A first option is that an intermediate connecting substrate "connects the connecting terminal of the first module substrate with the external connecting substrate." A second option is that an intermediate connecting substrate provides that connection "between the connecting terminal of the module substrates." As explained in Ground 1, limitation [1c] and Claim 2, Roberts teaches the second option. (Ex-1003-Krames at ¶¶174-175.)

Specifically, Roberts' ***edge connector 13*** is "an intermediate connecting substrate" that electrically interconnects the connecting terminals of adjacent lighting tiles (module substrates), i.e., connects "between the connecting terminal of the module substrates." (Ex-1004-Roberts at 0082.)

Thus, Roberts teaches limitation [3b], and Roberts in view of Karlicek renders obvious Claim 3. (Ex-1003-Krames at ¶176.)

Claim 4. The light source apparatus as claimed in claim 3, wherein the connecting substrate comprises a connecting terminal, which corresponds to at least one of connecting terminals provided at both side ends of the module substrate.

Roberts teaches and suggests Claim 4.

Specifically, Roberts suggests, and a POSITA would have expected and would have found it obvious, that Roberts' ***edge connector 13*** (connecting substrate) would have had a "connecting terminal" that corresponds to the connecting terminal provided at the side end of the ***lighting tile 10*** (module substrate) that the ***edge connector 13*** is connected to. Roberts teaches that its ***edge connectors 13*** are separate components that provide "an electrical and/or mechanical connection between adjacent tiles" (Ex-1004-Roberts at 0082), and a POSITA would have understood that providing such a corresponding "connecting terminal" in the ***edge connector 13*** would have facilitated the electrical interconnection between adjacent tiles. (Ex-1003-Krames at ¶178.)

Thus, Roberts in view of Karlicek renders obvious Claim 4. (*Id*. at ¶179.)

Claim 5. The light source apparatus as claimed in claim 3, wherein the external connecting substrate comprises an external connector to which a light emitting diode driver is connected.

Roberts in view of Karlicek teaches Claim 5.

As explained above relative to Claim 3, Karlicek discloses a terminating element (external connecting substrate). Karlicek's terminating element comprises "an external connector to which a light emitting diode driver is connected."

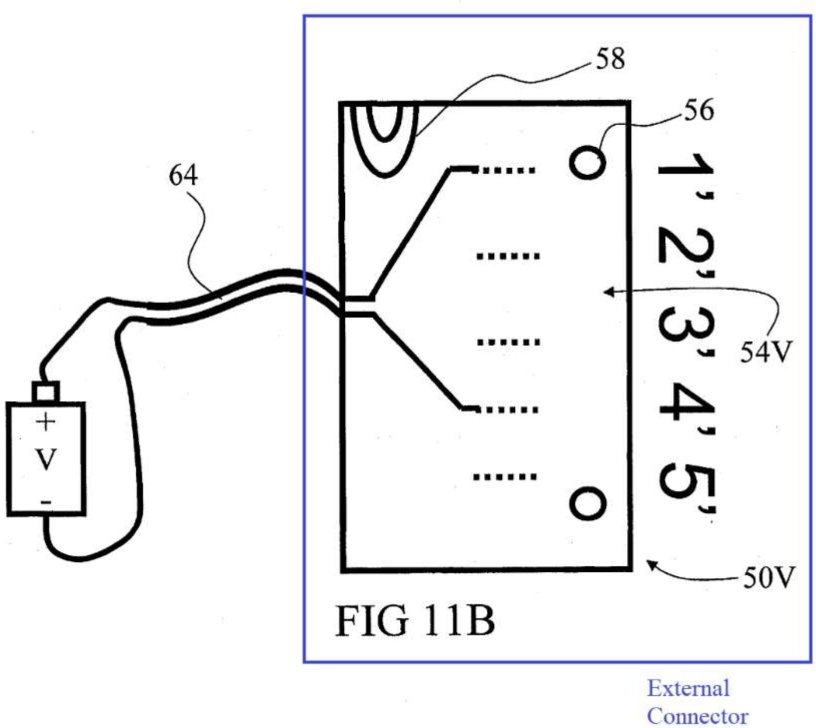


FIG 11B

(Ex-1006-Karlicek at FIG. 11B, 0055, 0061.)

In the combination of Roberts and Karlicek, each of Roberts' light bar assemblies (30) would have been electrically connected to Roberts' current driver (220) (light emitting diode driver) via the external connector of Karlicek's terminating element. (Ex-1003-Krames at ¶182.)

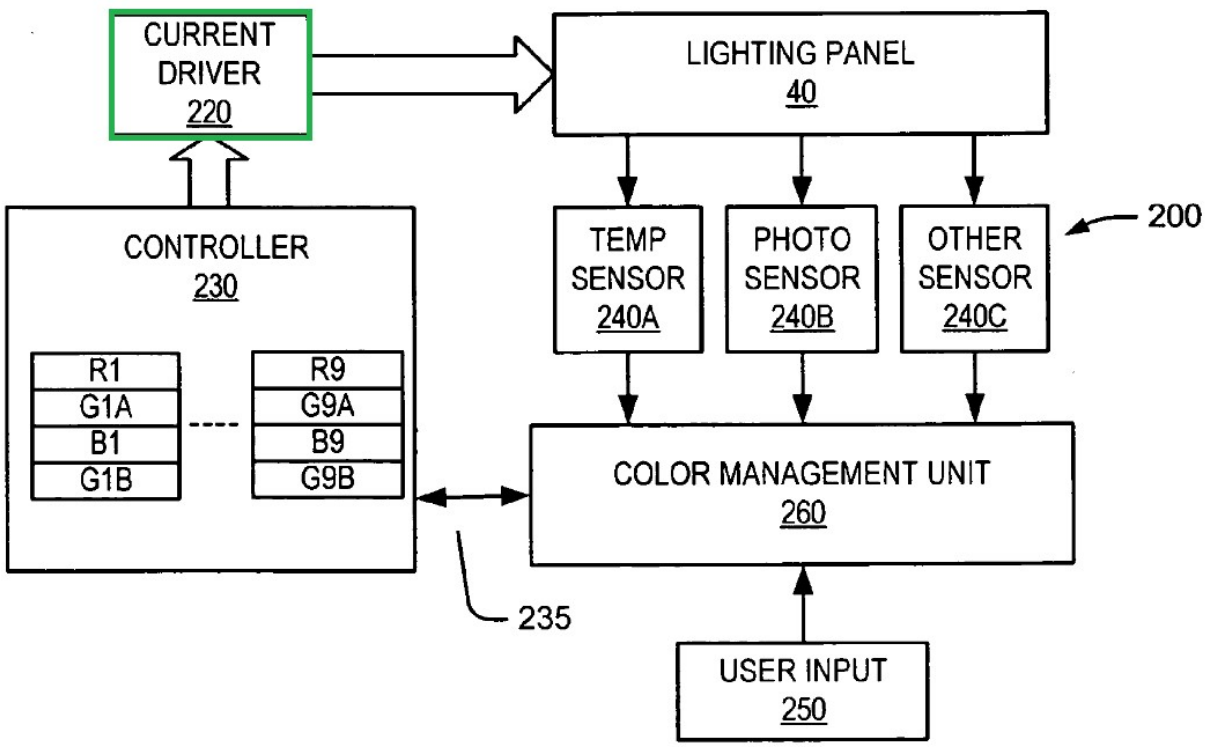


FIGURE 8

(Ex-1004-Roberts at FIG. 8.)

Thus, Roberts in view of Karlicek teaches and renders obvious Claim 5. (Ex-1003-Krames at ¶183.)

Claim 6. The light source apparatus as claimed in claim 4, [6a] wherein the connecting terminal is formed on the module substrate or under the module substrate, and

Roberts teaches limitation [6a].

Specifically, Roberts' lighting tiles (module substrates) have connecting terminals formed on the substrate:

> "In the embodiments illustrated in FIG. 1, the lighting elements 12 are multi-chip clusters of four solid state emitting devices per cluster. In the tile 10, four lighting elements 12 are serially arranged in a first path 20, while four lighting elements 12 are serially arranged in a second path 21. *The lighting elements 12 of the first path 20 are connected, for example via printed circuits, to* ***a set of four anode contacts 22*** *arranged at a first end of the tile 10, and* ***a set of four cathode contacts 24*** *arranged at a second end of the tile 10. The lighting elements 12 of the second path 21 are connected to* ***a set of four anode contacts 26*** *arranged at the second end of the tile 10, and* ***a set of four cathode contacts 28*** *arranged at the first end of the tile 10*."

(Ex-1004-Roberts at 0061.)

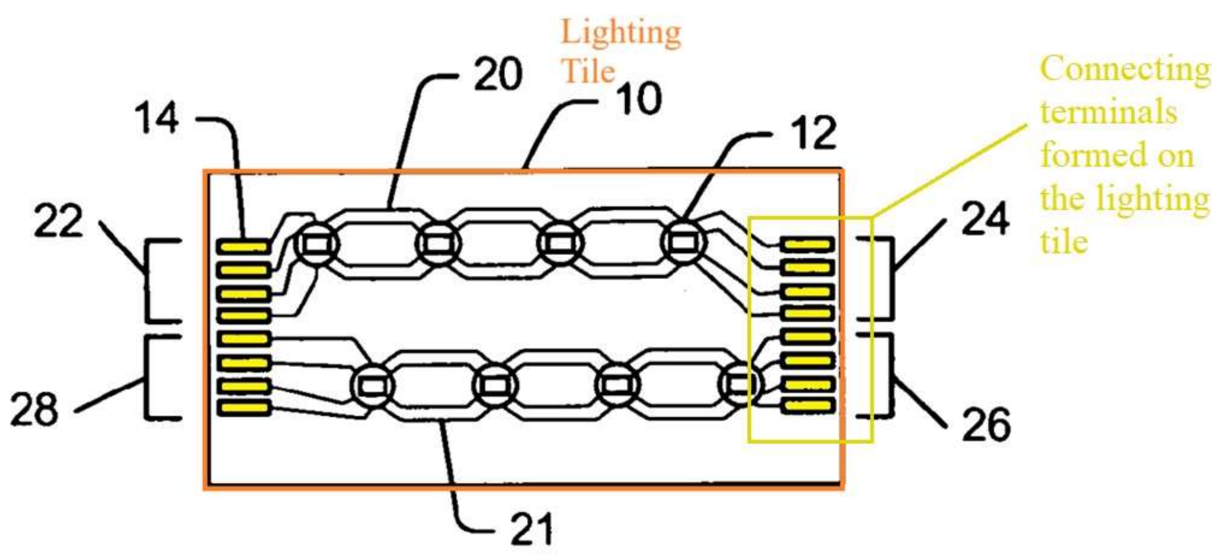


FIGURE 1

(Ex-1004-Roberts at FIG. 1.)

Thus, Roberts teaches limitation [6a]. (Ex-1003-Krames at ¶¶184-186.)

[6b] the intermediate connecting substrate is mounted on the external connecting substrate and on the connecting terminals between plural module substrates.

To the extent this limitation can be understood, Roberts in view of Karlicek teaches limitation [6b].[4]

As explained above in Ground 1, limitation [1c] and Claim 2, Roberts suggests and a POSITA would have found it obvious that Roberts' ***edge connector 13*** (intermediate connecting substrate) is mounted "on the connecting terminals between plural module substrates." Roberts illustrates the ***edge connector 13*** as being "mounted on" each lighting tile (module substrate):

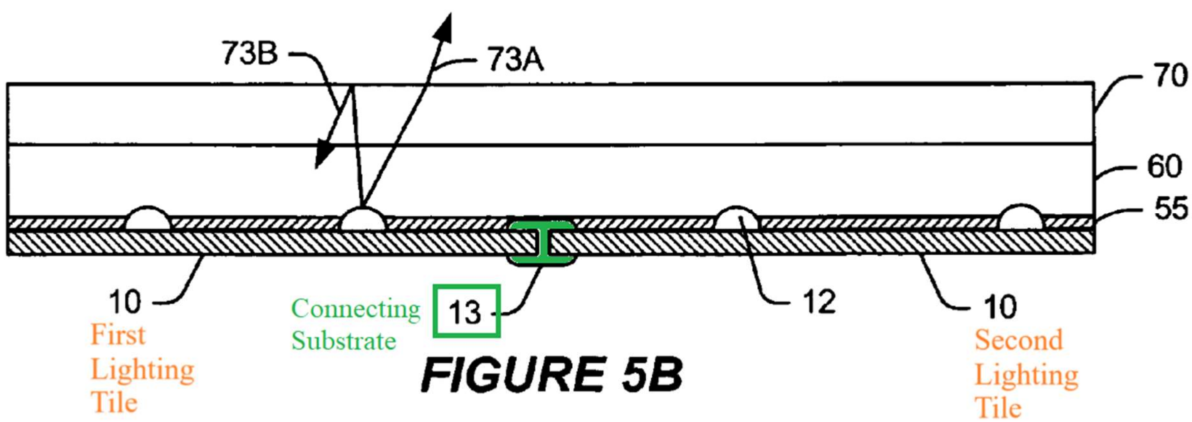


FIGURE 5B

[4] It is unclear how a single "intermediate connecting substrate" can be both "mounted on the external connecting substrate" and mounted "on the connecting terminals *between plural module substrates*." It seems multiple interconnecting substrates would be required to achieve the claimed configuration.

(Ex-1004-Roberts at FIG. 5B.)

Moreover, Roberts teaches that its lighting tiles are connected in series via its connecting terminals (e.g., anodes 22, 26 and cathodes 24, 28) and Roberts expressly discloses that the ***edge connector 13*** may provide an electrical connection between adjacent tiles. (*Id.* at 0071-74, FIG. 4A.) Thus, Roberts alone suggests, and a POSITA would have expected and would have found it obvious, that Roberts' ***edge connector 13*** is "mounted … on the connecting terminals between plural module substrates." (Ex-1003-Krames at ¶¶188-190.)

Roberts in view of Karlicek also teaches and suggests "the intermediate connecting substrate is mounted … on the connecting terminals between plural module substrates." As explained previously, it was obvious to employ Karlicek's interconnecting element 50A in lieu of or in addition to Roberts ***edge connector 13*** to connect adjacent Roberts ***lighting tiles 10*** to one another, and a POSITA would have had a reasonable expectation of successfully doing so. (*Id.* at ¶¶191-192.) Further, Karlicek teaches that its interconnecting elements 50A may be ***mounted on*** adjacent tiles:

> "With reference now to FIGS. 6 and 7, an approach for effectuating the interconnection of pairs of connectors 16 is described. An interconnecting element 50A of a type 'A' operatively connects to a pair of connectors 16 at mating ports 52 and 54 of the interconnecting element 50A. *The interconnecting element 50A mechanically connects*

> <u>*to the two substrates 12*</u> that have the pair of connectors 16 to effectuate structural interconnection between the two substrates 12."

(Ex-1006-Karlicek at 0055.)

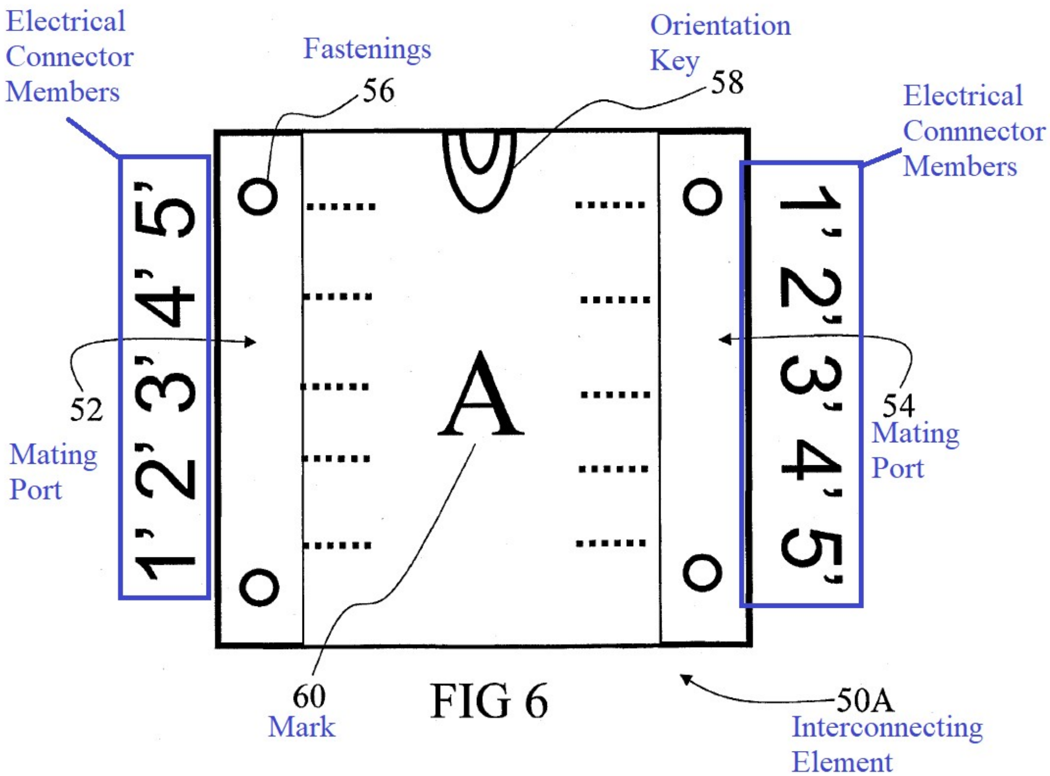
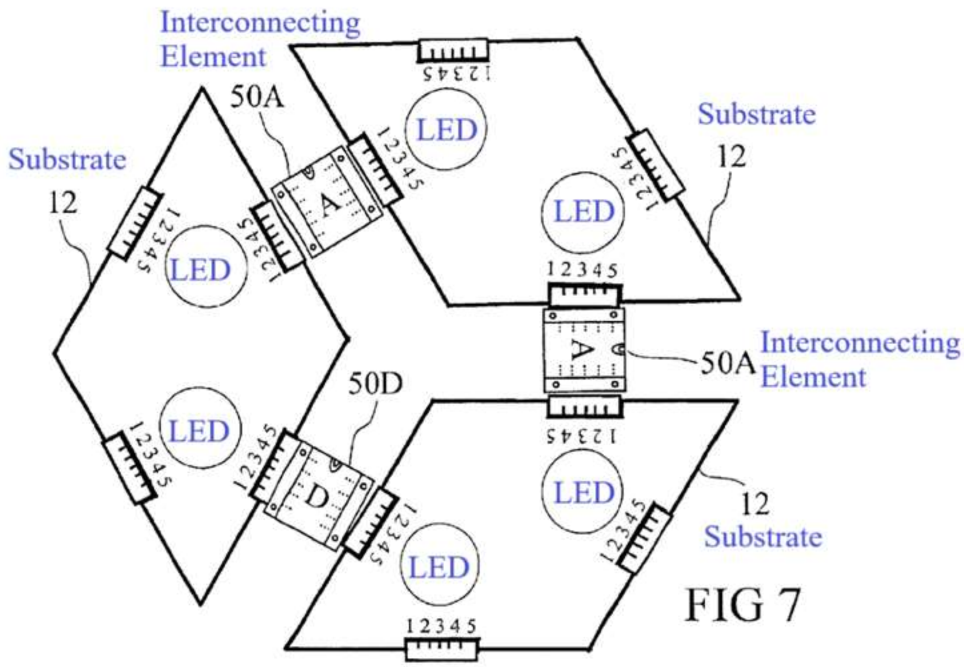


FIG 6

(*Id.* at FIG. 6.)



(*Id.* at FIG. 7.)

> "The mechanical connection can be by a frictional fit (not shown) or ***by fastenings 56 which can be screws, rivets, or the like***. … As can be seen in FIG. 6, ***the two mating ports 52, 54*** *each have five electrical connector members 1', 2', 3', 4', 5'* ***that correspond to and electrically connect with*** *the connector members 1, 2, 3, 4, 5 of* ***the connectors 16 of the substrates 12***."

(*Id.* at 0055; Ex-1003-Krames at ¶194 (explaining a POSITA would have understood Karlicek as disclosing, teaching and suggesting that its interconnecting elements 50A are "mounted on" adjacent LED substrates given drawings and fastening disclosures of Karlicek).) Thus, A POSITA would have understood Roberts in view of Karlicek as teaching an interconnecting element 50 (intermediate substrate) "mounted on … the connecting terminals between plural module substrates." (Ex-1003-Krames at ¶194.)

It also was obvious for Karlicek's terminating element 50V (external connecting substrate) to be used with (i) Roberts' ***edge connector 13*** or (ii) Karlicek's interconnecting element 50A. (*Id*. at ¶195.) Both Roberts and Karlicek expressly disclose connectors that provide an electrical and/or mechanical connection between adjacent lighting tiles (substrates). (Ex-1004-Roberts at 0071-74, FIG. 4A; Ex-1006-Karlicek at 0055.) To facilitate increased modularity and ease of manufacturability, it would have been obvious to preinstall Roberts' ***edge connector 13*** at one end of each lighting tile 10 such that adjacent lighting tiles may be readily connected to form a lighting bar assembly 30. At the closed-loop end, loopback connectors 35 may thus be readily installed since no edge connector is located on that particular end of the lighting bar assembly:

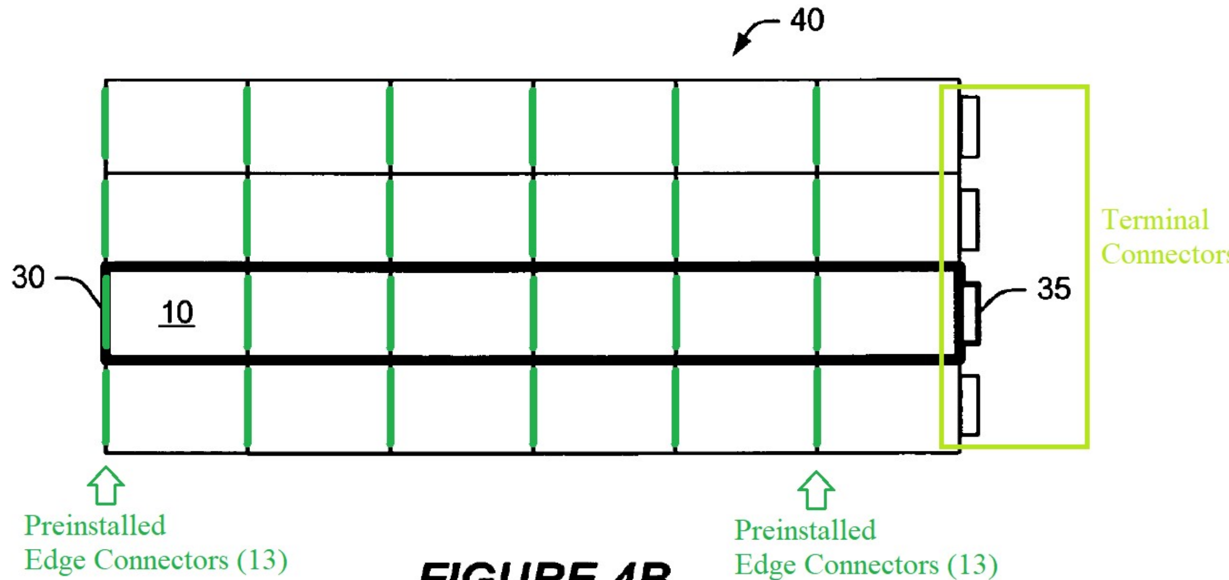
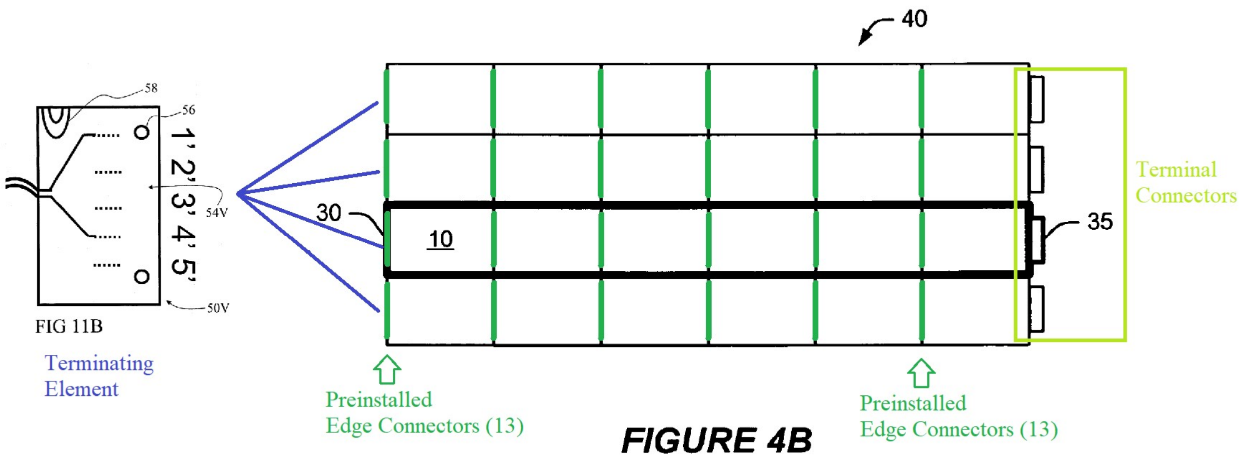


FIGURE 4B

(Ex-1004-Roberts at FIG. 4B, 0072, 0082; Ex-1003-Krames at ¶196.)

However, on the opposite end of each lighting bar assembly 30, a preinstalled edge connector would already be in place. To facilitate ease of interconnection between a voltage/power source and an end of the lighting bar assembly, a POSITA would have found it obvious to have Roberts' preinstalled edge connector "mounted on" Karlicek's terminating element 50V to facilitate interconnection Roberts' voltage/power source:



(Ex-1003-Krames at ¶197.)

This would have been consistent with the intended function and purpose of Roberts' ***edge connector 13*** and would have beneficially provided uniform electro-mechanical connections between each of the substrates (e.g., module substrates and external connecting substrate) in a lighting bar, which would have been consistent with Roberts' goal of providing a modular system and would have increased system simplicity. For these same reasons, it also was obvious to use Karlicek interconnecting elements 50A with the Roberts lighting tiles (instead of Roberts' edge connectors 13), and thus also mount the Karlicek interconnecting elements 50A on a Karlicek terminating element 50V to facilitate ease of construction, modularity and connection to an external voltage/power source. (*Id*. at ¶198.)

Thus, Roberts in view of Karlicek teaches limitation [6b], and Roberts in view of Karlicek renders obvious Claim 6. (*Id*. at ¶199.)

D. <u>GROUND 4</u>: Roberts in View of Karlicek and Liu Renders Obvious Claims 12-15.

1. Scope, Content and Motivation to Combine

Claims 12-15 are obvious based on the combination of Roberts, Liu and Karlicek. As explained in §§VIII.B.1, VIII.C.1, *supra*, a POSITA would have been motivated to apply the teachings of Liu and Karlicek to Roberts with a reasonable expectation of success. The motivations and expectations for Grounds 2-3 remain unchanged when the teachings of both Liu and Karlicek are applied to Roberts because a POSITA would have been motivated to employ a housing comprising a receiving groove per Liu irrespective of whether an external connecting substrate is used per Karlicek, as doing so would have beneficially secured Roberts' lighting bar assemblies to a housing. Likewise, a POSITA would have been motivated to employ an external connecting substrate to connect Roberts' lighting bar assemblies to Roberts' current driver (220) / controller (230) irrespective of whether a housing having a receiving groove was used per Liu, as doing so would have beneficially facilitated electrical connections between Roberts' lighting bar assemblies and Roberts' current driver (220) / controller (230) and in a manner that would have facilitated individual serial control of Roberts' LED strings. (Ex-1003-Krames at ¶200.)

2. The Challenged Claims

<u>Claims 12 and 15</u>

As discussed above with respect to Ground 2, Roberts in view of Liu renders obvious Claims 12 and 15. To the extent the term "connecting substrate" is improperly and narrowly construed to require a substantially flat substrate, Roberts in view of Liu and Karlicek teaches substantially flat connecting substrates, and thus renders obvious Claims 12 and 15 for the same reasons discussed in §VIII.C, *supra*. (Ex-1003-Krames at ¶¶201-202.)

<u>Claim 13. The light source apparatus as claimed in claim 12, wherein the connecting substrate comprises an external connecting substrate, which is provided at one end of a first module substrate of the module substrates to supply a driving power.</u>

Roberts in view of Karlicek teaches Claim 13 for the same reasons as provided above relative to Ground 3, Claim 3. (Ex-1003-Krames at ¶¶203-205.)

Specifically, Karlicek teaches the use of a terminating element 50V (external connecting substrate) that is provided at a first end of a first of a series of lighting tiles (module substrates) to supply a driving power from an external voltage source (current driver):

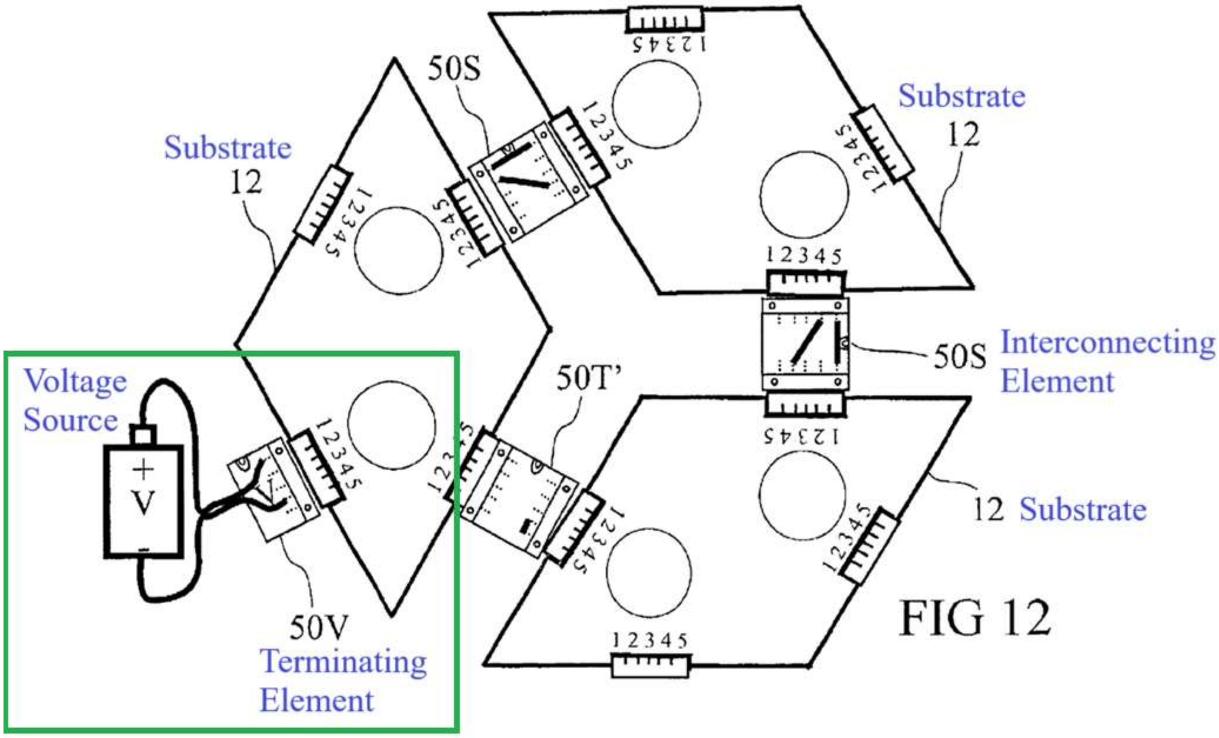


FIG 12

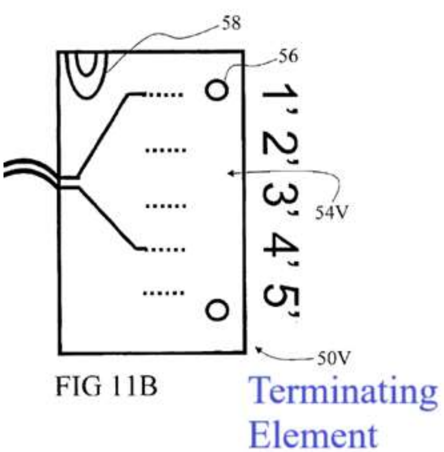


FIG 11B

(Ex-1006-Karlicek at FIGS. 12, 11B, 0055, 0061.) As shown and described, Karlicek's terminating element 50V is configured as a substrate. (*Id.* at FIGS. 11B, 12; 0061.)

As explained in §§VIII.C.1, VIII.D.1, a POSITA would have been motivated to apply Karlicek's terminating element teachings to Roberts and with a reasonable expectation of success, wherein Karlicek's terminating element (50V) (external connecting substrate) is provided at an end of the first lighting tile (module substrate) of each of Roberts' lighting bar assemblies to supply a driving power from Roberts' current driver (220) / controller (230):

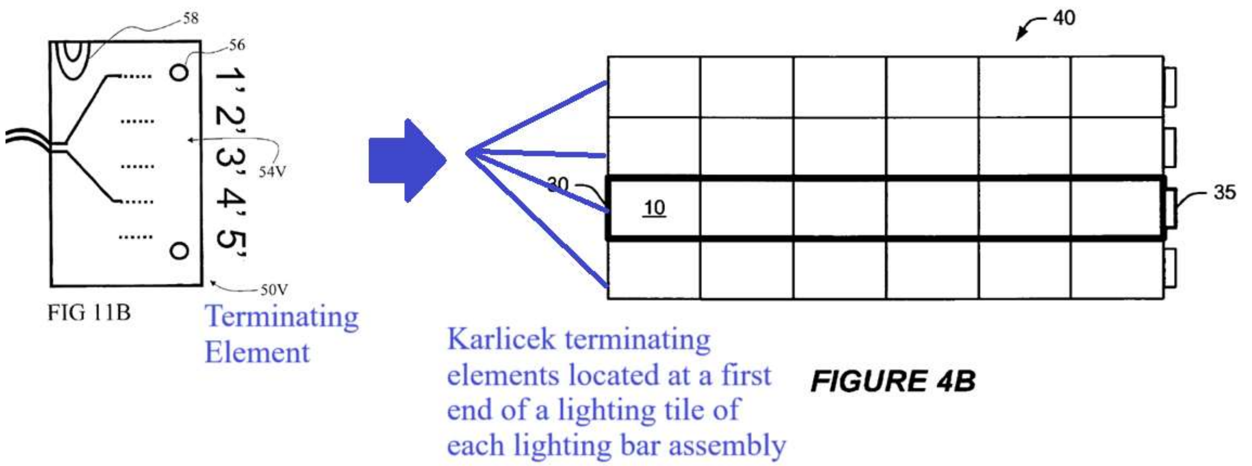


FIG 11B

FIGURE 4B

(Ex-1006-Karlicek at FIG. 11B, 0061; Ex-1004-Roberts at FIG. 4B, 0075; Ex-1003-Krames at ¶206.)

Thus, Roberts in view of Karlicek teaches Claim 13, and Roberts in view of Liu and Karlicek renders obvious Claim 13. (Ex-1003-Krames at ¶207.)

Claim 14. The light source apparatus as claimed in claim 13, wherein the connecting substrate comprises a plurality of intermediate connecting substrates which connect both connecting terminals of a plurality of module substrates and/or between the external connecting substrate and the first connecting terminal of the first module substrate.

Roberts teaches and suggests Claim 14.

Specifically, as explained in Ground 1, limitation [1c] and Claim 2, Roberts discloses that its ***lighting tiles (10)*** (module substrates) may be "*connected at respective opposing edges by an **edge connector 13** [connecting substrate], which may provide an **electrical** and/or mechanical connection between adjacent **tiles 10**.*" (Ex-1004-Roberts at 0082.)

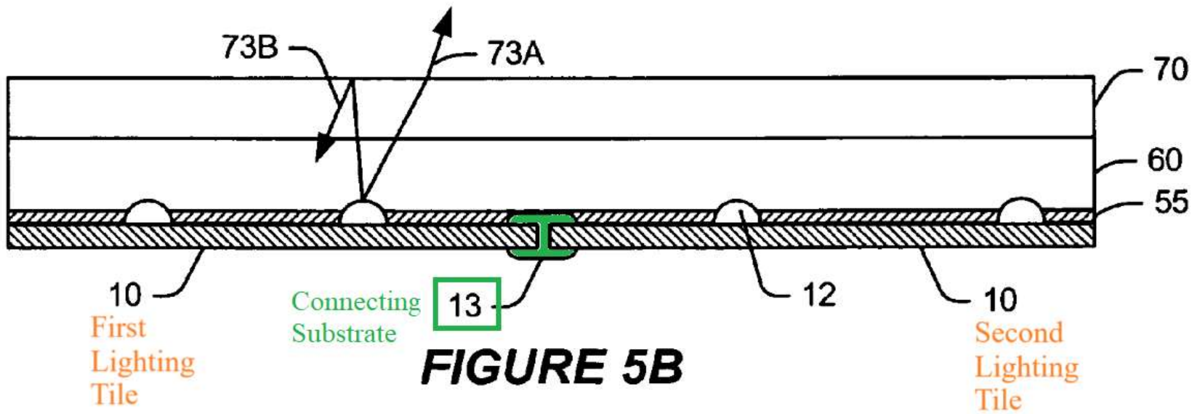


FIGURE 5B

(Ex-1004-Roberts at FIG. 5B.)

Roberts suggests, and a POSITA would have found it obvious, that Roberts' ***edge connector 13*** would have "connect[ed] both connecting terminals of a plurality of module substrates" because, as illustrated above, Roberts' ***edge connector 13*** is mounted on adjacent ***lighting tiles 10*** and Roberts' ***edge connector 13*** is used to provide "an electrical … connection between adjacent tiles 10." (Ex-1003-Krames at ¶210; Ex-1004-Roberts at 0071-74, 0082 FIG. 4A.) Thus, Roberts teaches and suggests, and a POSITA would have expected and would have found it obvious, that Roberts' edge connector 13 "connect[s] both connecting terminals of a plurality of module substrates" to facilitate an electrical connection between adjacent tiles.

A POSITA also would have found it obvious to use multiple edge connectors 13 (a plurality of intermediate connecting substrates) because Roberts discloses that numerous ***lighting tiles 10*** "may be connected at respective opposing edges by an edge connector 13, which may provide an electrical and/or mechanical connection between adjacent tiles 10," and Roberts illustrates numerous ***lighting tiles 10*** in a ***lighting bar assembly 30***:

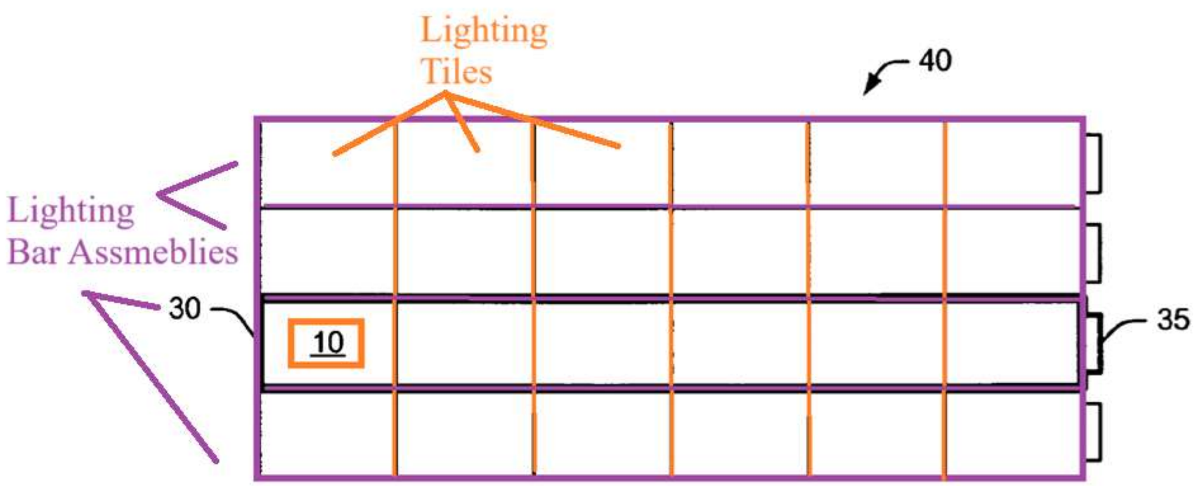


FIGURE 4B

(Ex-1004-Roberts at 4B, 0040, 0071, 0096; Ex-1003-Krames at ¶211.)

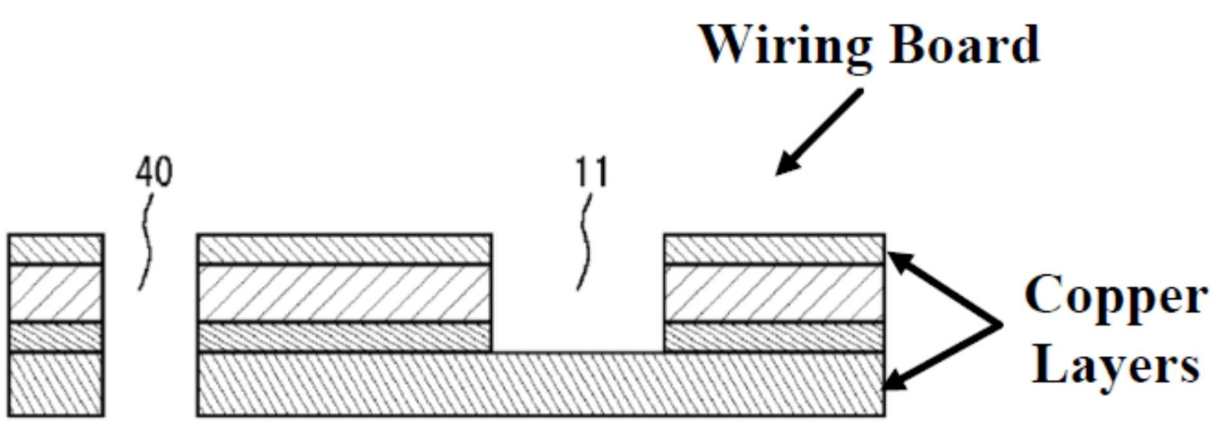
Thus, Roberts teaches and suggests Claim 14, and Roberts in view of Liu and Karlicek renders obvious Claim 14. (Ex-1003-Krames at ¶212.)

E. <u>GROUND 5</u>: Roberts in View of Nishida, Optionally in View of Karlicek, Renders Obvious Claim 9.

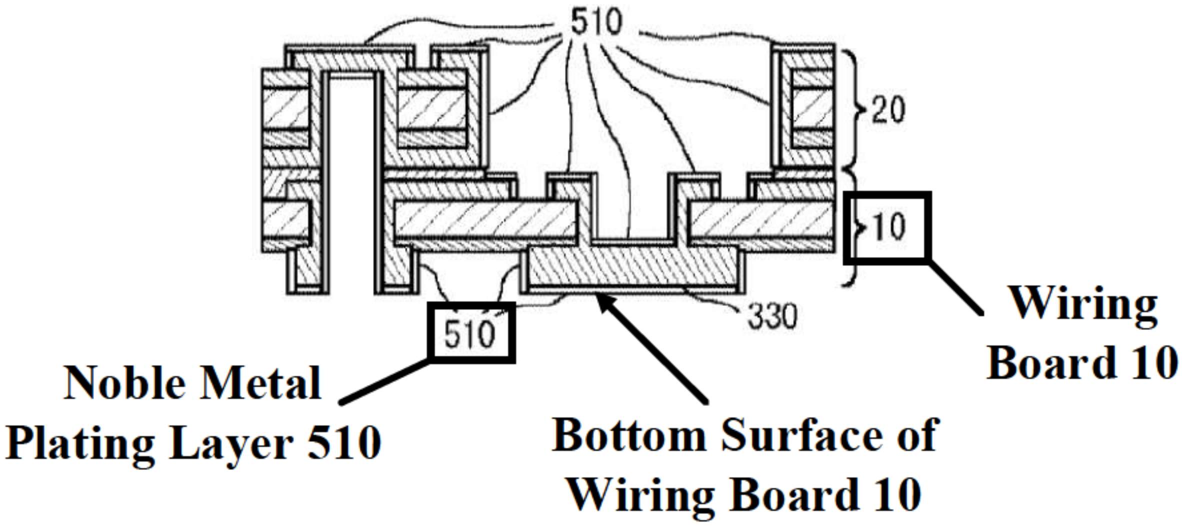
1. Scope, Content and Motivation to Combine

As shown in Ground 1, Roberts discloses that its lighting tiles 10 may include a printed circuit board (PCB) on which one or more circuit elements, such as discrete light emitting components, may be mounted, such as a metal core PCB (MCPCB). (Ex-1004-Roberts at 0060.) However, Roberts omits details as to how to implement its lighting tiles 10 with PCBs. (*Id.*) Nishida provides such details.

Nishida discloses a wiring board (base board 10) having a plurality of LEDs 30 that may be used as the backlight of an LCD. (Ex-1009-Nishida at FIG. 2, 0001, 0018-0020, 0029-36.) The wiring board comprises multiple layers of copper 310, 330, 340, and a noble metal plating layer 510 formed on a bottom surface thereof. (*Id*. at FIGS. 3a-3g and 5c, 0018-20, 0024, 0029-30.) A POSITA would have recognized that Nishida's wiring board is a type of PCB. (Ex-1003-Krames at ¶215.)



(Ex-1009-Nishida at FIG. 3(d).)



(*Id*. at FIG. 5(c).)

A POSITA would have been motivated to apply Nishida's wiring board (PCB) teachings to Roberts' lighting tiles (10). (Ex-1003-Krames at ¶¶216-217.) Both Roberts and Nishida are directed to PCBs for LCD backlight panels. (Ex-1004-Roberts at 0134; Ex-1009-Nishida at 0001.) Nishida expressly discloses that its PCB beneficially prevents damage from foreign objects. (Ex-1009-Nishida at 0034.) Nishida also expressly discloses that its PCB beneficially offers "excellent heat dissipation properties," provides "high optical output with good conversion efficiency," and diffuses outputted light prior to emission, thus making Nishida's PCB "particularly suitable for chip component type light emitting devices that may be used as the light source for display panels," such as Roberts' lighting tiles (10). (*Id*.)

Roberts, like Nishida, is also concerned with improving heat dissipation. (Ex-1004-Roberts at 0017-18, 0066, 0087-88.) Indeed, Roberts discloses that the bottom of its tiles 10 may be connected to a heat sink panel 80 with heat sink features:

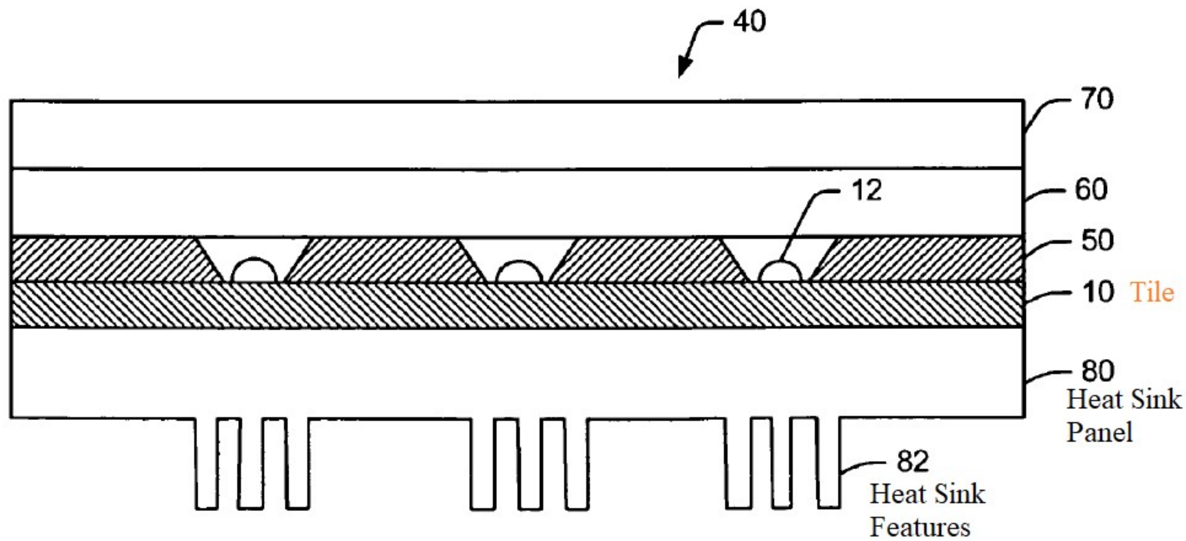


FIGURE 7

(*Id.* at FIG. 7, 0087)

A POSITA would have recognized that Nishida's noble metal plating layer would have provided significant thermal management advantages because noble metals (especially silver and gold) have excellent thermal conductivity, allowing the plating material on the bottom of the wiring board (PCB) to efficiently transfer heat to a heat sink or mounting surface. (Ex-1003-Krames at ¶218.) A POSITA would have similarly recognized that Nishida's multiple copper layers would have provided thermal management advantages, as copper has a high thermal conductivity and using multiple copper layers was a recognized way to spread and dissipate heat evenly and effectively. (*Id.*)

In view of the above, a POSITA would have found it obvious to apply Nishida's PCB teachings to Roberts. (*Id.* at ¶219.) Specifically, a POSITA would have found it obvious to employ PCBs having multiple copper layers and a noble metal plating layer formed on a bottom surface thereof to facilitate improved thermal management. As explained previously, the multiple copper layers facilitate heat dissipation in the lateral direction. Further, applying a noble metal plating layer on the bottom of Roberts' PCB tile 10 would have facilitated enhanced heat transfer to Roberts' heat sink panel 80. Such heat transfer benefits are expressly desired by Roberts. (Ex-1004-Roberts at 0066, 0087, 0088.)

A POSITA also would have had a reasonable expectation of successfully applying Nishida's teachings to Roberts. (Ex-1003-Krames at ¶220.) PCBs were well-known and widely used at the time of the alleged invention of the '415 patent, and applying Nishida's PCB teachings to Roberts' lighting tiles (10) would have been straightforward and routine to a POSITA. (*Id.*)

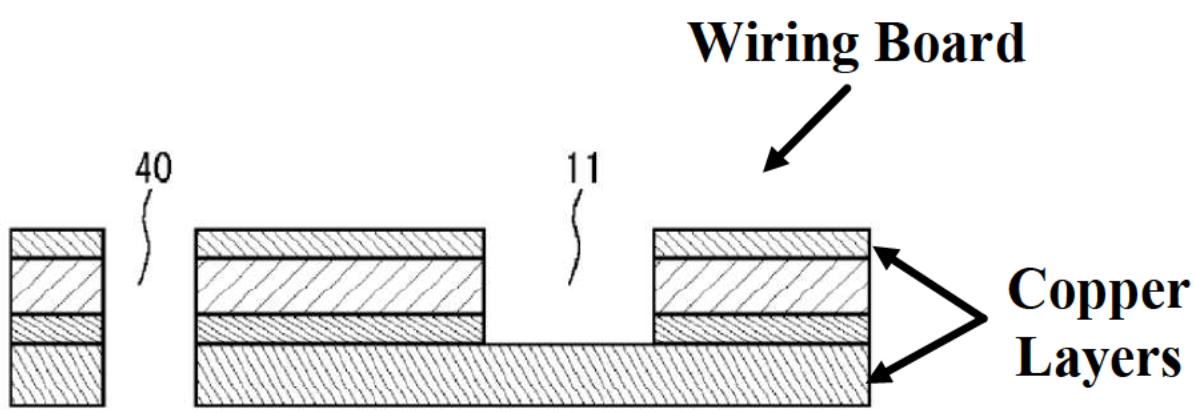
2. The Challenged Claims

Claim 9. The light source apparatus as claimed in claim 1, wherein the module substrate comprises a multi-copper layer and a via hole formed in the module substrate, and a silver plating layer formed on a bottom surface of the module substrate.

Roberts in view of Nishida, optionally in view of Karlicek, teaches Claim 9.

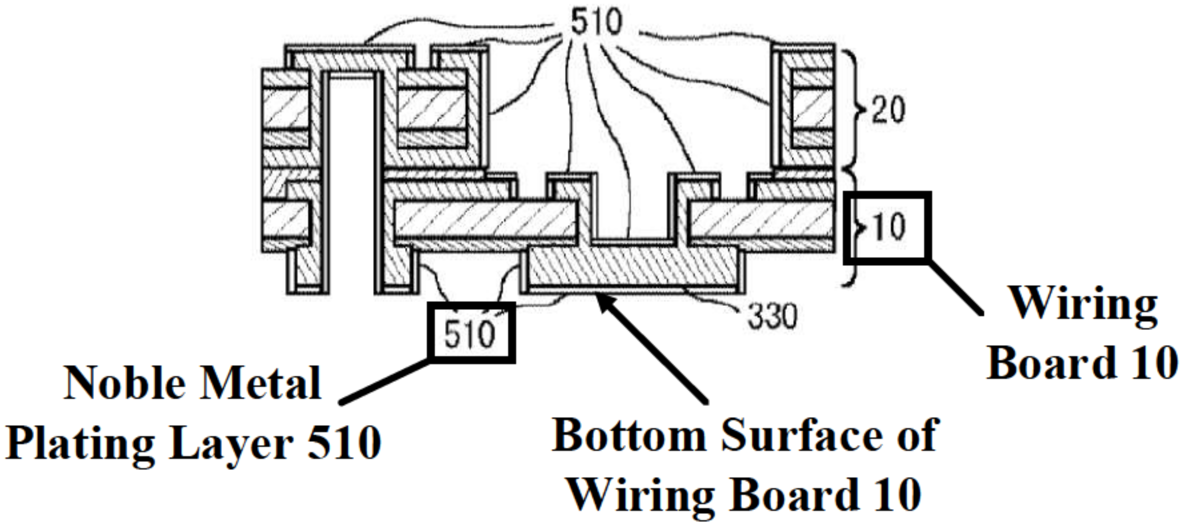
Specifically, Roberts discloses that its lighting tiles (10) (module substrates) may be PCBs with thermal vias (via holes) formed therein. (Ex-1004-Roberts at 0060.) Roberts, however, does not disclose that its lighting tiles (10) (module substrates) comprise a multi-copper layer or a silver plating layer formed on a bottom surface of the substrate. Nishida does.

Specifically, Nishida discloses a wiring board (module substrate) with a plurality of light emitting elements 30 (*e.g.*, LEDs) that may be used as the light source for various types of display panels, such as the backlight of an LCD. (Ex-1009-Nishida at FIG. 2, 0001, 0018-0020, 0029-36.) The wiring board comprises multiple copper layers 310, 330, 340 (a multi-copper layer). (*Id*. at FIGS. 3a-3g and 6-7, 0018-20, 0024, 0029-30.)



(*Id*. at FIG. 3(d).)

Nishida further discloses a noble metal plating layer 510 formed on a bottom surface of the wiring board:



(*Id*. at FIG. 5(c), 0029.)

A POSITA would have known that silver is a type of noble metal. (Ex-1003-Krames at ¶225; *see also* Cooperative Patent Classification System, Section C (defining "Noble metals" to include "Ag [silver]"); United States Patent Classification System, Class 420 (defining "Noble Metal" to include "Silver").) A POSITA also would have known that silver was commonly used as a plating layer in PCBs due to silver's high thermal and electrical conductivity, oxidation resistance, and relative inexpensiveness compared to other noble metals such as gold. (Ex-1003-Krames at ¶225; Ex-1018-Cowie at Abstract, 1:6-10, 1:62-68, 2:31-38, 3:24, 4:41-57.)

As explained above relative to §VIII.E.1, a POSITA would have been motivated to apply Nishida's wiring board teachings with Roberts' lighting tiles (10) (module substrates) to achieve enhanced heat removal and with a reasonable expectation of success. Applying Nishida's teachings to Roberts would thus have resulted in a module substrate that includes "a multi-copper layer and a via hole formed in the module substrate, and a silver plating layer formed on a bottom surface of the module substrate." (Ex-1003-Krames at ¶226.)

Thus, Roberts in view of Nishida teaches and renders obvious Claim 9. (*Id*. at ¶¶221-227.)

Further, to the extent the term "connecting substrate" is incorrectly and narrowly construed to require a substantially flat substrate, Roberts in view of Nishida and Karlicek renders obvious Claim 9 for the same reasons discussed above in Ground 3. (*Id*. at ¶228.)

F. <u>GROUND 6</u>: Roberts in View of Newman, Optionally in View of Karlicek, Renders Obvious Claim 10.

1. Scope, Content and Motivation to Combine

As shown in Ground 1, Roberts discloses lighting tiles having a plurality of LEDs, but does not specifically disclose test pads for those LEDs. (Ex-1004-Roberts at 0062-72, FIGS. 1-2.) Newman discloses a plurality of LED array modules, each of which comprises an ***LED array chip (16)***. (Ex-1010-Newman at 1:8-10.) The LED array module provides all the wiring for connecting chips together and testing the module, "thereby protecting the delicate components and allowing the module to be completely tested" prior to final assembly. (*Id*. at Abstract, 1:11-18, 2:47-3:8.)

To facilitate this testing, each LED array module includes ***test pads (50)*** for testing the ***LED array chip (16)***. (*Id*. at FIGS. 3-4, 2:61-66, 4:43-46, 5:39-44.)

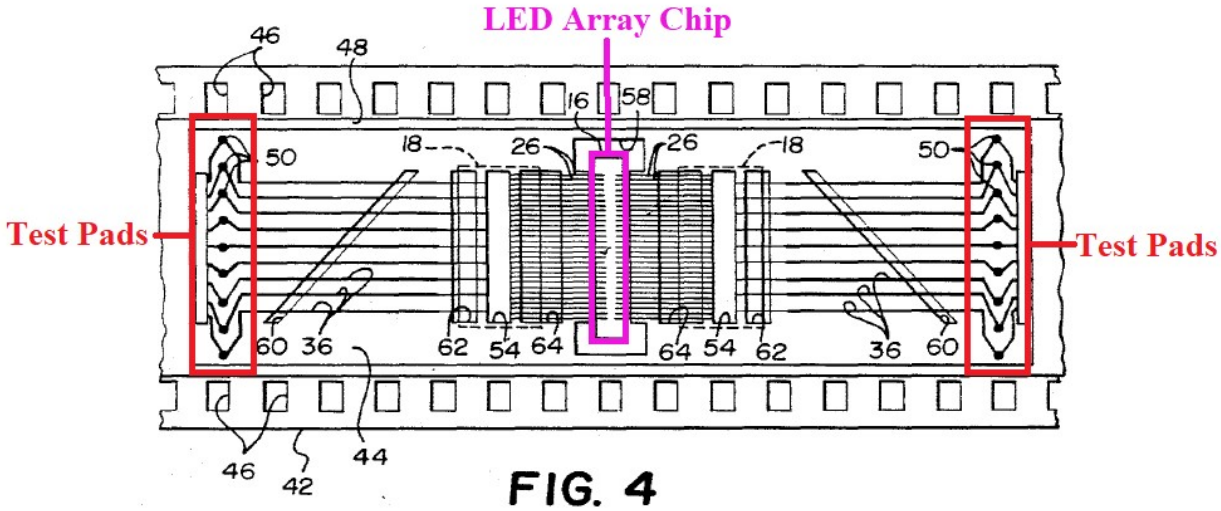


FIG. 4

(*Id*. at FIG. 4.)

A POSITA would have been motivated to apply Newman's teachings to Roberts wherein Roberts' lighting tiles (10) include test pads for testing Roberts' LED chips. (Ex-1003-Krames at ¶230.) Test pads have been routinely used on PCBs (including LED modules) for decades and offer several well-known benefits for manufacturing, quality control, and maintenance. For example, a POSITA would have known that incorporating test pads into an LED module would have beneficially allowed for in-circuit testing to easily verify functionality during production and detect defects before the module leaves the factory. (*Id.*) A POSITA also would have recognized that test pads facilitate easy troubleshooting after deployment. If an LED module fails in the field, a technician can quickly probe the test pads to determine whether the failure is in the LED array, driver circuitry, or power supply. (*Id.*)

A POSITA also would have had a reasonable expectation of successfully applying Newman's teachings to Roberts. (*Id*. at ¶231.) The use of test pads has been a standard practice in electronics manufacturing since at least the 1980s, and incorporating test pads into LED modules, such as Roberts' lighting tiles (10), would have been straightforward and routine to a POSITA. (*Id.*)

2. The Challenged Claims

Claim 10. The light source apparatus as claimed in claim 7, wherein the module substrate includes a test pad terminal for testing the LED chip.

Roberts in view of Newman teaches Claim 10.

Specifically, Newman teaches a plurality of LED array modules, each of which comprises an ***LED array chip (16)*** and ***test pads (50)*** (test pad terminals) for testing the ***LED array chip (16)***. (Ex-1010-Newman at FIGS. 3-4, 2:61-66, 4:43-46, 5:39-44.)

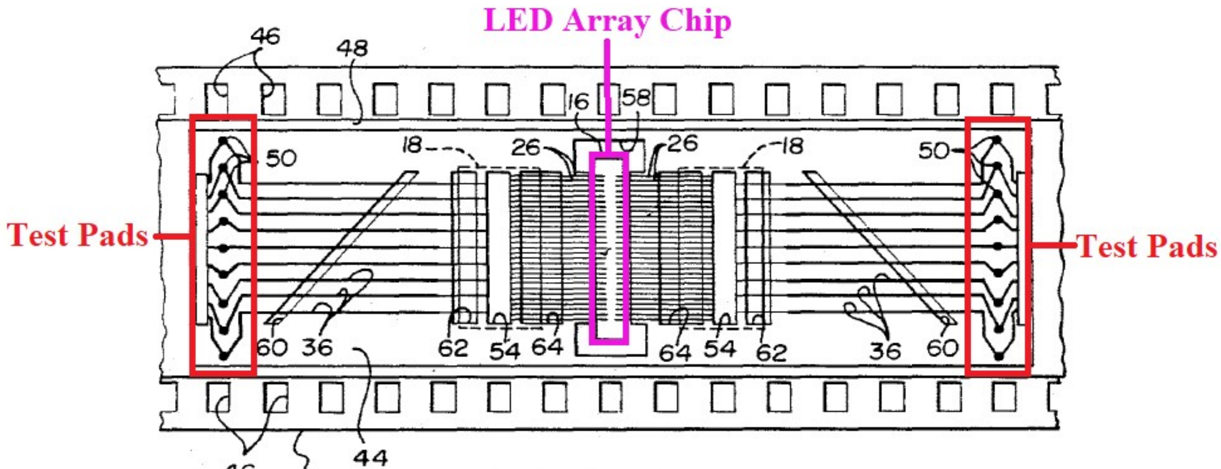


FIG. 4

(*Id*. at FIG. 4.)

As explained above relative to §VIII.F.1, a POSITA would have been motivated to combine the teachings of Roberts and Newman with a reasonable expectation of success wherein Roberts' lighting tiles (10) (module substrates) are provided with test pad terminals for testing Roberts' LED chips. Applying Newman's teaching to Roberts would thus result in a module substrate that includes "a test pad terminal for testing the LED chip." (Ex-1003-Krames at ¶234.)

Thus, Roberts in view of Newman teaches and renders obvious Claim 10. (*Id*. at ¶¶232-235.)

Further, to the extent the term "connecting substrate" is incorrectly and narrowly construed to require a substantially flat substrate, Roberts in view of Newman and Karlicek renders obvious Claim 10 for the same reasons discussed above in Ground 3. (*Id*. at ¶236.)

G. GROUND 7: Roberts in View of Liu, Karlicek, and Hsiao Renders Obvious Claims 16-18.

1. Scope, Content and Motivation to Combine

Claims 16-18 are obvious based on the combination of Roberts with Liu, Karlicek, and Hsiao.[5] As shown herein, Roberts in view of Liu and Karlicek teaches all limitations of the Ground 7, including a "a closed loop digital control system for ***a lighting panel, such as an LCD backlight***," but does not specifically disclose "a light unit disposed below the liquid crystal panel." (Ex-1004-Roberts at 0134; *see also id.* at 0003 (defining "LCD" as "liquid crystal display").) However, Hsiao discloses that this arrangement was conventional in liquid crystal displays (LCDs).

Specifically, Hsiao describes the arrangement of a "conventional LCD":

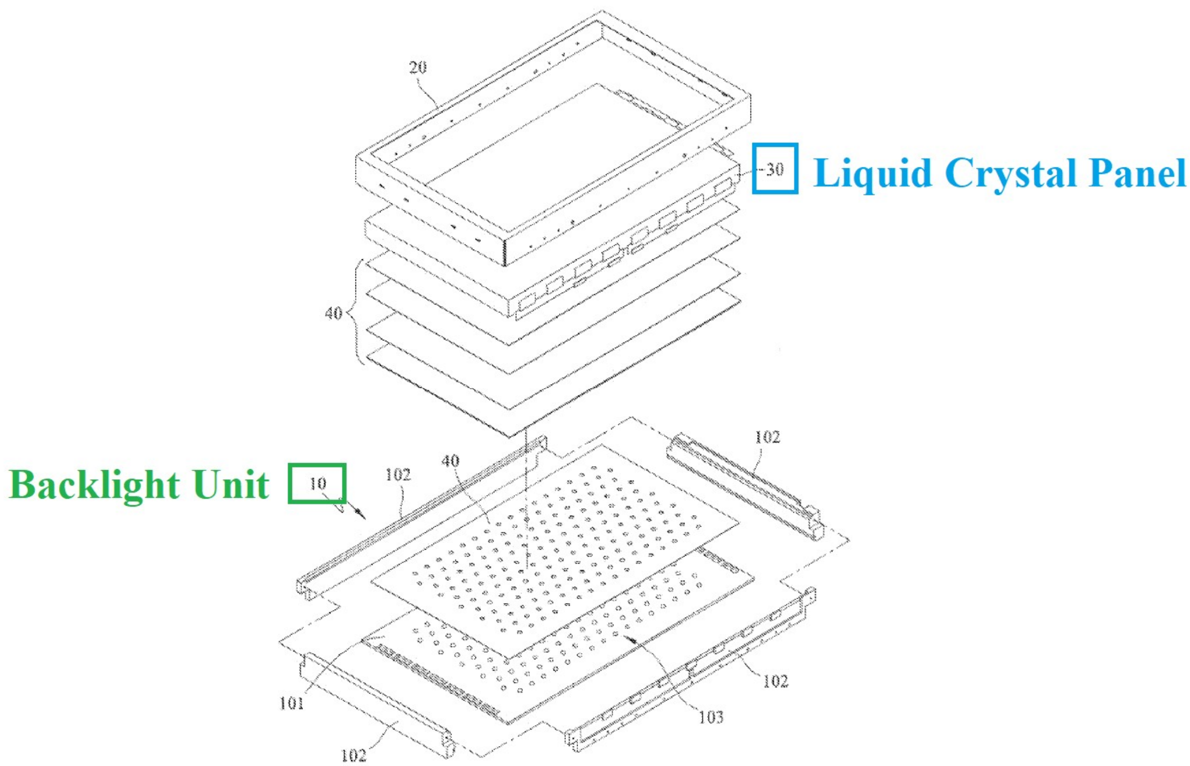
> "FIG. 1 is a perspective view of *a conventional LCD*, which comprises an LCD panel 30, a front frame 20 disposed on the LCD panel 30, a backlight module 10 having an LED array 103 disposed on a back bezel 101, and a frame assembly 102 disposed along the edges of the back bezel 101. The backlight module 10 is a direct type backlight module. There are a plurality of optical films 40 disposed between the LCD panel 30 and the backlight module 10 for enhancing the efficiency

[5] As explained in §§VIII.B.1, VIII.C.1, VIII.D.1, *supra*, a POSITA would have been motivated to apply the teachings of Liu and Karlicek to Roberts with a reasonable expectation of success. The motivations and expectations for combining Roberts with Liu and Karlicek remain unchanged in Ground 7.

> of light usage and luminance promotion. The optical films 40 can be diffusing films, prism films, acrylic films and/or light enhancing films.

(Ex-1011-Hsiao at 1:33-43.)

Hsiao also provides the following illustration of a conventional LCD showing the ***backlight unit 10*** disposed below the ***liquid crystal panel 30***:



(*Id*. at FIG. 1.)

Hsiao further describes how the backlight unit and the liquid crystal panel of a conventional LCD work in conjunction with each other to produce visible images:

> "Liquid crystal displays (LCDs) have become the most popular displays because of the light weight and good displaying quality. <u>The</u>

> backlight module is an important illumination structure of the LCD. Controlling the transmissive light provided from the backlight module in association with the liquid crystal cells in a matrix of a panel, and appropriately controlling switches, make the brightness and quality of the images presented on the display be determined. Light emitting diodes (LEDs) widely serve as the light source of the backlight module because of the low power consumption, light weight and high luminance. Therefore, LEDs have gradually become substitutes for fluorescent lamps when selecting light sources for the backlight module."

(*Id*. at 1:19-32.)

> "Generally, the LCD panel 30 comprises an upper glass substrate, a lower glass substrate, and a liquid crystal layer (not shown) disposed therebetween. The upper glass substrate and the lower glass substrate can be a color filter substrate and an active (or passive) array substrate, respectively. The voltage difference between the upper and the lower glass substrates makes the liquid crystal in the liquid crystal layer rotate or tilt accordingly. Therefore, the light transmitting through the LCD panel 30 will be controlled and will then produce images on the LCD panel 30.

(*Id*. at 1:44-53.)

A POSITA would have been motivated to apply the conventional LCD arrangement taught in Hsiao to Roberts. (Ex-1003-Krames at ¶241.) Roberts discloses that its backlight panel 40 may be implemented as an LCD backlight. (Ex-1004-Roberts at 0134; *see also id*. at 0003.) However, Roberts omits conventional details on how to do so. Hsiao provides such details, explaining that a conventional LCD comprises a backlight panel disposed below a liquid crystal panel. (Ex-1011-Hsiao at FIG. 1, 1:33-46.) Hsiao further explains that, by controlling the light provided by the backlight panel and the orientation of the liquid crystals in the liquid crystal panel, this conventional arrangement allows the LCD to produce images. (*Id*. at 1:19-32, 1:44-53.) A POSITA would have found it obvious and beneficial to apply Hsiao's teachings to Roberts in the conventional manner to create an LCD capable of producing visible pictures. (Ex-1003-Krames at ¶241.)

A POSITA also would have had a reasonable expectation of successfully applying Hsiao's teachings to Roberts. Hsiao confirms that disposing a light unit below a liquid crystal panel was conventional (Ex-1011-Hsiao at FIG. 1, 1:19-53), and a POSITA would have found it straightforward to implement this conventional arrangement to produce Roberts' LCD panel. (Ex-1003-Krames at ¶242.)

2. The Challenged Claims

Claim 16. [16-PRE] A liquid crystal display comprising: [16a] a liquid crystal panel; and a light unit disposed below the liquid crystal panel,

Roberts in view of Hsiao teaches limitations [16-PRE] and [16a].

Specifically, Roberts teaches that its lighting panel 40 (light unit) may be a backlight panel for an LCD (liquid crystal display):

> "[A] backlight panel 40 may include a plurality of red LED strings 23, each of which may be driven with a different pulse width, resulting in

> a different average current level. Accordingly, some embodiments of the invention provide a closed loop digital control system for a lighting panel, such as an *LCD backlight*…."

(Ex-1004-Roberts at 0134.)

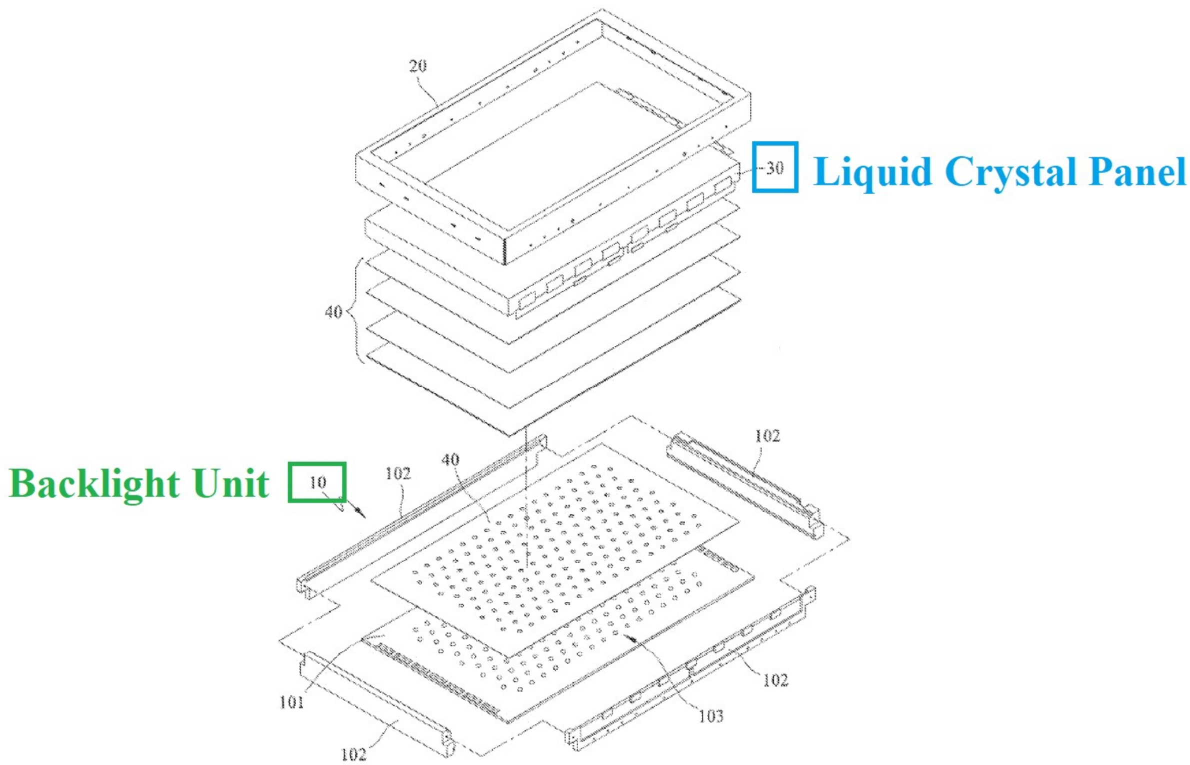
> "The lighting panel 40 may include, for example, a plurality of bar assemblies 30, which, as described above, may include a plurality of tiles 10. However, it will be appreciated that embodiments of the invention may be employed in conjunction with lighting panels formed in *other configurations*. For example, some embodiments of the invention may be employed with *solid state backlight panels* that include a single, large area tile."

(*Id.* at 0095.)

Hsiao teaches that a "conventional LCD" includes an ***LCD panel 30*** comprising a liquid crystal layer (liquid crystal panel) and a ***backlight module 10*** (light unit) disposed below the ***LCD panel 30***:

> "FIG. 1 is a perspective view of a conventional LCD, which comprises an LCD panel 30, a front frame 20 disposed on the LCD panel 30, a backlight module 10 having an LED array 103 disposed on a back bezel 101, and a frame assembly 102 disposed along the edges of the back bezel 101. The backlight module 10 is a direct type backlight module. There are a plurality of optical films 40 disposed between the LCD panel 30 and the backlight module 10 for enhancing the efficiency of light usage and luminance promotion. The optical films 40 can be diffusing films, prism films, acrylic films and/or light enhancing films."

(Ex-1011-Hsiao at 1:33-43.)



(*Id*. at FIG. 1.)

As explained above relative to §VIII.G.1, a POSITA would have been motivated to combine the teachings of Roberts and Hsiao with a reasonable expectation of success, wherein Roberts' lighting panel 40 (light unit) is implemented as a backlight panel for an LCD that is disposed below a liquid crystal panel. Applying Hsiao's teaching to Roberts would thus result in an LCD comprising "a liquid crystal panel" and "a light unit disposed below the liquid crystal panel." (Ex-1003-Krames at ¶246.)

Thus, Roberts in view of Hsiao teaches limitations [16-PRE] and [16a]. (*Id.* at ¶¶243-247.)

[16b] wherein the light unit comprises a housing comprising a receiving groove,

Roberts in view of Liu teaches limitation [16b] for the same reasons as provided above relative to Ground 2, limitation [12a]. (Ex-1003-Krames at ¶248.)

[16c] at least one module substrate which is received in the housing and has a first connecting terminal and a second connecting terminal at both end portions of the module substrate,

Roberts in view of Liu teaches limitation [16c] for the same reasons as provided above relative to Ground 2, limitation [12b]. (Ex-1003-Krames at ¶249.)

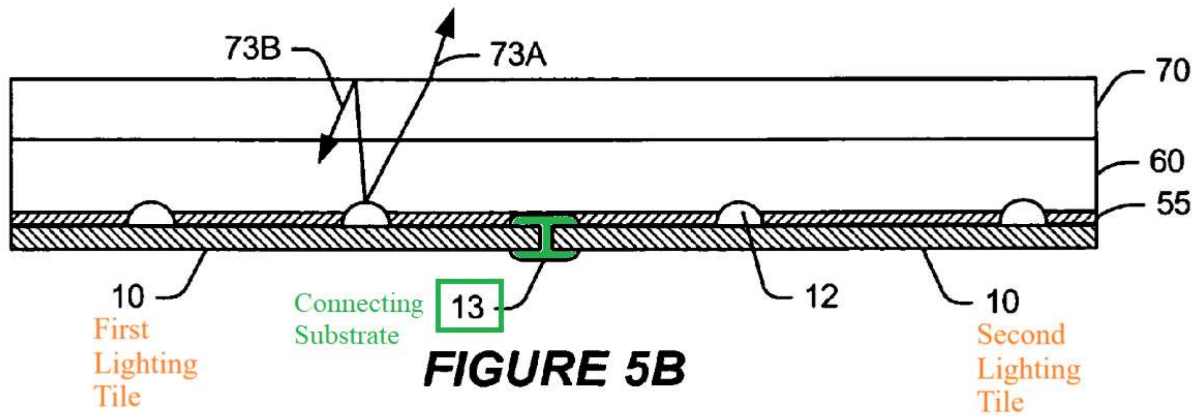
[16d] a light emitting diode on the module substrate, and

Roberts teaches limitation [16d] for the same reasons as provided above relative to Ground 1, limitation [1b]. (Ex-1003-Krames at ¶250.)

[16e] a connecting substrate which is connected to the first connecting terminal of a first end of the module substrate or the second connecting terminal of a second end of the module substrate, wherein the connecting substrate comprises a termination connecting substrate which comprises a closed loop pattern for forming a second connecting terminal of a second end of a final module substrate as a closed loop circuit.

Roberts teaches and suggests limitation [16e] for the same reasons as provided above relative to Ground 1, limitation [1c]. (Ex-1003-Krames at ¶251.)

As explained above relative to Ground 1, limitation [1c], Roberts teaches and suggests that its ***edge connectors 13*** (connecting substrates) are connected to the first connecting terminal of a first end of a ***lighting tile*** (module substrate) and/or the second connecting terminal of a second end of the ***lighting tile*** (module substrate). (*Id*. at ¶252.)



(Ex-1004-Roberts at FIG. 5B; *see also id*. at 0082.)

As further explained above relative to Ground 1, limitation [1c], Roberts also teaches that its connecting substrates may include ***a loopback connector 35*** (termination connecting substrate) which comprises a closed loop pattern for forming a connecting terminal at the rightmost end of the final lighting tile 10" (a second connecting terminal of a second end of a final module substrate) as a closed loop circuit. (Ex-1003-Krames at ¶253.)

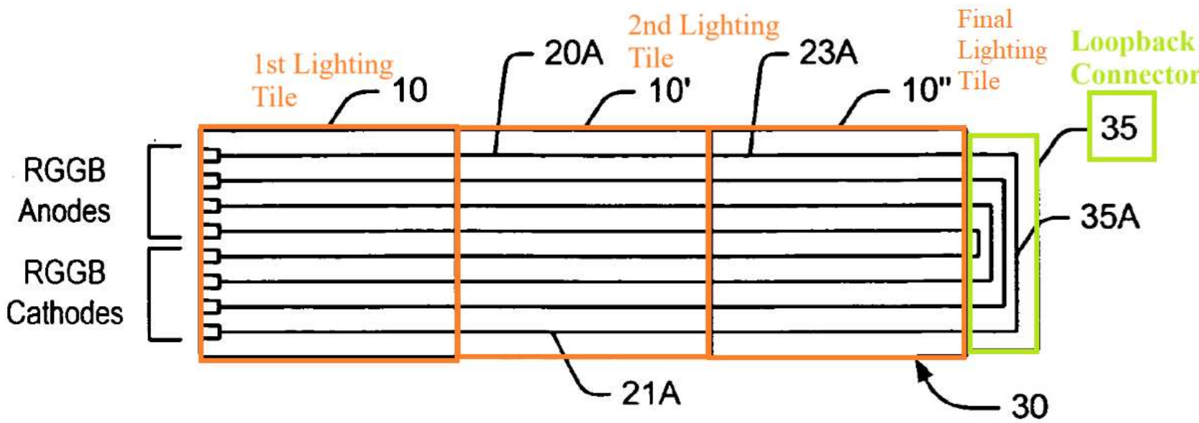


FIGURE 4A

(Ex-1004-Roberts at FIG. 4A; *see also id*. at FIG. 4B, 0071-73, 0075, 0134, 0136.)

Thus, Roberts teaches and suggests limitation [16e], and Roberts in view of Liu and Hsiao renders obvious Claim 16. (Ex-1003-Krames at ¶254.)

Further, to the extent the term "connecting substrate" is incorrectly and narrowly construed to require a substantially flat substrate, Roberts in view of Liu, Karlicek, and Hsiao renders obvious Claim 16 for the same reasons discussed above in Ground 3. (*Id*. at ¶255.)

Claim 17. The liquid crystal display as claimed in claim 16, [17a] wherein the connecting substrate comprises: an external connecting substrate for external connection; and

Karlicek teaches limitation [17a] for the same reasons as provided above relative to Ground 3, limitation [3a]. (Ex-1003-Krames at ¶256.)

[17b] at least one intermediate connecting substrate comprising a third connecting terminal which connects the external connecting substrate with the first connecting terminal of the first module substrate and/or between the connecting terminals of module substrates.

Roberts teaches limitation [17b] for the same reasons as provided above relative to Ground 3, limitation [3b] and Claim 4. (Ex-1003-Krames at ¶257.)

Thus, Roberts in view of Liu, Karlicek, and Hsiao renders obvious Claim 17. (*Id*. at ¶258.)

18. The liquid crystal display as claimed in claim 17, wherein one of the module substrate, the external connecting substrate, the intermediate substrate and the termination substrate comprises a flexible substrate.

Roberts teaches Claim 18.

Specifically, Roberts' loopback connector 35 (termination substrate) may be a flexible wiring board (flexible substrate):

> "The loopback connector 35 may include an edge connector, *a flexible wiring board*, or any other suitable connector. In addition, the loop connector may include printed traces formed on/in the tile 10."

(Ex-1004-Roberts at 0073.)

Thus, Roberts teaches Claim 18, and Roberts in view of Karlicek, Liu, and Hsiao renders obvious Claim 18. (Ex-1003-Krames at ¶¶259-261.)

IX. CONCLUSION

For the foregoing reasons, Petitioner respectfully requests that *inter partes* review of the '415 patent be instituted and the Challenged Claims be cancelled as unpatentable.

Respectfully submitted,
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CERTIFICATE OF SERVICE

The undersigned certifies that a true and correct copy of the Petition together with exhibits 1001-1018 identified in the above Table of Exhibits and Petitioner's Power of Attorney, have been served on the Patent Owner via Priority Mail Express or by means at least as fast and reliable as Priority Mail Express on the below date, at the following addresses:

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