UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CREE, INC.

Petitioner

v.

OPTOLUM, INC.

Patent Owner

Case No. IPR2017-01261

Patent 7,242,028

PETITION FOR *INTER PARTES* REVIEW

Mail Stop "PATENT BOARD"
Patent Trial and Appeal Board
U.S. Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

TABLE OF CONTENTS

Page

TABLE OF CONTENTS
(continued)

Page

TABLE OF CONTENTS
(continued)

Page

TABLE OF AUTHORITIES

Page

CASES

STATUTES

OTHER AUTHORITIES

LIST OF EXHIBITS

Ex. 1001	U.S. Patent No. 7,242,028 ("the '028 patent")
Ex. 1002	U.S. Patent No. 6, 220,722 ("the '722 patent" or "Begemann")
Ex. 1003	U.S. Patent No. 6,682,211 ("the '211 patent" or "English")
Ex. 1004	U.S. Patent No. 6,425,678 ("the '678 patent" or "Verdes")
Ex. 1005	U.S. Patent No. 6,848,819 ("the '819 patent" or "Arndt")
Ex. 1006	U.S. Patent No. 4,296,539 ("the '539 patent" or "Asami")
Ex. 1007	U.S. Patent No. 5,949,347 ("the '347 patent" or "Wu")
Ex. 1008	Declaration of Jianzhong Jiao ("the Jiao Decl.")
Ex. 1009	Amended Complaint dated February 2, 2017 in *OptoLum v. Cree, Inc*., 16-cv-3828 (D. Ariz.)
Ex. 1010	Prosecution History of U.S. Patent Application No. 10/984,366
Ex. 1011	Prosecution History of U.S. Patent Application No. 10/430,732
Ex. 1012	Prosecution History of U.S. Patent Application No. 10/156,810
Ex. 1013	U.S. Patent No. 6,462,669 ("the '669 patent")
Ex. 1014	U.S. Patent Application Publication No. 20020005826 ("the '826 publication")
Ex. 1015	U.S. Patent Application Publication No. 20010049893 ("the '893 publication")
Ex. 1016	U.S. Patent Application Publication No. 20020191396 ("the '396 publication")
Ex. 1017	Prosecution History of U.S. Patent Application No. 10/631,027
Ex. 1018	U.S. Patent No. 6,799,864 ("the '864 patent")
Ex. 1019	Prosecution History of U.S. Patent Application No. 10/430,696 ("the '696 application)

I. INTRODUCTION

The Petition demonstrates that claims 1-3, 5-8, 13-16 and 19-29 of U.S. Patent No. 7,242,028 (Ex. 1001, "the '028 patent") are unpatentable in view of various prior art references: U.S. Patent No. 6,220,722 (Ex. 1002, "the '722 patent, or "Begemann"), U.S. Patent No. 6,682,211 (Ex. 1003, "the '211 patent," or "English"), U.S. Patent No. 6,425,678 (Ex. 1004, "the '678 patent," or "Verdes"), U.S. Patent No. 6,848,819 (Ex. 1005, "the '819 patent," or "Arndt"), and U.S. Patent No. 4,296,539 (Ex. 1006, "the '539 patent," or "Asami"). Declaratory evidence from a distinguished expert, Dr. Jianzhong Jiao, who has been working in the technological fields of light-emitting diodes ("LEDs") and lighting for over 25 years, corroborates why a person of ordinary skill in the art ("POSA") would have understood that the various combinations of the above noted patents disclose the subject matter of claims 1-3, 5-8, 13-16 and 19-29 and why it would have been obvious to a POSA to combine those patents. *See* Ex. 1008, Declaration of Dr. Jianzhong Jiao.

The '028 patent is being asserted against Cree, Inc. ("Cree") by the alleged assignee, OptoLum, Inc. ("OptoLum"), in a patent infringement lawsuit (*OptoLum v. Cree, Inc.*, 2:16-cv-3828 (D. Ariz.)) to recover alleged damages for certain LED devices. *See* Ex. 1009, Amended Complaint in 2:16-cv-03828.

As explained herein, there is a reasonable likelihood that at least one claim of the '028 patent is unpatentable under the identified grounds, and Petitioner requests that the Board institute an *inter partes* review proceeding.

II. GROUNDS FOR STANDING PURSUANT TO 37 C.F.R. § 42.104(A)

Petitioner Cree certifies that the '028 patent is available for *inter partes* review and that Petitioner is not barred or estopped from requesting *inter partes* review on the grounds identified herein.

III. OVERVIEW OF THE '028 PATENT AND PRIOR ART

A. Overview of the '028 patent

The '028 patent (Ex. 1001), entitled "Light Emitting Diode Light Source," discloses a "light source that utilizes light emitting diodes that emit white light" wherein "[t]he diodes are mounted on an elongate member having at least two surfaces upon which the light emitting diodes are mounted." Ex. 1001, Abstract. "The elongate member is thermally conductive and is utilized to cool the light emitting diodes … [and] is a tubular member through which a heat transfer medium flows." *Id*. FIGS. 1-3 (below) illustrate light source 100, which includes an elongate thermally conductive heat sink 101 of excellent thermal conductivity. *Id.* at 2:62-66. Ex. 1008 at ¶ 39.

The tubular heat sink 101 is hollow (FIG. 2) and has an interior cavity 103 that includes heat dissipating protrusions 105. *Id*. at 3:4-6. Cooling of the heat sink is improved by movement of a medium 102, *e.g*., air, through the heat sink.

Id. at 3:10-15. The exterior surface 107 of the heat sink 101 has LEDs 109 mounted thereon. *Id*. at 3:17-18. Electrically conductive paths electrically connect the LEDs 109 to an electrical connector 111, the conductive paths being disposed on an electrically insulating layer(s) on surface 107 in the form of a flexible printed circuit(s) disposed on surface 107. *Id*. at 3:27-34. The flexible printed circuit 113 is adhered to the tube 101 with a heat conducting epoxy to enhance heat transmission from the LEDs 109 to the tube 101. *Id*. at 3:47-49. The light source may be mounted into a fixture by mounting clips. *Id*. at 3:63-64. Ex. 1008 at ¶ 40.

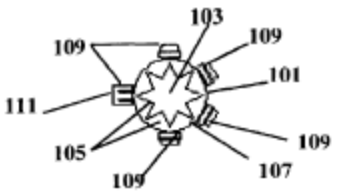


FIG. 2

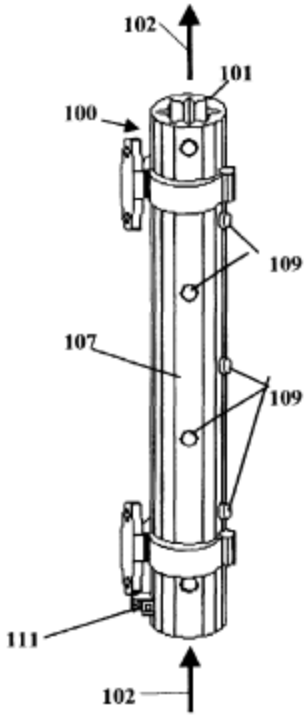


FIG. 3

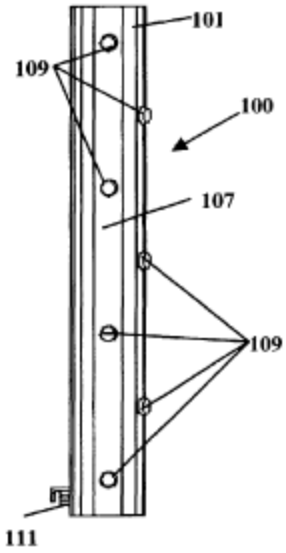


FIG. 1

B. Prosecution of the ‘028 patent and related applications

The ‘028 patent was filed as Application No. 10/984,366 (“the ‘366 application”) on November 8, 2004, as a continuation of Application No. 10/430,732 (“the ‘732 application”) filed May 5, 2003, which became, U.S. Patent No. 6,831,303 (“the ‘303 patent”), which was a continuation of Application No. 10/156,810 (“the ‘810 application”) filed May 29, 2002, which became U.S. Patent No. 6,573,536 (“the ‘536 patent”). Ex. 1001, p. 1. Two Office Actions issued rejecting claims for obviousness-type double patenting in view of both the ‘536

patent and the '303 patent, and rejecting claims as anticipated and obvious in view of the '819 patent and other references. Ex. 1010 at 55-70, 121-140. First and second Amendments were filed, along with a Terminal Disclaimer for the '303 patent, whereby the Applicant amended the application to obtain allowance based on the Examiner's identified allowable claims 2, 23, 29, 33 and 46 then pending, and a Notice of Allowance issued. *Id.* at 76-111, 145-162, 172-176. Ex. 1008 at ¶¶ 41-46.

A summary of prosecution of several other related applications is presented in the Jiao Declaration. Ex. 1008 at ¶¶ 47-55.

C. Overview of the '722 patent

The '722 patent (Ex. 1002, Begemann), entitled "LED Lamp," discloses an LED lamp (FIG. 1 below) comprising a tubular, hollow gear column 1, connected at one end to lamp cap 2 and at the other end to substrate 3, and provided with plural LEDs 4. Ex. 1002 at 3:39-44. A space within the gear column 1 accommodates electronics for controlling the LEDs 4. *Id*. at 3:44-45. The lamp includes an envelope 5 of synthetic resin, which envelops gear column 1 and substrate 3. *Id*. at 3:47-50.

In FIG. 1, substrate 3 is a regular pyramid with four flat faces, whose vertex is connected to the gear column 1. *Id*. at 3:53-55. The outer surface of substrate 3 is made of metal or metal alloy, *e.g*., copper alloy, which enables good heat

conduction from LEDs 4 to column 1. *Id*. at 3:56-58. Each face of substrate 3 has multiple LEDs 4. *Id*. LEDs 4 are secured to substrate 3 faces with a heat-conducting adhesive. *Id.* at 3:59-62. Each LED 4 has two electrical connections by which the LEDs are soldered onto substrate 3, with the heat-conducting adhesive providing good heat dissipation from the LEDs to the substrate. *Id.* at 4:61-65.

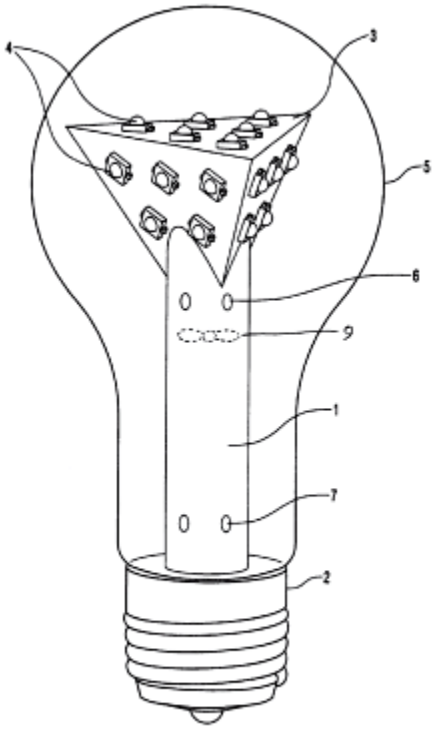


FIG. 1

The outer surface of gear column 1 is made of a metal or a metal alloy, *e.g.*, a copper alloy, enabling good heat conduction from substrate 3 to metal lamp cap 2. *Id*. at 3:66-4:2. Heat dissipation provided by the arrangement permits LEDs with high luminous flux to be used without heat problems. *Id*. at 4:3-6. The LED

lamp of FIG. 1 also includes a fan 9 disposed in gear column 1, which generates an air flow during operation, whereby air leaves gear column 1 via holes 6 therein and re-enters gear column 1 via holes 7 therein. *Id*. at 4:7-12. As a result, air flow is guided past a substantial number of LEDs 4 on substrate 3, and an improved heat dissipation from substrate 3 and LEDs 4 is achieved. *Id*. at 4:13-16. This arrangement permits good heat conduction from substrate 3 to metal lamp cap 2. *Id*. at 3:66-4:2. Accordingly, heat is conducted from LEDs 4 to metal substrate 3, from metal substrate 3 to metal gear column 1, and from metal gear column 1 to metal lamp cap 2. Moreover, as explained above, the hollow tubular structure of gear column 1 with fan 9 and holes 6, 7 provides circulation of air within the lamp and within gear column 1, such that heat transferred from LEDs 4 to substrate 3 to gear column 1 can further be transferred to air contained by the gear column 1. Ex. 1008 at ¶¶ 56-58.

Begemann issued on April 24, 2001, and is prior art under § 102(b).

D. Overview of the ‘211 patent

The ‘211 patent (Ex. 1003, English), entitled “Replaceable LED Lamp Capsule,” describes an LED lamp system that comprises a replaceable LED lamp capsule incorporating a support on which LEDs are directly placed, for automotive and other applications. Ex. 1003 at 1:5-8, 2:22-24, Abstract. The LED lamp system (FIG. 1 below) comprises a replaceable LED lamp capsule 10 that fits in a

reflector 12 and lens 14 housing, wherein LED lamp capsule 10 comprises a support 16 for one or more LED chips 22, the support 16 being formed from a material with high heat conductivity, such as a metal. *Id*. at 2:22-26, 36-37. The support 16 has a head 18 portion and a base 20 portion, where the head 18 and base 20 portions may be a single piece or may be separately formed and coupled to enable good heat conduction from LEDs 22. *Id*. at 2:37-45.

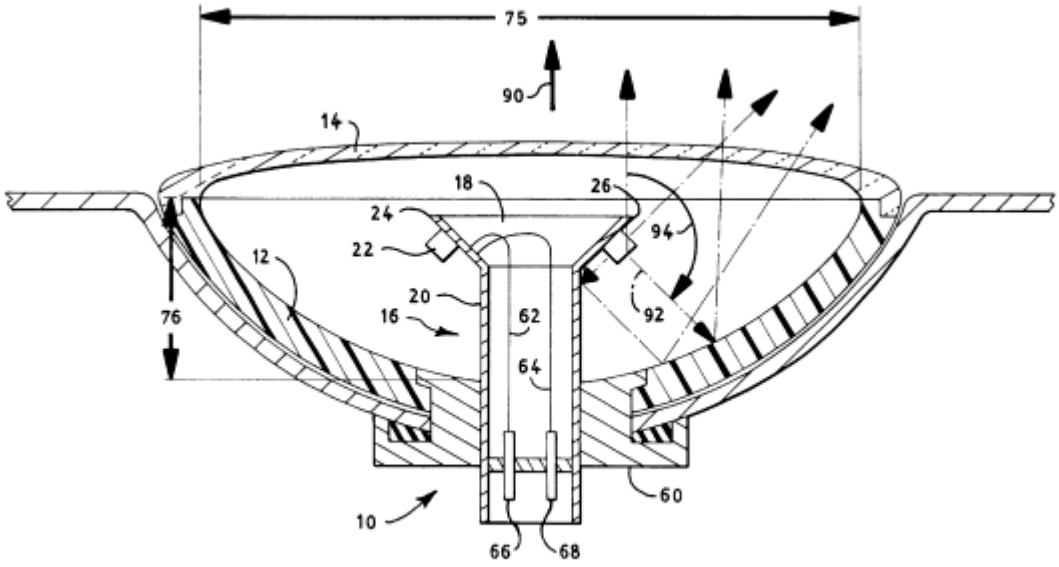


FIG. 1

The head 18 provides a surface on which to mount LED chips 22, which generally face away from the field to be illuminated and towards the base 20 or reflector 12. *Id*. at 2:46-48. Metal base portion 20 includes a coupling 60 providing direct metal to metal contact with a vehicle, enabling good thermal conduction away from LED chips 22 to the vehicle. *Id*. 3:56, 63-67. In a variation, "***the base 20 portion may include on an exterior side cooling fins or other heat***

dissipating structures exposed on the exterior of the base 20." *Id*. at 4:7-9.[1] By mounting LED chips directly on metal support 16, a substantial amount of heat is conducted away, thereby enhancing the lamp's life and reducing elevated junction temperatures that may otherwise lead to LED failures, achieving greater total light output than would be possible with SMT package mounting. *Id*. at 6:47-52; *see also* 5:20-31. Ex. 1008 at ¶¶ 59-60.

English was filed on September 28, 2001, and is prior art under § 102(e).

E. Overview of the '678 patent

The '678 patent (Ex. 1004, Verdes), entitled "LED Obstruction Lamp," describes an obstruction lamp that replaces conventional incandescent obstruction lamps and which utilizes LEDs. Ex. 1004 at 1:61-64, Abstract. The lamp 10 (FIG. 1 below) includes an optical lens 11 mounted on a rugged metal base 18 with good heat dissipation properties. *Id.* at 3:16-19. The optical lens 11 houses LED elements, and a clamp 17 and gasket secures the lens 11 to the base 18, which are secured to a wire housing 12 by screws 13. *Id.* at 3:19-24.

[1] All emphasis herein is added unless otherwise indicated.

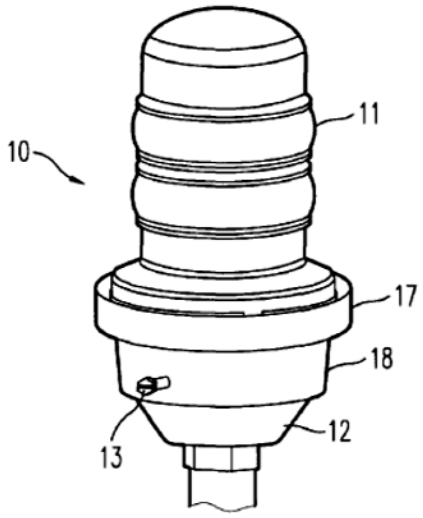


FIG. 1

The internal illuminating unit 30 (FIG. 3 below) comprises a vertical metal cylinder 35 on which plural high-power LEDs 31 and driving circuitry are mounted and which provides heat sinking for the plural LEDs 31. *Id*. at 3:38-46, 3:51-55. By inspection, metal cylinder 35 has a polygon shape in cross section with multiple faces around its circumference on which the LEDs 31 are mounted. Ex. 1008 at ¶¶ 61-62.

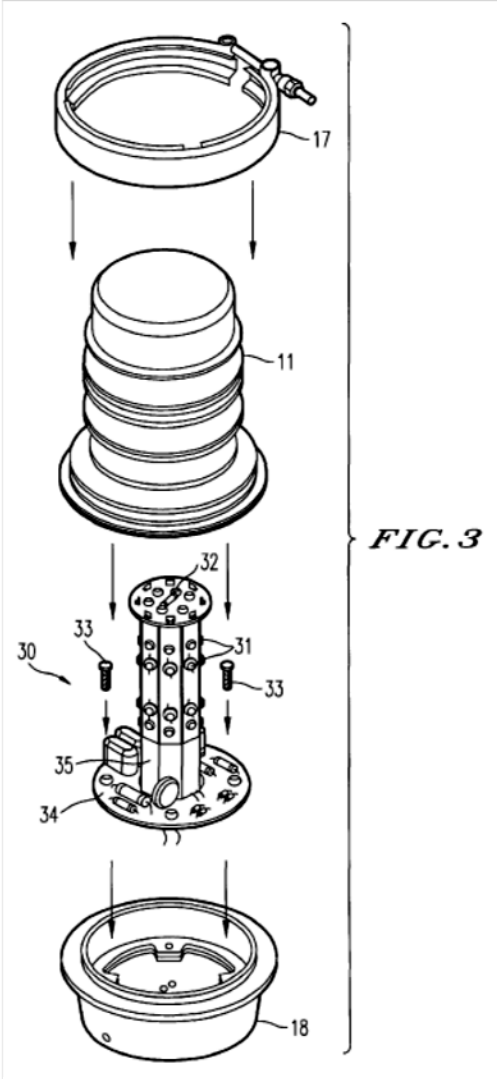


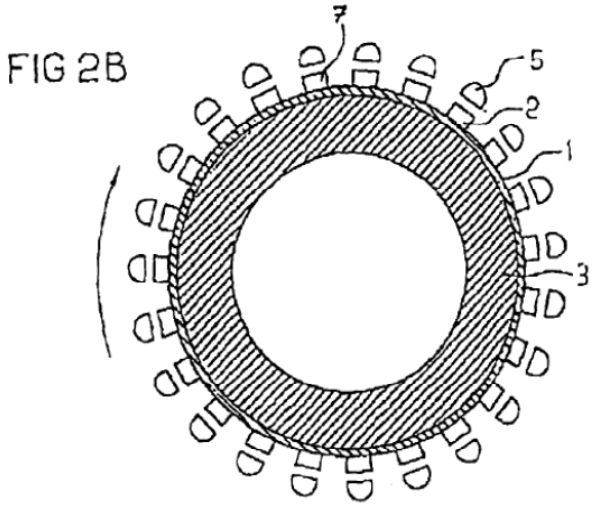
FIG. 3

Verdes was filed on August 23, 1999, and is prior art under § 102(e).

F. Overview of the '819 patent

The '819 patent (Ex. 1005, Arndt), entitled "Light-Emitting Diode Arrangement," describes an array of LEDs 2 with lenses 5 surface mounted on a flexible printed circuit board (PCB 1) and laminated to a hollow cylindrical cooling member 3 through which a gas such as air, or a liquid coolant, may flow to improve heat elimination (FIG. 2B below). Ex. 1005 at Abstract, 4:23-32, 59-61.

The PCB 1 is laminated onto the cooling member 3 with a thermally conductive adhesive, paste, or film 6, the cooling member 3 being fabricated of metal, *e.g.*, copper or aluminum, exhibiting high thermal conductivity. *Id*. at 4:2-9. Ex. 1008 at ¶ 63.



Arndt was filed as the National Stage of PCT/DE00/01508, has a § 371(c)(1), (2), (4) date of March 26, 2002, and is prior art under § 102(e).

G. Overview of the '539 patent

The '539 patent (Ex. 1006, Asami), entitled "Heat Transfer Tubing For Natural Gas Evaporator," describes an easily fabricated heat transfer tube 1 comprising a tubular body 3, internal fins 4, and external fins (flutes) 6 formed by extrusion of an aluminum alloy (FIGs. 3 and 7 below) to provide effective, high-performance heat transfer. Ex. 1006 at 1:12-15, 4:8-13, 7:7-18. The tubular body

3 can be easily formed by extrusion of aluminum alloy as a single integral unit. *Id.* at 7:59-66. Ex. 1008 at ¶ 64.

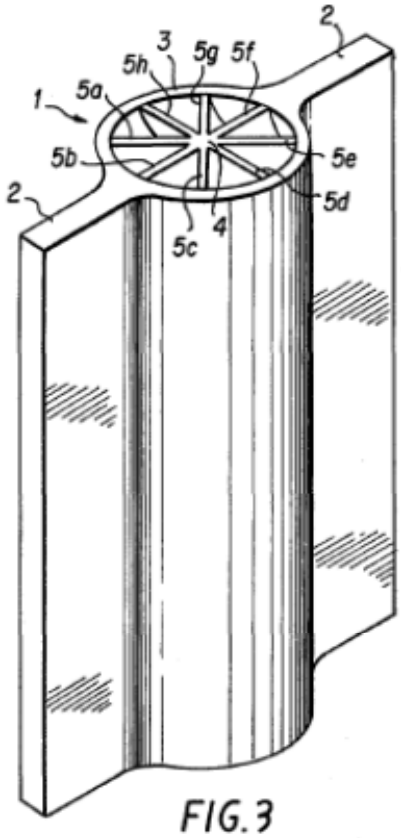


FIG. 3

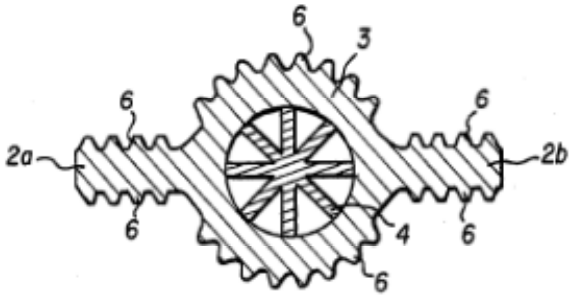


FIG. 7

Asami issued on October 27, 1981, and is prior art under § 102(b).

H. Person of Ordinary Skill in the Art

A person of ordinary skill in the subject of the '028 patent, as of the effective filing date of the '028 patent, would have been a person having at least a bachelor's degree in electrical or mechanical engineering or physics (or equivalent) and at least three years of training and practical experience in lighting or lighting related fields, including good working skills and knowledge related to LEDs and optical, electrical and mechanical designs for lighting applications. Alternatively,

a POSA could have a Master's Degree or a Ph.D. degree in electrical or mechanical engineering or physics (or equivalent) and at least one year of training and practical experience in lighting or lighting related fields, including good working skills and knowledge related to LEDs and optical, electrical and mechanical designs for lighting applications. Ex. 1008 at ¶ 37.

IV. IDENTIFICATION OF CHALLENGE PURSUANT TO 37 C.F.R. § 42.104(B)

A. 37 C.F.R. § 42.104(b)(1): Claims For Which *Inter Partes* Review Is Requested

Inter Partes review is requested for claims 1-3, 5-8, 13-16 and 19-29 of the '028 patent.

B. 37 C.F.R. § 42.104(b)(2): The Prior Art And Specific Grounds On Which The Challenge To The Claims Is Based

Inter Partes review is requested in view of the following prior art references:

- U.S. Patent No. 6,220,722 (Ex. 1002, "Begemann");
- U.S. Patent No. 6,682,211 (Ex. 1003, "English");
- U.S. Patent No. 6,425,678 (Ex. 1004, "Verdes");
- U.S. Patent No. 6,848,819 (Ex. 1005, "Arndt");
- U.S. Patent No. 4,296,539 (Ex. 1006, "Asami").

The specific statutory grounds under which 35 U.S.C. §§ 102 or 103 on which the challenge to the claims are based and the references relied upon for each ground are as follows:

Ground	Claims	Statutory Provision (pre-AIA)	Prior Art
1	1	§ 102(b)	Begemann (Ex. 1002)
2	1	§ 103(a)	Begemann (Ex. 1002), English (Ex. 1003)
3	2-3, 5-8, 13-16	§ 102(b)	Begemann (Ex. 1002)
4	2-3, 5-8, 13-16	§ 103(a)	Begemann (Ex. 1002), English (Ex. 1003)
5	5-7	§ 103(a)	Begemann (Ex. 1002), Verdes (Ex. 1004)
6	5-7	§ 103(a)	Begemann (Ex. 1002), Verdes (Ex. 1004), English (Ex. 1003)
7	19-22, 27-29	§ 102(b)	Begemann (Ex. 1002)
8	19-22, 27-29	§ 103(a)	Begemann (Ex. 1002), English (Ex. 1003)
9	23-26	§ 103(a)	Begemann (Ex. 1002), Arndt (Ex. 1005), Asami (Ex. 1006)
10	23-26	§ 103(a)	Begemann (Ex. 1002), Arndt (Ex. 1005), Asami (Ex. 1006), English (Ex. 1003)
11	19-22, 27-29	§ 103(a)	Begemann (Ex. 1002), Verdes (Ex. 1004)
12	19-22, 27-29	§ 103(a)	Begemann (Ex. 1002),

			Verdes (Ex. 1004), English (Ex. 1003)
13	23-26	§ 103(a)	Begemann (Ex. 1002), Verdes (Ex. 1004), Arndt (Ex. 1005), Asami (Ex. 1006)
14	23-26	§ 103(a)	Begemann (Ex. 1002), Verdes (Ex. 1004), Arndt (Ex. 1005), Asami (Ex. 1006), English (Ex. 1003)

C. 37 C.F.R. § 42.104(b)(3): Claim Construction

Pursuant to 37 C.F.R. § 41.100(b), solely for the purposes of this review, Petitioner construes the claim language such that the claims are given their broadest reasonable interpretation (BRI) in light of the disclosure of the '028 patent. For this review, each claim should be construed in accordance with its plain and ordinary meaning under the required BRI. Because the standard for claim construction at the Patent Office is different than that used during a litigation in a United States District Court (*see In re Am. Acad. Sci. Tech. Ctr.*, 367 F.3d 1359, 1364, 1369 (Fed. Cir., 2004); MPEP § 2111), Petitioner reserves the right to assert a different claim construction in litigation for any term of the '028 patent as appropriate in any such proceeding.

Term 1: "Elongate" means "having more length than width." This interpretation represents the plain meaning in the context of the specification (*e.g.*, illustrated by elongate heat sink 101 in FIGS. 1, 3, 4 of the '028 patent). Moreover, the patentee asserted the definition during prosecution of the '028 application and a family member application, and the Examiner applied it. *See* Ex. 1010 at 100; Ex. 1017 at 36, 48, 52-53. Ex. 1008 at ¶ 66.

Term 2: "Thermally conductive member" means a "structural unit that is thermally conductive." This interpretation represents the plain meaning of the term in the context of the specification The patentee asserted a similar definition ("structural unit that is a thermal conductor") during prosecution of a related application. *See* Ex. 1017 at 48, 50-52. However, the patentee's proposal is too narrow to the extent the language "is a thermal conductor" suggests that the thermally conductive member should be made of a single material, which is not required. Ex. 1008 at ¶ 67.

Term 3: "Heat dissipation protrusions" means "protrusions that dissipate heat." This interpretation represents the plain meaning of the term in the context of the specification, which uses the term "fins" more narrowly than "protrusions," indicating that "protrusions" is a broader term than "fins." *See, e.g.,* Ex. 1001 at1:65-67, 3:1-5. Ex. 1008 at ¶ 68.

D. 37 C.F.R. § 42.104(b)(4): How The Construed Claims Are Unpatentable

A detailed explanation of how claims 1-3, 5-8, 13-16, and 19-29 are unpatentable, including how each claim element is found in the prior art, is explained below at Section V.

E. 37 C.F.R. § 42.104(b)(5): Supporting Evidence

An Appendix of Exhibits supporting this petition is attached, including Ex. 1008, the Declaration of Jianzhong Jiao, under 37 C.F.R. § 1.68. In addition, the relevance of the evidence to the challenged claims, including an identification of the specific portions of the supporting evidence, is included in Section V.

V. THERE IS A REASONABLE LIKELIHOOD THAT AT LEAST ONE CLAIM OF THE '028 PATENT IS UNPATENTABLE

As explained below, claims 1-3, 5-8, 13-16 and 19-29 are unpatentable in view of the '722 patent alone or in combination with other references.

For each prior art ground based on obviousness, Petitioner states where each element is found in the prior art, *i.e*., Petitioner has evaluated the scope and contents of the prior art, any differences between the art and the claims, and the knowledge of person of ordinary skill in the art in accordance with *Graham v. John Deere Co*. 383 U.S. 1 (1966) and *KSR Int'l Co. v. Teleflex, Inc*., 550 U.S. 398 (2007). For each ground under §103 a more than adequate written rationale is provided to support the combination. *See KSR*, 550 U.S. at 418. In general, "[A] 'patent for a combination which only unites old elements with no change in their

respective functions . . . obviously withdraws what already is known into the field of its monopoly and diminishes the resources available to skillful men.' . . . The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results." *KSR*, 550 at 415-16 (citation omitted). "For the same reason, if a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill." *Id.* at 417; MPEP § 2141. Additional details regarding rationales for the prior art combinations are provided in the detailed discussion below.

A. Independent claims 1 and 19 are anticipated by the '722 patent (Ground 1)

Independent claims 1 and 19 are anticipated by Begemann under § 102(b) as explained below and in connection with the following claim chart with reference to each of the claim elements.

1.1: "A light source comprising"

Claims 1 and 19 each recite "A light source" in the preambles thereof. Begemann discloses this subject matter, *e.g.*: "These and other objects of the invention are achieved by a LED lamp…." Ex. 1002 at 1:40-41. *See* also FIGS. 1 and 2. Ex. 1008 at ¶ 72.

1.2: "An elongate thermally conductive member having an outer surface"

Claim 1 recites, "an elongate thermally conductive member having an outer surface." Begemann discloses this limitation, *e.g.*, via the structural unit of the substrate 3, gear column 1, and lamp cap 2, which plainly has more (vertical) length than width, as shown in annotated FIG. 1 below:

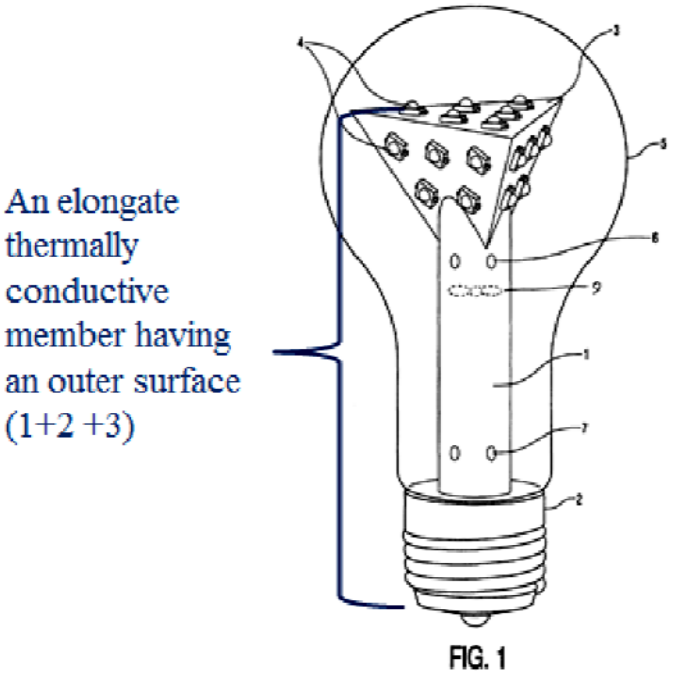


FIG. 1

Begemann discloses, *e.g.*: "This lamp comprises a tubular, hollow gear column (1), which is connected with one end to a lamp cap (2). The other end of the gear column (1) is connected to a substrate (3), which is provided with a number of LEDs (4)." Ex. 1002 at 3:39-44. "The outer surface of the gear column (1) of the LED lamp is made of a metal or a metal alloy. This enables a good heat conduction from the substrate (3) to the (metal) lamp cap (2) to be attained." *Id*. at

3:66-4:2. "A further interesting embodiment of the LED lamp is characterized in that the heat-dissipating means comprise a metal connection between the substrate and the lamp cap." *Id*. at 2:20-22. *See also* FIG. 2. Ex. 1008 at ¶¶ 73-74.

1.3: "A plurality of solid state light sources carried on said elongate member outer surface"

Claim 1 recites, "a plurality of solid state light sources carried on said elongate member outer surface." Begemann discloses this limitation by virtue of LEDs 4 carried on an outer surface of substrate 3 (which is part of the elongate member formed by features 1, 2, and 3), as shown in FIGs. 1 and 2. Begemann discloses, *e.g.*: "This lamp comprises a tubular, hollow gear column (1), which is connected with one end to a lamp cap (2). The other end of the gear column (1) is connected to a substrate (3), which is provided with a number of LEDs (4)." Ex. 1002 at 3:40-44. "The outer surface to the substrate (3) is made of metal or a metal alloy, thereby enabling a good heat conduction from the LEDs (4), to the column (1)…. The outer surface of the gear column (1) of the LED lamp is made of a metal or metal alloy." Ex. 1002 at 3:56-67. *See also* FIGs. 1 and 2. The term "solid state light source" is not mentioned in the specification of the '028 patent and only appears as a claim term. The only "solid state light sources" disclosed or suggested in the '028 patent are LEDs. *See generally* Ex. 1001. Accordingly, the LEDs 4 disclosed in Begemann satisfy the recitation of "solid state light sources" in claim 1. Ex. 1008 at ¶ 75.

1.4: "At least some of said solid state light sources being disposed in a first plane and others of said solid state light sources being disposed in a second plane not coextensive with said first plane"

Claim 1 recites, "at least some of said solid state light sources being disposed in a first plane and others of said solid state light sources being disposed in a second plane not coextensive with said first plane." Begemann discloses this limitation as shown in FIGs. 1 and 2, wherein LEDs 4, which are solid state light sources, are disposed on differently oriented (not coextensive) surface planes of the polyhedron substrate 3. Begemann discloses, *e.g.*: "[T]he substrate (3) has the shape of a pyramid with four flat faces…. Each of the faces of the pyramid is provided with a number (five or six) LEDs (4), which are secured to the faces by means of a heat-conducting adhesive." 1002 at 3:53-61. "[T]he substrate (3) is cube-shaped with six flat faces.… Each one of the faces … is provided with a number (eight or nine) LEDs (4)…." *Id*. at 4:23-31. Ex. 1008 at ¶ 76.

1.5: "Electrical conductors carried by said elongate thermally conductive member and connected to said plurality of solid state light sources to supply electrical power thereto"

Claim 1 recites, "electrical conductors carried by said elongate thermally conductive member and connected to said plurality of solid state light sources to supply electrical power thereto." Begemann discloses this limitation via electrical connections 14 to the LEDs 4 (FIGs. 3A and 3B below), which supply power to the LEDs 4:

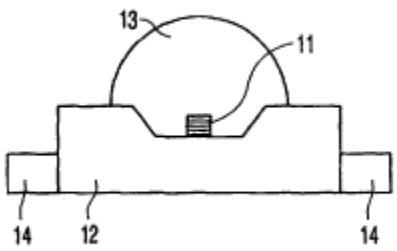


FIG. 3A

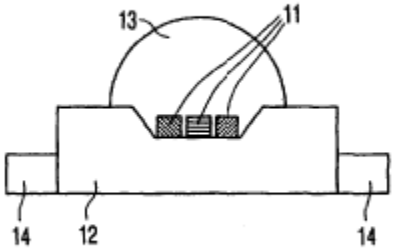


FIG. 3B

Ex. 1002 at FIG. 3A, 3B. Begemann discloses, *e.g.*: "The LED (4) is also provided with two electrical connections (14). Via these connections, the LED is soldered onto the substrate 3." *Id*. at 4:61-63. "The space within the hollow gear column (1) accommodates the ***electronic gear*** necessary for ***controlling the LEDs*** (4)." *Id.* at 3:44-46. "A particular aspect of the invention resides in that the heat-dissipating means remove the heat, generated during operation of the lamp, from the substrate via the gear column to the lamp cap and the ***mains supply connected thereto***." *Id.* at 1:54-58. To provide for the described electronic control of the LEDs 4, the electrical connections 14 would necessarily supply power to the LEDs 4, which comes from the stated mains supply. Ex. 1008 at ¶ 77.

1.6: "Said elongate thermally conductive member being configured to conduct heat away from said solid state light sources to fluid contained by said elongate thermally conductive member"

Claim 1 recites, "said elongate thermally conductive member being configured to conduct heat away from said solid state light sources to fluid contained by said elongate thermally conductive member." Begemann discloses

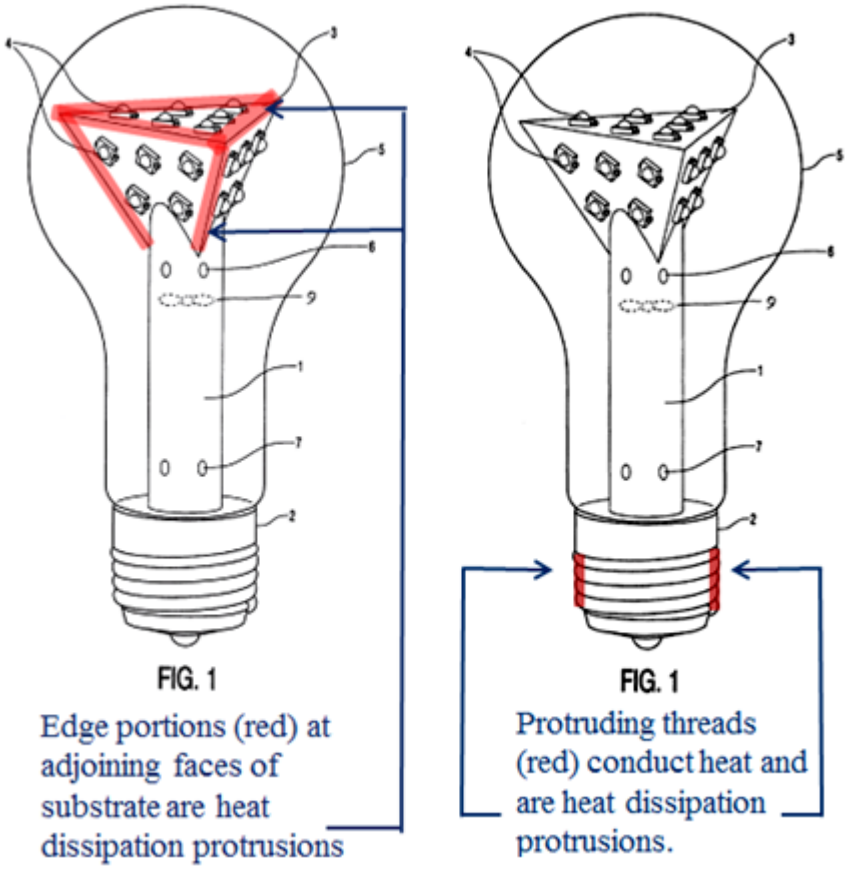
this limitation, *e.g.*, via the assembly of the substrate 3, lamp cap 2, and gear column 3, which is provided with fan 9 and air holes 6, 7 to circulate fluid (air) for conducting heat away from the LEDs 4. Begemann teaches that the outer surfaces of the substrate 3, the gear column 1, and the lamp cap are metal, are connected as a unit, and that LEDs 4 are mounted on the metal outer surface of substrate 3 with heat-conducting adhesive. *See, e.g.,* Ex. 1002 at 3:40-44, 3:56-4:3. Ex. 1008 at ¶¶ 78-79. Thus, with substrate 3, gear column 1, and lamp cap 2 all being metal and joined together as a unit, heat is conducted from LEDs 4 to metal substrate 3 to metal gear column 1 and to metal lamp cap 2. *Id.*

Regarding heat conduction to contained fluid, Begemann discloses, *e.g.*: "The LED lamp … also includes a fan (9) incorporated in the gear column (1), which fan generates an air flow during operation of the lamp. This air flow leaves the gear column (1) via holes (6) provided in the gear column, and re-enters the gear column via the holes (7) provided in the gear column…. By virtue thereof, an improved heat dissipation from the substrate and the LEDs is obtained." Ex. 1002 at 4:7-16; *see also id.* at 2:33-39. Thus, in addition to conducting heat from LEDs 4 to metal substrate 3 to metal gear column 1 to metal lamp cap 2, the fan 9 and air holes 6, 7 in gear column 1 provide circulation of air within the lamp and within gear column 1, whereby heat transferred from LEDs 4 to substrate 3 and to gear

column 1 can further be transferred to air contained by the gear column 1, which further facilitates heat dissipation from the LEDs 4. Ex. 1008 at ¶¶ 80-81.

1.7: "Said elongate thermally conductive member comprises one or more heat dissipation protrusions, at least one of said heat dissipation protrusions being carried on said elongate member outer surface"

Claim 1 recites, "said elongate thermally conductive member comprises one or more heat dissipation protrusions, at least one of said heat dissipation protrusions being carried on said elongate member outer surface." Begemann discloses this limitation by virtue of the edge portions of adjoining faces of substrate 3 (and points thereof) and/or the protruding threads of the lamp cap 2 as shown in annotated FIG. 1 below:



Ex. 1002, FIG. 1 (annotated). The protruding threads (above right, red), which are carried on an outer surface of the elongate member, are metal because the lamp cap 2 is metal, and these protruding threads would conduct heat to the socket in which the LED lamp is mounted. Ex. 1008 at ¶ 82. Begemann discloses, "The outer surface of the substrate (3) is made of metal or a metal alloy, thereby enabling a good heat conduction from the LEDs (4) to the column (1).… The outer surface of the gear column (1) of the LED lamp is made of a metal or metal alloy. This enables a good heat conduction from the substrate (3) to the (metal) lamp cap (2) to

be attained." Ex. 1002 at 3:56-4:2. The threads are therefore protrusions that dissipate heat.

In addition, or alternatively, the edges of adjoining faces of the substrate 3 and the points where those edges intersect (above left, red) protrude from the remainder of the substrate 3, and those edges and intersecting points, which are carried on an outer surface of the elongate member, dissipate heat to the air circulating within the envelope, because the substrate 3 as whole dissipates heat to circulating air. *See, e.g.,* Ex. 1002 at 4:7-16, Ex. 1008 at ¶ 83. Begemann discloses, "The LED lamp shown in FIG, 1 also includes a fan (9) incorporated in the gear column (1), which fan generates an air flow during operation of the lamp…. By virtue thereof, an improved heat dissipation ***from the substrate*** and the LEDs ***is obtained***." Ex. 1002 at 4:7-16. The edge portions of adjoining faces of Begemann's substrate 3 are triangularly shaped like the heat dissipating protrusions disclosed in the '028 patent as shown below (annotated FIG. 1, Begemann left; annotated FIG. 2, '028 patent right), with one heat dissipating protrusion for each highlighted in red. Thus, the edges of adjoining faces of the substrate 3 are likewise protrusions that dissipate heat.

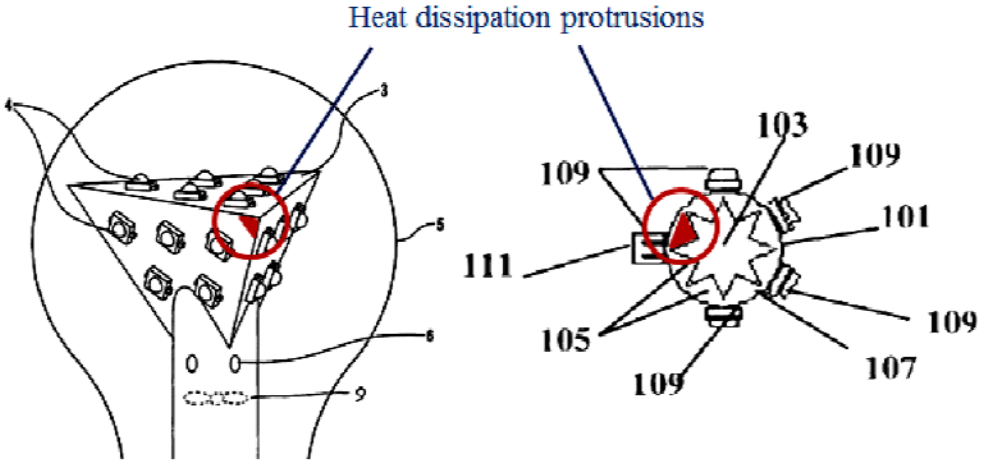


FIG. 1 '722 patent (annotated)

FIG. 2 '303 patent (annotated)

Ex. 1008 at ¶¶ 82-84. Accordingly, claims 1 and 19 are anticipated by Begemann.

B. Independent claim 1 is obvious in view of the '722 patent and the '211 patent (Ground 2)

Should it be determined that Begemann does not disclose the claimed heat dissipation protrusions, then claim 1 is obvious in view of Begemann in combination with English under § 103(a). English expressly discloses the placement of cooling fins on an exterior of a hollow, metal base portion 20 of an elongated, thermally conductive metal support 16 to further enhance heat dissipation for cooling LEDs mounted on the metal support 16. *See, e.g.*, Ex. 1003 at 4:6-9. A POSA would have been motivated at the time of the alleged invention to provide the cooling fins of the lamp of English to the outer surface of gear column 1 (part of the elongate, thermally conductive member) of the lamp of Begemann to enhance the performance and/or efficiency of cooling the LEDs 4 by enhancing heat dissipation away from the gear column 1, substrate 3, and LEDs 4

to air circulating inside and at the outer surface of the gear column 1. Ex. 1008 at ¶ 85. Begemann and English address common technical issues of managing heat in high illumination LED-based light sources in which a thermally conductive member is formed in the shape of a hollow channel and wherein a fluid (notably air) is utilized to cool the LED light sources. Ex. 1008 at ¶ 85. Begemann expressly describes a fan 9 used to circulate air through holes 6, 7 in a hollow, metal gear column 1 so as to further enhance heat dissipation away from LEDs 4 mounted on a metal substrate 3 of an elongate, thermally conductive member. *See, e.g.,* Ex. 1002 at 4:7-16.

Thus, a POSA would have been motivated to apply the external cooling fins of English to the outer surface of the gear column 1 of Begemann because English expressly teaches the placement of exterior cooling fins on an outer surface of an elongate thermally conductive member to enhance heat dissipation away from LEDs, to enhance the lamp's life, reduce elevated junction temperatures that may otherwise lead to LED failures, and enhance a total light output that may be achieved. *See* Ex. 1003 at 4:6-9, 6:47-52, 5:6-31. Ex. 1008 at ¶ 86. An illustration of the modification with added labeling is shown below.

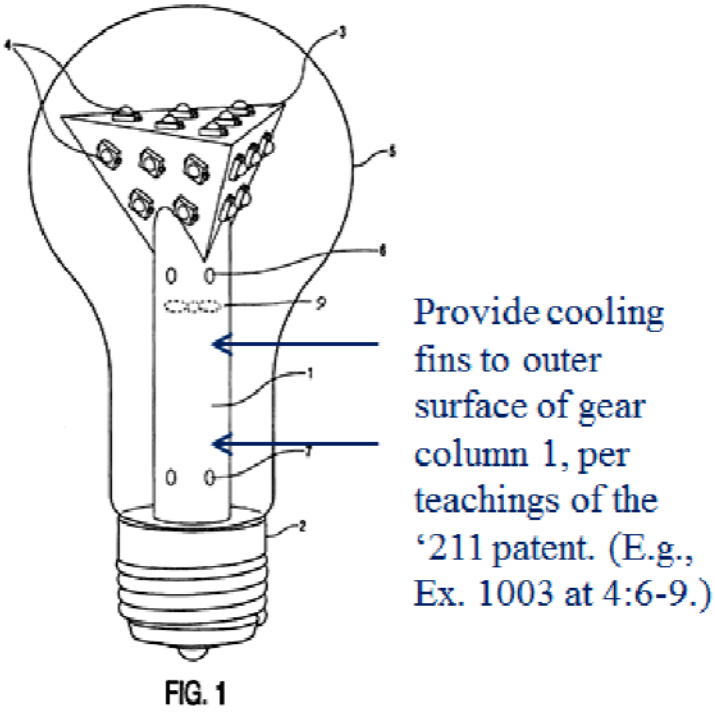


FIG. 1

The devices described in the '722 and '211 patents relate to similar technical issues, and combining their features would have amounted to combining known prior art elements according to known methods, with no change in respective functions, to yield predictable results. Ex. 1008 at ¶ 87; see, *KSR*, 550 U.S. at 416; MPEP § 2141. English and Begemann teach a common goal of dissipating heat from LEDs in elongate thermally conductive members to enhance lamp performance as described above. *See, e.g.*, Ex. 1002 at 3:56-62, 3:66-4:16, 4:7-16 ; Ex. 1003 at 4:6-9, 6:47-52, 5:6-31. A POSA would reasonably have expected the modification of Begemann's lamp to be successful at least because 1) the addition of cooling fins to the gear column 1 would have been a straightfoward modification easily made to the lamp of Begemann, and 2) Begemann describes air

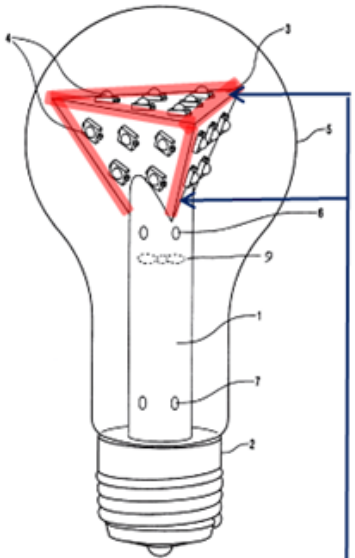
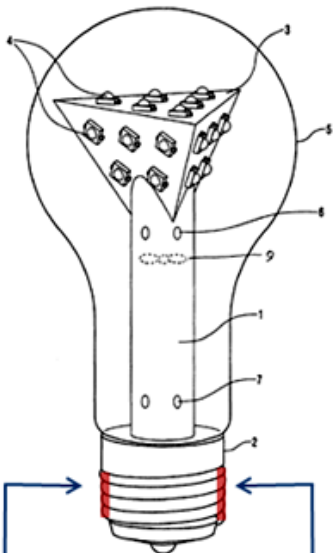
flow within the envelope 5 via fan 9 and holes 6, 7, which would have been able to effectuate enhanced cooling provided by such cooling fins placed on the outer surface of the gear column 1. Ex. 1008 at ¶ 87.

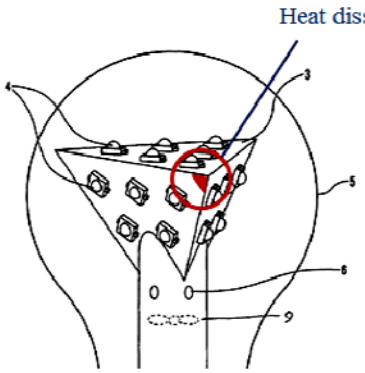
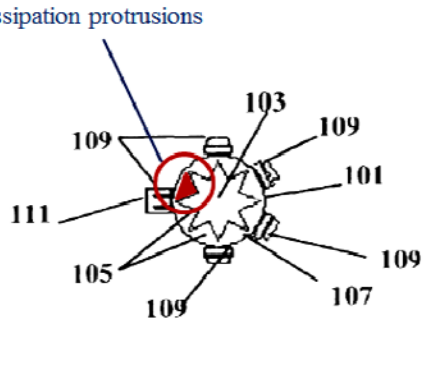
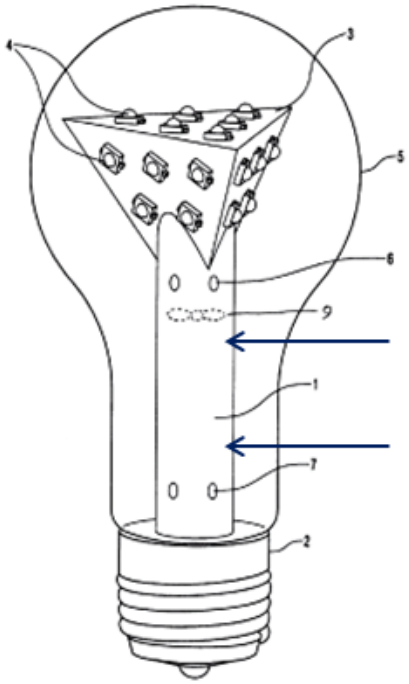
A claim chart is presented below showing where each limitation of claim 1 is found in the references, either as anticipated by Begemann or obvious in view of Begemann and English. Ex. 1008 at ¶ 88.

CLAIM 1 – Anticipation and Obviousness

Claim Element	**Prior Art Teaching**
1.1: A light source comprising:	Ex. 1002 (Begemann) at 1:40-41. "These and other objects of the invention are achieved by a LED lamp…"
1.2: an elongate thermally conductive member having an outer surface;	Ex. 1002 at 3:39-44. "This lamp comprises a tubular, hollow gear column (1), which is connected with one end to a lamp cap (2). The other end of the gear column (1) is connected to a substrate (3), which is provided with a number of LEDs (4)." Ex. 1002 at 3:56-4:2. "The outer surface to the substrate (3) is made of metal or a metal alloy, thereby enabling a good heat conduction from the LEDs (4) to the column (1).… The outer surface of the gear column (1) of the LED lamp is made of a metal or metal alloy. This enables a good heat conduction from the substrate (3) to the (metal) lamp cap (2) to be attained." *See also* Ex. 1002 at 2:20-22.
1.3: a plurality of solid state light sources carried on said elongate member outer surface	Ex. 1002 at 3:40-44. "This lamp comprises a tubular, hollow gear column (1), which is connected … to a substrate (3), which is provided with a number of LEDs (4)." *See* FIG. 1 and FIG. 2

Claim Element	Prior Art Teaching
1.4: at least some of said solid state light sources being disposed in a first plane and others of said solid state light sources being disposed in a second plane not coextensive with said first plane;	Ex. 1002 at 3:53-61. "In the example described herein, the substrate (3) has the shape of a regular pyramid with four flat faces…. Each of the faces of the pyramid is provided with a number (five or six) LEDs (4), which are secured to the faces by means of a heat-conducting adhesive." *See also* Ex. 1002 at 4:23-31.
1.5: electrical conductors carried by said elongate thermally conductive member and connected to said plurality of solid state light sources to supply electrical power thereto; and	Ex. 1002 at 4:61-63. "The LED (4) is also provided with two electrical connections (14). Via these connections, the LED is soldered onto the substrate (3)." Ex. 1002 at 3:44-46. "The space within the hollow gear column (1) accommodates the electronic gear necessary for controlling the LEDs (4)." *See also* Ex. 1002 at 1:54-58 (describing "mains supply connected" to lamp cap).
1.6: said elongate thermally conductive member being configured to conduct heat away from said solid state light sources to fluid contained by said elongate thermally conductive member;	Ex. 1002 at 3:40-44. "This lamp comprises a tubular, hollow gear column (1), which is connected with one end to a lamp cap (2). The other end of the gear column (1) is connected to a substrate (3), which is provided with a number of LEDs (4)." Ex. 1002 at 3:56-4:2. "The outer surface of the substrate (3) is made of a metal or a metal alloy, thereby enabling a good heat conduction from the LEDs (4) to the column (1)…. The outer surface of the gear column (1) of the LED lamp is made of a metal or a metal alloy. This enables a good heat conduction from the substrate (3) to the (metal) lamp cap (2) to be attained." Ex. 1002 at 4:7-16. "The LED lamp shown in FIG, 1 also includes a fan (9) incorporated in the gear column (1), which fan generates an air flow during operation of the lamp. This air flow leaves the gear column (1)

Claim Element	Prior Art Teaching
	via holes (6) provided in the gear column, and re-enters the gear column via the holes (7) provided in the gear column…. By virtue thereof, an improved heat dissipation from the substrate and the LEDs is obtained." *See also* Ex. 1002 at 2:33-39.
1.7: said elongate thermally conductive member comprises one or more heat dissipation protrusions, at least some of said heat dissipation protrusions being carried on said elongate member outer surface.	<u>Anticipation by Ex. 1002 (Begemann):</u> Ex. 1002 at 3:56-4:2. "The outer surface to the substrate (3) is made of metal or a metal alloy, thereby enabling a good heat conduction from the LEDs (4) to the column (1)…. The outer surface of the gear column (1) of the LED lamp is made of a metal or metal alloy. This enables a good heat conduction from the substrate (3) to the (metal) lamp cap (2) to be attained."  FIG. 1 Edge portions (red) at adjoining faces of substrate are heat dissipation protrusions  FIG. 1 Protruding threads (red) conduct heat and are heat dissipation protrusions.

Claim Element	Prior Art Teaching
	 FIG. 1 '722 patent (annotated)  FIG. 2 '303 patent (annotated) <u>Obviousness in view of Ex. 1002 (Begemann) and Ex. 1003 (English):</u> Ex. 1003 (English) 4:6-8: "In another variation, the base 20 portion may include on an exterior side cooling fins or other heat dissipating structures exposed on the exterior of the base 20."  FIG. 1

C. Claims 2 and 3 are anticipated by the '722 patent (Ground 3) and obvious in view of the '722 and '211 patents (Ground 4)

Claim 2 depends from claim 1 and recites, "said elongate thermally conductive member is configured to conduct heat away from said solid state light sources to fluid proximate said elongate member outer surface." Claim 3 depends from claim 2 and recites, "said fluid proximate said elongate member outer surface comprises air." Begemann discloses the limitations of claims 2 and 3 (Ground 3), *e.g.*, via the assembly of the substrate 3, lamp cap 2 and gear column 1, which is provided with fan 9 and air holes 6, 7 to circulate fluid (air) for conducting heat away from the LEDs 4. Begemann discloses, "The LED lamp shown in FIG, 1 also includes a fan (9) incorporated in the gear column (1), which fan generates an air flow during operation of the lamp. This air flow leaves the gear column (1) via holes (6) provided in the gear column, and re-enters the gear column via the holes (7) provided in the gear column…. By virtue thereof, an improved heat dissipation from the substrate and the LEDs is obtained." *Id*. at 4:7-16, *see also id.* at 2:33-39. Thus, Begemann discloses these limitations. Ex. 1008 at ¶ 89.

However, should it be determined that Begemann does not disclose heat dissipating protrusions as claimed in claim 1, then claims 2 and 3 are obvious (Ground 4) under the combination of Begemann and English with the addition of English's cooling fins to gear column 1 as explained for claim 1. *See, e.g.*, Ex. 1002 at 3:56-62, 3:66-4:16; Ex. 1003 at 4:6-9, 6:47-52, 5:6-31. Ex. 1008 at ¶ 90.

D. Claims 5-7 are anticipated by the '722 patent (Ground 3)

Claim 5 depends from claim 3 and recites, "said elongate thermally conductive member comprises a tube." Begemann discloses this limitation at least via tubular hollow gear column 1 shown in FIGS. 1 and 2. Begemann discloses, *e.g.*, "FIG. 1 shows a first embodiment of the invented light emitting [d]iode lamp (LED lamp). This lamp comprises a ***tubular, hollow gear column (1)***, which is connected with one end to a lamp cap (2)." Ex. 1002 at 3:38-42. A POSA would also reasonably consider the substrate 3 to be an extension of the gear column 1 to which it is attached, such that the gear column 1 and substrate 3 of FIGS. 1 and 3 together may be considered the claimed tube. The polyhedron substrate 3 is referred to as a "substrate," which indicates a thin planar structure in the electrical arts, and a POSA would understand the substrate 3 to be hollow and not a solid block of metal. Ex. 1008 at ¶ 91. A POSA therefore would consider the hollow substrate 3 structure to be a tubular extension of the gear column 1. *Id*. Thus, Begemann anticipates claim 5.

Claim 6 depends from claim 5 and recites, "said tube has a cross-section in the shape of a polygon." Claim 7 depends from claim 5 and recites, "said tube has a cross-section having flat portions." Begemann discloses these limitations at least because the hollow polygon shaped substrate 3 forms part of the claimed tube as explained above. Begemann discloses, *e.g.*: "In the example described herein, the

substrate (3) has the shape of a pyramid with four flat faces…. Each of the faces of the pyramid is provided with a number (five or six) LEDs (4), which are secured to the faces by means of a heat-conducting adhesive." 1002 at 3:53-62, *see also id.* at 4:23-31. Thus, a cross-section of the substrate 3 would have a shape of a polygon (claim 6), and such a cross-section would likewise have flat portions (claim 7). Ex. 1008 at ¶ 92. Thus, Begemann anticipates claims 6 and 7 (Ground 3). *Id.*

E. Claims 5-7 are obvious in view of the '722 patent and obvious in view of the '722 and '211 patents (Ground 4)

A POSA would understand Begemann's substrate 3 to be hollow as explained above. But should it be determined that Begemann does not teach that polyhedron substrate 3 is hollow, a POSA would have found it obvious at the time of the alleged invention to make polyhedron substrate 3 to be hollow. With the polyhedron substrate 3 being hollow, the limitations of claims 5-7 are accounted for as explained in Section V.D for claims 5-7 (Ground 3) . It would have been obvious to make the polyhedron substrate 3 hollow at least because it is referred to as a "substrate" (which indicates a thin planar structure in the electrical arts) and also to reduce the weight and materials cost of the lamp, since fabricating such lamps with a hollow metal, *e.g.*, copper, substrate 3 instead of solid blocks of copper metal or copper alloy for the substrate 3 would reduce the manufacturing and shipping costs. Ex. 1008 at ¶ 93. In addition, it would have been obvious to

make the substrate 3 hollow to provide convenient means for making electrical connections to LEDs from beneath, *i.e.*, from inside, the substrate 3 and to further enhance air circulation for heat dissipation from the LEDs 4. *Id*. With a hollow polyhedron substrate 3, the limitations of claims 5-7 are accounted for as explained for claims 5-7 in Section V.D above. *Id*.

Also, should it be determined that Begemann does not disclose heat dissipating protrusions of claim 1, then claims 5-7 are obvious (Ground 4) under the combination of Begemann and English with the addition of English's cooling fins to gear column 1 as explained for claim 1. *See, e.g.*, Ex. 1002 at 3:56-62, 3:66-4:16; Ex. 1003 at 4:6-9, 6:47-52, 5:6-31. Ex. 1008 at ¶ 93.

F. Claims 5-7 are obvious in view of the '722 and '678 patents (Ground 5) and obvious in view of the '722, '678, and '211 patents (Ground 6)

Should the substrate 3 of Begemann not be considered part of the claimed tubular member, then claims 5-7 are obvious in view of Begemann in combination with Verdes. Verdes discloses an LED obstruction lamp that can replace incandescent obstruction lamps, wherein an internal illuminating unit 30 comprises a vertical metal cylinder 35 on which plural high-power LEDs 31 and driving circuitry are mounted and which provides heat sinking for plural LEDs 31. Ex. 1004 at 3:38-46, 51-55, FIG. 3. Ex. 1008 at ¶ 95.

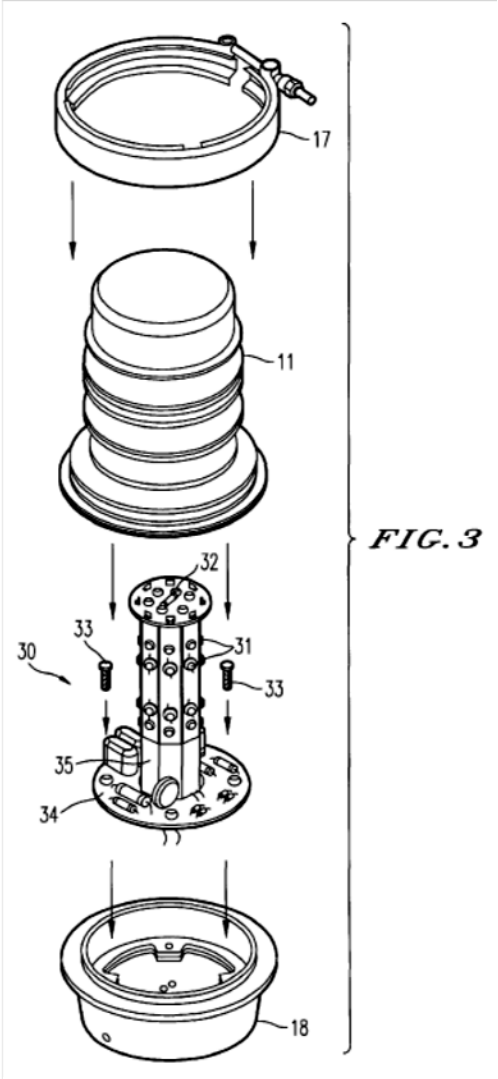


FIG. 3

The metal cylinder 35 has a polygon shape in cross section with multiple side faces around its circumference on which LEDs 31 are mounted and a top plate on which LEDs 32 are mounted. A POSA would have recognized the desirability of Verdes's teaching of a simple,uniform, polygon shaped, vertical cylinder 35, which would be easy to manufacture, would provide convenient flat mounting surfaces (as opposed to curved) on which to easily mount LEDs, and would provide for uniform side and top illumination given the 360 degree distribution of

flat mounting surfaces. Ex. 1008 at ¶ 96. A POSA would have been motivated at the time of the alleged invention to replace the hollow gear column 1 and polygon substrate 3 of Begemann with a simple vertical metal tube (consistent with Begemann's teaching of a hollow tube 1) having the uniform polygon cross-sectional shape of the metal cylinder 35 of Verdes and top plate of Verdes, with Begemann's LEDs 4 being mounted on the side polygon surfaces and top plate of such vertical metal tube, such as illustrated for LEDs 31 and 32 mounted on the vertical metal cylinder 35 of Verdes, while retaining the fan 9 and air holes 6, 7 of Begemann inside the resulting vertical, polygon metal tube to provide the desired heat dissipation provided by those components. Ex. 1008 at ¶ 96.

A POSA would have been motivated to make such modifications to Begemann's lamp to provide a simpler supporting structure on which to mount LEDs 4, which avoids the complexity of the polygon shape substrate 3 and complexity of its attachment to the gear column 1, thereby simplifying the manufacturing process and reducing the cost of manufacturing the lamp of Begemann, while still retaining the fan 9 and air holes 6, 7 disclosed in Begemann for maintaining the enhanced heat dissipation provided by those features. *Id*. There would have been a reasonable expectation of success at least because replacement of the gear column 1 and substrate 3 of Begemann with a modified vertical metal tube and top plate having the outer shape of Verdes's vertical metal

cylinder 35 would have been a straightforward reconfiguration of easily manipulated components. *Id*. at ¶ 96. Also, the resulting vertical metal tube with cross-sectional polygon shape and top plate would have provided desirable and convenient flat surfaces on which to mount Begemann's LEDs 4 as well as a desirable structure for directing light both vertically and horizontally, consistent with the omnidirectional illumination of the Begemann's lamp. *Id.*

With the gear column 1 and substrate 3 of Begemann thus replaced with a simpler, vertical metal tube with polygon-cross sectional shape and top plate, having an outer shape as illustrated by the vertical metal cylinder 35 of Verdes, the resulting lamp would have accounted for all the limitations of claims 5-7. In particular, claim 5 depends from claim 2 and recites, "said elongate thermally conductive member comprises a tube." The modified lamp of Begemann as described above would possess an elongate thermally conductive member in the form the modified vertical metal tube in combination with Begemann's lamp cap 2, which would have possessed the same heat dissipating properties as the combined substrate 3 and gear column 1 as explained for claim 1 above. That structure would also meet all the other limitations of claim 1 (as explained for claim 1). That structure would possess heat dissipating protrusions by virtue of the protruding threads at the outer surface of the elongate member which dissipate heat as explained above for claim 1. *Id*. at ¶ 96.

Claim 6 depends from claim 5 and recites, "said tube has a cross-section in the shape of a polygon." The resulting modified lamp with the vertical metal tube meets the limitation of claim 6, because the modified vertical metal tube is purposefully configured to have the polygon cross-sectional shape with multiple flat surfaces like Verdes vertical metal cylinder 35. Claim 7 depends from claim 5 and recites, "said tube has a cross-section having flat portions." Again, the resulting modified lamp with a vertical metal tube purposefully modified to have the polygon cross-sectional shape with multiple flat surfaces like Verdes vertical metal cylinder 35 meets the limitation of claim 7. Ex. 1008 at ¶¶ 96-97.

Thus, claims 5-7 would have been obvious in view of Begemann and Verdes (Ground 5). Ex. 1008 at ¶¶ 95-97.

Should it be determined that the protruding threads of Begemann's lamp cap 2 are not heat dissipating protrusions as claimed (in the modified lamp of Begemann as described above), then claims 5-7 are obvious under the combination of Begemann, Verdes, and English with the addition of English's cooling fins to the outer surface of the modified vertical tube having the polygon cross-sectional shape as described above (which would still contain fan 9 and air holes 6,7, as explained above). *See, e.g.*, Ex. 1002 at 3:56-62, 3:66-4:16; Ex. 1003 at 4:6-9, 6:47-52, 5:6-31. Ex. 1008 at ¶ 98.

G. Claims 8 and 13-15 are anticipated by the '722 patent (Ground 3) and obvious in view of the '722 and '211 patents (Ground 4)

Claims 8 and 13-15 recite:

> 8. A light source in accordance with claim 1, wherein: said elongate thermally conductive member comprises a channel.
>
> 13. A light source in accordance with claim 1, wherein: said fluid is moved in said elongate thermally conductive member.
>
> 14. A light source in accordance with claim 1, wherein: said elongate thermally conductive member comprises a thermal transfer media disposed therein.
>
> 15. A light source in accordance with claim 14, wherein: said elongate thermally conductive member comprises a flow channel for said thermal transfer media.

Begemann discloses the limitations of claims 8 and 13-15 (Ground 3) at least because Begemann's tubular hollow gear column 1 is hollow and therefore comprises a channel, *e.g.*, the open interior of gear column 1 (claim 8), wherein fluid (namely, air) is moved therein (claim 13), comprises a thermal transfer media (namely, air) disposed therein (claim 14), and comprises a flow channel (open interior of gear column 1) for the thermal transfer media (namely, air) (claim 15). The '028 patent indicates that air is considered a thermal transfer media: "In the illustrative embodiment of the invention, the medium is air." Ex. 1001 at 2:1-2. Begemann discloses, "The LED lamp shown in FIG, 1 also includes a fan (9) incorporated in the gear column (1, which fan generates an air flow during

operation of the lamp. This air flow leaves the gear column (1) via holes (6) provided in the gear column, and re-enters the gear column via the holes (7) provided in the gear column…. By virtue thereof, an improved heat dissipation from the substrate and the LEDs is obtained." *Id*. at 4:7-16, *see also id.* at 2:33-39. Thus, Begemann anticipates claims 8 and 13-15 (Ground 3). Ex. 1008 at ¶ 100.

Should it be determined that Begemann does not disclose heat dissipating protrusions as claimed, then claims 8 and 13-15 are obvious under the combination of Begemann and English (Ground 4) with the addition of English's cooling fins to gear column 1 as explained for claims 1 and 2. *See, e.g.*, Ex. 1002 at 3:56-62, 3:66-4:16; Ex. 1003 at 4:6-9, 6:47-52, 5:6-31. Ex. 1008 at ¶ 101.

H. Claim 16 is anticipated by the '722 patent (Ground 3) and obvious in view of the '722 patent and the '211 patent (Ground 4)

Claims 16 depends from claim 1 and recites, "each of said solid state light sources emits white light." Begemann discloses that the LEDs 4 described therein can be red (R), green (G), yellow (Y), blue (B), or white LEDs, including combinations, *e.g.*: "A further embodiment of the invented LED lamp is characterized in that the faces of the polyhedron are provided with an array of LEDs, which preferably comprises at least one green, at least one red and at least one blue LED or at least one green, at least one red, at least one yellow and at least one blue LED or at least one white LED." Ex. 1002 at 2:40-45. Thus, according

to Begemann, the LEDS can be R, G, B, Y LEDS, or white LEDs, or combinations thereof, including that all LEDs can be white LEDs. Thus, Begemann discloses the limitation of claim 16 (Ground 3). Ex. 1008 at ¶ 102.

Should it be determined that Begemann does not disclose heat dissipating protrusions as claimed, then claim 16 is obvious under the combination of the Begemann and English (Ground 4) with the addition of cooling fins as taught by English to gear column 1 of Begemann as explained for claim 1. *See, e.g.*, Ex. 1002 at 3:56-62, 3:66-4:16; Ex. 1003 at 4:6-9, 6:47-52, 5:6-31. Ex. 1008 at ¶ 103.

I. Claim 19 is anticipated by the '722 patent (Ground 7) and obvious in view of the '722 patent and the '211 patent (Ground 8)

Independent claim 19 substantially overlaps with claims 1, 2 and 5, as shown in the table below which compares the claim language. Claim elements 19.1-19.8 are identical to claim elements 1.1-1.7, except that preamble of claim 1 recites a "light source," and the preamble of claim 19 recites a "radiation emitting source," and except that claim 1 recites "solid state light sources," and claim 19 recites "radiation emitting semiconductor devices" (and one instance of "said radiation emitting sources"). These latter differences are highlighted in bold text below in each claim. Also, claim element 19.9 is identical in substance to the claim element recited in claim 2 (which depends from claim 1), except that claim 2 recites "solid state light sources," whereas claim 19 recites "radiation emitting

semiconductor devices." Further, claim element 19.10 is identical in substance to the claim element recited in claim 5 (which depends from claim 2).

Comparison of Claim 19 with Claims 1, 2, 5

Claims 1, 2, 5	Claim 19
1.1: A **light source** comprising:	19.1: A **radiation emitting source**, comprising:
1.2: an elongate thermally conductive member having an outer surface;	19.2: an elongate thermally conductive member having an outer surface;
1.3: a plurality of **solid state light sources** carried on said elongate member outer surface	19.3: a plurality of **radiation emitting semiconductor devices** carried on said elongate member outer surface
1.4: at least some of said **solid state light sources** being disposed in a first plane and others of said **solid state light sources** being disposed in a second plane not coextensive with said first plane;	19.4: at least some of said **radiation emitting sources** being disposed in a first plane and others of said **radiation emitting semiconductor devices** being disposed in a second plane not coextensive with said first plane;
1.5: electrical conductors carried by said elongate thermally conductive member and connected to said plurality of **solid state light sources** to supply electrical power thereto; and	19.5: electrical conductors carried by said elongate thermally conductive member and connected to said plurality of **radiation emitting semiconductor devices** to supply electrical power thereto; and
1.6: said elongate thermally conductive member being configured to conduct heat away from said **solid state light sources** to fluid contained by said elongate thermally conductive member;	19.6: said elongate thermally conductive member being configured to conduct heat away from said **radiation emitting semiconductor devices** to fluid contained by said elongate thermally conductive member;
1.7: said elongate thermally conductive member comprises one or more heat dissipation protrusions, at	19.7: said elongate thermally conductive member comprises one or more heat dissipation protrusions;

Claims 1, 2, 5	Claim 19
least one of said heat dissipation protrusions being carried on said elongate member outer surface.	19.8: at least one of said heat dissipation protrusions being carried on said elongate member outer surface;
Claim 2: A light source in accordance, with claim 1, wherein: said elongate thermally conductive member is configured to conduct heat away from said **solid state light sources** to fluid proximate said elongate member outer surface.	19.9: said elongate thermally conductive member is configured to conduct heat away from said **radiation emitting semiconductor devices** to fluid proximate said elongate member outer surface; and
Claim 5: A light source in accordance with claim 2, wherein: said elongate thermally conductive member comprises a tube.	19.10: said elongate thermally conductive member comprises a tube.

The terms "radiation emitting semiconductor device" and "radiation emitting source" are not mentioned in the specification of the '028 patent and only appears as claim terms. The only "radiation emitting semiconductor devices" disclosed or suggested in the '028 patent are LEDs. See generally Ex. 1001. Accordingly, the LEDs qualify as "radiation emitting semiconductor devices" for purposes of analysis of claim 19 and dependent claims relative to the prior art. LEDs also qualify as "solid state light sources" in claim 1 and dependent claims, for the same reason, as previously discussed above.

Given these considerations, and in view of the chart above comparing claim 19 with claims 1, 2 and 5, Begemann anticiaptes claim 19. In particular, claim elements 19.1-19.8 of claim 19 are disclosed by Begemann for the same reasons

described above for claim elements 1.1-1.7 of claim 1. Claim element 19.9 is disclosed by Begemann for the same reasons as described above for claim 2. Claims element 19.10 is disclosed by Begemann for the same reasons as described above for claim 5. Those explanations are not repeated here for brevity, and detailed explanations are presented above in Sections V.A, V.C and V.D above for claims 1, 2 and 5, respectively. Nevertheless, a summary based on the analyses of claims 1, 2 and 5 is presented in the claim chart below, illustrating how Begemann anticipates claim 19. Ex. 1008 at ¶ 106.

Regarding obviousness of claim 19 in view of Begemann and English, should it be determined that Begemann does not disclose heat dissipating protrusions as claimed, then claim 19 is obvious under the combination of the Begemann and English (Ground 8) with the addition of cooling fins to gear column 1 of Begemann as taught by English to enhance heat dissipation and improve LED performance and lifetimes as explained previously for claim 1 and as summarized in the chart below. *See, e.g.*, Ex. 1002 at 3:56-62, 3:66-4:16; Ex. 1003 at 4:6-9, 6:47-52, 5:6-31. Ex. 1008 at ¶¶ 107-110.

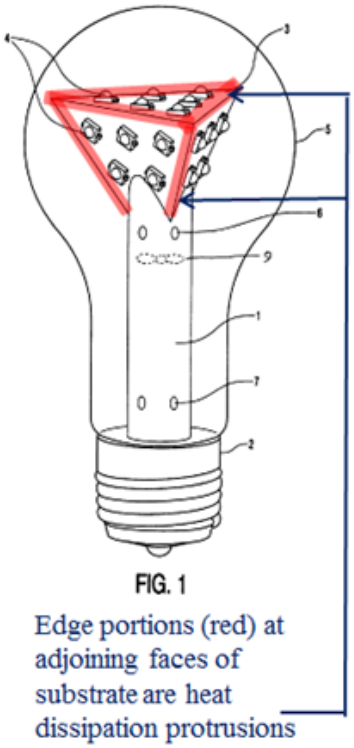
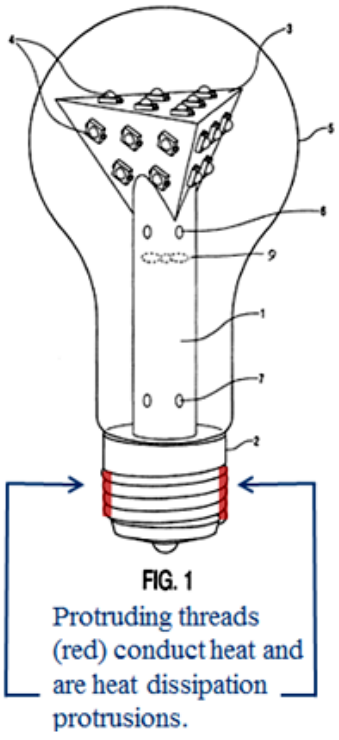
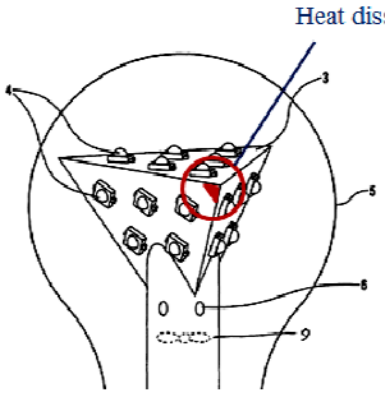
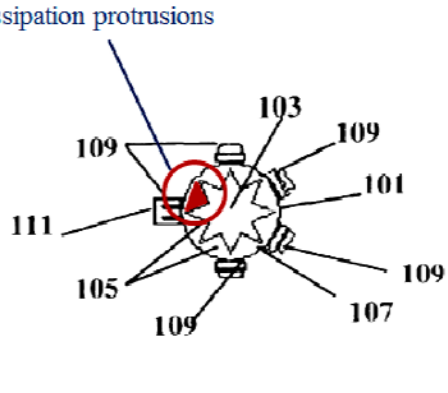
A chart summarizing how claim 19 is anticipated (Ground 7) and obvious (Ground 8) is presented below. *See* Ex. 1008 at ¶ 111.

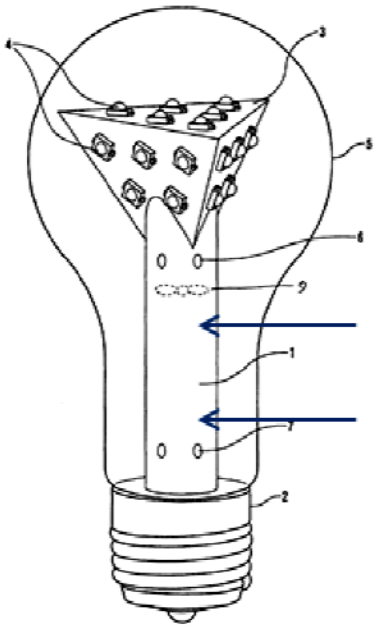
CLAIM 19– Anticipation and Obviousness

Claim 19 Element	Prior Art Teaching
19.1: A radiation emitting source, comprising:	Ex. 1002 (Begemann) at 1:40-41. "These and other objects of the invention are achieved by a LED lamp…."
19.2: an elongate thermally conductive member having an outer surface;	Ex. 1002 at 3:39-44. "This lamp comprises a tubular, hollow gear column (1), which is connected with one end to a lamp cap (2). The other end of the gear column (1) is connected to a substrate (3), which is provided with a number of LEDs (4)." Ex. 1002 at 2:20-22. "A further interesting embodiment of the LED lamp is characterized in that the heat-dissipating means comprise a metal connection between the substrate and the lamp cap." Ex. 1002 at 3:56-4:2. "The outer surface to the substrate (3) is made of metal or a metal alloy, thereby enabling a good heat conduction from the LEDs (4) to the column (1).… The outer surface of the gear column (1) of the LED lamp is made of a metal or metal alloy. This enables a good heat conduction from the substrate (3) to the (metal) lamp cap (2) to be attained."
19.3: a plurality of radiation emitting semiconductor devices carried on said elongate member outer surface	Ex. 1002 at 3:40-44. "This lamp comprises a tubular, hollow gear column (1), which is connected … to a substrate (3), which is provided with a number of LEDs (4)." See FIG. 1 and FIG. 2
19.4: at least some of said radiation emitting sources being disposed in a first plane and others of said radiation emitting semiconductor	Ex. 1002 at 3:53-61. "In the example described herein, the substrate (3) has the shape of a regular pyramid with four flat faces…. Each of the faces of the pyramid is provided with a number (five or six) LEDs (4), which are secured to the faces by means of a heat-conducting adhesive."

Claim 19 Element	Prior Art Teaching
devices being disposed in a second plane not coextensive with said first plane;	*See also* Ex. 1002 at 4:23-31.
19.5: electrical conductors carried by said elongate thermally conductive member and connected to said plurality of radiation emitting semiconductor devices to supply electrical power thereto; and	Ex. 1002 at 4:61-63. "The LED (4) is also provided with two electrical connections (14). Via these connections, the LED is soldered onto the substrate 3." Ex. 1002 at 3:44-46. "The space within the hollow gear column (1) accommodates the electronic gear necessary for controlling the LEDs (4)." Ex. 1002 at 1:54-58. "A particular aspect of the invention resides in that the heat-dissipating means remove the heat, generated during operation of the lamp, from the substrate via the gear column to the lamp cap and the mains supply connected thereto."
19.6: said elongate thermally conductive member being configured to conduct heat away from said radiation emitting semiconductor devices to fluid contained by said elongate thermally conductive member;	Ex. 1002 at 3:40-44. "This lamp comprises a tubular, hollow gear column (1), which is connected with one end to a lamp cap (2). The other end of the gear column (1) is connected to a substrate (3), which is provided with a number of LEDs (4)." Ex. 1002 at 3:56-4:2. "The outer surface of the substrate (3) is made of a metal or a metal alloy, thereby enabling a good heat conduction from the LEDs (4) to the column (1). . . . The outer surface of the gear column (1) of the LED lamp is made of a metal or a metal alloy. This enables a good heat conduction from the substrate (3) to the (metal) lamp cap (2) to be attained." Ex. 1002 at 4:7-16. "The LED lamp shown in FIG, 1 also includes a fan (9) incorporated in the gear column (1), which fan generates an air flow during operation of the lamp. This air flow leaves the gear column (1) via holes (6) provided in the gear column, and re-enters the gear column via the holes (7) provided in the gear column…. By virtue thereof, an improved heat dissipation from the substrate and the LEDs is

Claim 19 Element	Prior Art Teaching
	obtained." *See also* Ex. 1002 at 2:33-39.
19.7: said elongate thermally conductive member comprises one or more heat dissipation protrusions; 19.8: at least one of said heat dissipation protrusions being carried on said elongate member outer surface;	<u>Anticipation by Ex. 1002 (Begemann):</u> The '722 patent discloses heat dissipation protrusions as shown in annotated FIG. 1 below by virtue of the edge portions of adjoining faces of the substrate 3 (or points thereof) (below left, red) and/or the protruding threads of metal lamp cap 2 (below right, red). Ex. 1002 at 3:56-4:2. "The outer surface to the substrate (3) is made of metal or a metal alloy, thereby enabling a good heat conduction from the LEDs (4) to the column (1).… The outer surface of the gear column (1) of the LED lamp is made of a metal or metal alloy. This enables a good heat conduction from the substrate (3) to the (metal) lamp cap (2) to be attained." Ex. 1002 at 4:7-16. "The LED lamp shown in FIG, 1 also includes a fan (9) incorporated in the gear column (1), which fan generates an air flow during operation of the lamp. This air flow leaves the gear column (1) via holes (6) provided in the gear column, and re-enters the gear column via the holes (7) provided in the gear column…. By virtue thereof, an improved heat dissipation from the substrate and the LEDs is obtained."

Claim 19 Element	Prior Art Teaching
	 FIG. 1 Edge portions (red) at adjoining faces of substrate are heat dissipation protrusions  FIG. 1 Protruding threads (red) conduct heat and are heat dissipation protrusions.  FIG. 1 '722 patent (annotated)  FIG. 2 '028 patent (annotated) <u>Obviousness in view of Ex. 1002 ('722 patent) and Ex. 1003 ('211 patent):</u> Ex. 1003 (English) 4:6-9: "In another variation, the base 20 portion may include on an exterior side cooling fins or other heat dissipating structures exposed on the exterior of the base 20."

Claim 19 Element	Prior Art Teaching
	 Provide cooling fins to outer surface of gear column 1, per teachings of the '211 patent. (E.g., Ex. 1003 at 4:6-9.) FIG. 1
19.9: said elongate thermally conductive member is configured to conduct heat away from said radiation emitting semiconductor devices to fluid proximate said elongate member outer surface; and	Air circulates in the envelope 5, both inside and outside the gear column 1, and heat therefore is conducted away from the LEDs 4 to air proximate the outer surface of the elongate member (1+2+3), as taught by the '722 patent, *e.g.*: Ex. 1002 at 3:56-4:2. "The outer surface to the substrate (3) is made of metal or a metal alloy, thereby enabling a good heat conduction from the LEDs (4) to the column (1).… The outer surface of the gear column (1) of the LED lamp is made of a metal or metal alloy. This enables a good heat conduction from the substrate (3) to the (metal) lamp cap (2) to be attained." Ex. 1002 at 4:7-16. "The LED lamp shown in FIG, 1 also includes a fan (9) incorporated in the gear column (1), which fan generates an air flow during operation of the lamp. This air flow leaves the gear column 1 via holes 6 provided in the gear column, and re-enters the gear column via the holes 7 provided in the gear column…. By virtue thereof, an improved heat

Claim 19 Element	Prior Art Teaching
	dissipation from the substrate and the LEDs is obtained." *See also* Ex. 1002 at 2:33-39.
19.10: said elongate thermally conductive member comprises a tube.	The claimed tube is satisfied by gear column 1, *e.g.*: Ex. 1002 at 3:38-42. "FIG. 1 shows a first embodiment of the invented light emitting [d]iode lamp (LED lamp). This lamp comprises a tubular, hollow gear column (1), which is connected with one end to a lamp cap (2)." Alternatively, the combination of the gear column 1 and polyhedron substrate 3 (understood to be hollow) may be considered the claimed tube: Ex. 1002 at 3:53-55. "In the example described herein, the substrate (3) has the shape of a regular pyramid with four flat faces and is connected to the gear column (1) via a vertex of the pyramid."

J. Claims 20-22 are anticipated by the '722 patent (Ground 7) or obvious in view of the '722 patent and the '211 patent (Ground 8)

Claim 20 depends from claim 19 and recites, "said tube has a cross-section in the shape of a polygon." Begemann discloses this subject matter as described in Section V.D above for claim 6 (namely, substrate 3 is part of the claimed tube and has a polygon cross section). Claim 21 depends from claim 19 and recites, "said tube has a cross-section having flat portions." Begemann discloses this subject matter as described Section V.D for claim 7 (substrate 3 in cross section has flat portions). Claim 22 depends from claim 19 and recites, "said elongate thermally

conductive member comprises a channel." Begemann discloses this subject matter as described in Section V.G above for claim 8 (interior of hollow gear column 1 is a channel). *See also* Ex. 1002 at 3:53-62, 3:39-44; Ex. 1008 at ¶¶ 112-114. Those analyses and evidence are not reproduced here for brevity. Thus, Begemann anticipates claims 20-22 (Ground 7).

Should it be determined that the substrate 3 is not hollow, claims 20-21 would have been obvious in view Begemann at the time of the alleged invention, since it would have been obvious to a POSA to make polyhedron substrate 3 hollow as explained in Section V.E above. Ex. 1008 at ¶ 116. With the polyhedron substrate 3 of Begemann thus being hollow and a part of the claimed tube, the limitations of claims 20-21 are accounted for as explained in Section V.D as described for claims 5-7. Those analyses are not reproduced here.

Also, should it be determined that Begemann does not disclose heat dissipating protrusions as claimed in claim 19, then claims 20-22 are obvious under the combination of the Begmann and English because it would have been obvious to add the cooling fins of English to the outer surface of the gear column 1 of the lamp of the 722 patent for reasons previously explained for claims 1 and 19. *See*, *e.g.*, Ex. 1002 at 3:56-62, 3:66-4:16; Ex. 1003 at 4:6-9, 6:47-52, 5:6-31. Ex. 1008 at ¶ 117.

K. Claims 27-29 are anticipated the '722 patent (Ground 7) and obvious in view of the '722 patent and the '211 patent (Ground 8)

Claim 27 depends from claim 19 and recites, "said elongate thermally conductive member comprises a thermal transfer media disposed therein." Claim 28 depends from claim 27 and recites, "said elongate thermally conductive member comprises a flow channel for said thermal transfer media." Begemann anticipates claims 27 and 28 as described in Section V.G above for claims 14 and 15, and those analyses are not reproduced here. *See also* Ex. 1002. at 3:39-44, 4:7-16, 2:33-30; Ex. 1008 at ¶ 118.

Claim 29 depends from claim 19 and recites, "each of said radiation emitting semiconductor devices emits white light." Begemann discloses the subject matter of claim 29 as described in Section V.H above for claim 16, and that analysis is not reproduced here. *See also* Ex. 1002 at 2:40-45; Ex. 1008 at ¶ 119.

Also, should it be determined that Begemann does not disclose heat dissipating protrusions as claimed in claim 19, then claims 27-29 are obvious under the combination of the Begmann and English because it would have been obvious to add the cooling fins of English to the outer surface of the gear column 1 of Begemann for reasons previous explained for claims 1 and 19. *See, e.g.*, Ex. 1002 at 3:56-62, 3:66-4:16; Ex. 1003 at 4:6-9, 6:47-52, 5:6-31. Ex. 1008 at ¶ 120.

L. Claims 23-26 are obvious in view of the '722 patent, the '819 patent, and the '539 patent (Ground 9), and obvious in view of the '722 patent, the '819 patent, the '539 patent, and the '211 patent (Ground 10)

Claims 23-26 recite the following:

> 23. A radiation emitting source in accordance with claim 19, wherein: said elongate thermally conductive member comprises an extrusion.
>
> 24. A radiation emitting source in accordance with claim 23, wherein: said extrusion is an aluminum extrusion.
>
> 25. A radiation emitting source in accordance with claim 23, wherein: said elongate thermally conductive member is a tubular member.
>
> 26. A radiation emitting source in accordance with claim 25, wherein: said tubular member has a polygon cross-section.

For claims 23 and 24, Begemann does not expressly disclose that any of the substrate 3, gear column 1, and lamp cap 2 (collectively, an elongate thermally conductive member) comprises an extrusion (claim 23) and that such extrusion is an aluminum extrusion (claim 24). However, Arndt discloses LEDs carried on a cooling member 3 fabricated of metal such as copper or aluminum with a high thermal conductivity. Ex. 1005 at Abstract, 4:5-8. Also, Asami discloses heat transfer tubes with improved heat transfer performance wherein a tube 1 includes a tubular body 3 with an internal fin element 4 and multiple external flutes 6 (fins) running longitudinally provide an extended external effective heat transfer area,

wherein the tubular body 3 is easily formed by ***extrusion of aluminum alloy*** as a single integral unit. Ex. 1006 at 1:12-14, 4:8-13, 7:8-11, 7:59-64.

In view of these teachings, a POSA would have been motivated at the time of the alleged invention to produce the gear column 1 of Begemann (including, optionally, with heat fins as disclosed in English as explained above for claim 19) using aluminum as a highly thermally conductive metal/alloy as taught by Arndt which can be easily extruded with external heat fins as taught by Asami for the purpose of achieving ease of fabrication of a thermally conductive tube with integrally formed heat fins, as explained above. There would have been a reasonable expectation of success because aluminum is easily extruded with integral heat fins as taught by Asami, and the modified aluminum gear column would provide good heat conduction as taught by Arndt consistent with the previously described heat-dissipation design goals of the lamp of Begemann. Accordingly, claims 23 and 24 are obvious in view of the teachings of the Begemann, Arndt and Asami (Ground 9). Ex. 1008 at ¶¶ 122-124.

Claim 25 depends from claim 23 and recites, "said elongate thermally conductive member is a tubular member." Claim 26 depends from claim 25 and recites, "said tubular member has a polygon cross-section." Begemann discloses this subject matter at least by virtue of gear column 1, lamp cap 2 and substrate 3 shown in FIGS. 1 and 2 thereof, which together form a tubular member.

Begemann discloses, *e.g.*, "This lamp comprises a tubular, hollow gear column (1), which is connected with one end to a lamp cap (2)." Ex. 1002 at 3:38-42. The polyhedron substrate 3 is understood to hollow for reasons explained in Section V.D above. Alternatively, it would have been obvious to a POSA to make the substrate 3 hollow for reasons explained in Section V.E above. In either case, the substrate 3 is a tubular extension of the gear column 1, such that the substrate, gear column 1 and lamp cap 2 form a tubular member. Ex. 1008 at ¶ 125. Alternatively, the lamp cap 2 need not be part of the claimed tubular member (in which case heat dissipation protrusions are still provided by the edges at intersecting faces of substrate 3 as explained above).

Claim 26 depends from claim 25 and recites, "said tubular member has a polygon cross-section." This limitation is taught by Begemann in this combination for the same reasons as discussed above in Section V.D for claim 6, which recites similar language "said tube has a cross-section in the shape of a polygon." *See also* Ex. 1008 at ¶ 126. Thus, Begemann, Arndt and Asami render claims 23-26 obvious (Ground 9).

Should it be determined that Begemann does not disclose heat dissipating protrusions as claimed in claim 19, then claims 23-26 are obvious under the combination of the Begmann, Arndt, Asami and English (Ground 10) because it would have been obvious to add the cooling fins of English to the outer surface of

the gear column 1 of Begemann as explained for claims 1 and 19. *See, e.g.*, Ex. 1002 at 3:56-62, 3:66-4:16; Ex. 1003 at 4:6-9, 6:47-52, 5:6-31. Ex. 1008 at ¶ 128.

M. Claims 19-22 and 27-29 are obvious in view of the '722 patent in view of the '678 patent (Ground 11)

If the substrate 3 of Begemann is not considered to be a part of a tube as claimed, or in an alternative combination, claims 19-22 and 27-29 are obvious in view of Begemann and Verdes. Verdes discloses an LED obstruction lamp (FIG. 3 below) comprising a polygon-shaped vertical metal cylinder 35 on which LEDs 31 and 32 are mounted and which provides heat sinking for the LEDs to maximize life and light output. Ex. 1004 at 3:44-47, 3:51-55, FIG. 3. Ex. 1008 at ¶ 129.

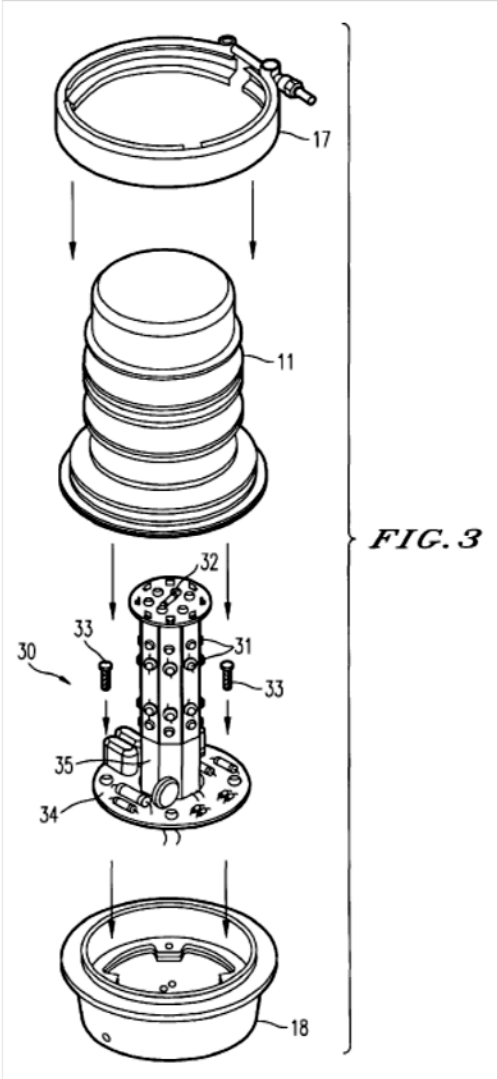


FIG. 3

As explained in Section V.F for claims 5-7, a POSA would have been motivated as of the time of the alleged invention to replace the hollow gear column 1 and polygon substrate 3 of Begemann with a simpler vertical, hollow metal tube (consistent with Begemann's teaching of a hollow gear column 1) but having the uniform, polygon cross-sectional shape of the metal cylinder 35 and top plate of Verdes, with Begemann's LEDs mounted on side polygon surfaces and top plate of the modified polygon-shaped, vertical metal tube (arranged like LEDs 31 and 32

are arranged on the vertical metal cylinder 35 of Verdes). A POSA would have been motivated to make those modifications while retaining the fan 9 and air holes 6, 7 (FIG. 1 of Begemann) inside the modified vertical, polygon-shaped metal tube that replaces the gear column 1 and the substrate 3 in order to provide the advantageous heat dissipation provided by those components, as explained in Section V.F, which is not reproduced here for brevity. Ex. 1008 at ¶ 130.

With the gear column 1 and substrate 3 of Begemann replaced in this way with a simpler, vertical polygon-shaped metal tube and top plate, with an outer polygon shape such as illustrated by the vertical metal cylinder 35 of Verdes, the resulting modified lamp would possess features recited in claims 19-22 and 27-29. Specifically, all limitations of claim 19 would be met as explained for claim 19, with reference to the evidence presented in the claim chart for claim 19 in Section V.I above, since all those features would be retained, except that the shape of modified vertical polygon-shaped metal tube and top plate would be borrowed from the teachings of Verdes (*see* Ex. 1004 at 3:44-47, 3:51-55, FIG. 3). The modified structure would provide a simpler outer polygon shape (instead of the combined circular tube 1 shape and pyramid substrate 3 shape shown in FIG. 1 of Begemann) advantageous for simplifying manufacturing/cost reduction. Ex. 1008 at ¶ 131.

The modified polygon-shaped, vertical metal tube and top plate would be elongate (as illustrated by the shape of cylinder 35 in FIG. 3 of Verdes) and would be fabricated using metal as taught by Begemann and Verdes, thereby having excellent heat conduction properties for dissipating heat from Begemann's LEDs 4 mounted thereon. The modified vertical polygon-shaped metal tube and top plate would connect to lap cap 2, which would provide power and heat sinking functions as previously explained for claims 1 and 19. The electrical conductors of Begemann would be retained to supply electrical power to LEDs, which would be mounted on non-coextensive polygon faces are the circumference and top of the modified polygon-shaped, vertical metal tube. The retained fan 9 and air holes 6, 7 of Begemann would provide the advantageous heat dissipating functions for conducting heat away from the LEDs 4 to air contained by (within) the modified vertical polygon-shaped metal tube and top plate and to air proximate an outer surface of the modified vertical metal tube and top plate by virtue of air circulation within the envelope 5. The protruding threads of lamp cap 2 of Begemann would remain as heat dissipation protrusions as previously explained for claim 19. The modified polygon-shaped, vertical metal tube and top plate would comprise a tube (and in fact would be a tube in entirety), being hollow like gear column 1 of Begemann but possessing the outer shape of the vertical metal cylinder 35 of the Verdes. The modified lamp structure would meet all the limitations of claim 19.

See Section V.I claim chart (for claim 19 citing evidence from Begemann, Ex.1002); Verdes Ex. 1004 at 3:44-47, 3:51-55, FIG. 3; Ex. 1008 at ¶ 131.

For the modified lamp, claims 20 and 21 would be satisfied because the vertical polygon-shaped metal tube and top plate would have a cross-section in the shape of a polygon with flat portions considering that the outer shape of the modified vertical metal tube would be like that of the vertical metal cylinder 35 of Verdes. *See* Ex. 1004 at 3:44-47, 3:51-55, FIG. 3. Claim 22 would be satisfied because the interior of the modified vertical metal tube and top plate would be a channel such as explained previously for gear column 1. *See* Ex. 1002 at 3:40-44, 4:7-16; Ex. 1008 at ¶ 132.

Claim 27 would be satisfied because the modified vertical metal tube would contain air as a thermal transfer media, which would be circulated via fan 9 and air holes 6, 7, and claim 28 would be satisfied because the interior of the modified vertical metal tube would provide a flow channel for air, for the same reasons. Claim 29 would be satisfied because the white LEDs of Begemann would be retained. *See* Ex. 1002 at 3:40-44, 4:7-16, 2:40-45; Ex. 1008 at ¶ 133.

Accordingly, the subject matter of claims 19-22 and 27-29 would have been obvious in view of Begemann and Verdes (Ground 11).

N. Claims 19-22 and 27-29 are obvious in view of the '722 patent, the '678 patent, and the '211 patent (Ground 12)

Should it be determined that Begemann does not disclose heat dissipating protrusions as claimed in claim 19, then claims 19-22 and 27-29 would be obvious in view of combination of Begemann, Verdes, and English because it would have been obvious (as explained for claims 1 and 19) to add the cooling fins English to the outer surface of the modified polygon-shaped vertical metal tube described in Section V.M immediately above. *See, e.g.*, Ex. 1002 at 3:56-62, 3:66-4:16; Ex. 1003 at 4:6-9, 6:47-52, 5:6-31. Ex. 1008 at ¶ 135.

O. Claims 23-26 are obvious in view of the '722, '678, '819, and '539 patents (Ground 13)

Claims 23-26 would likewise be obvious based on the modified lamp of Begemann having the modified polygon-shaped, vertical metal tube and top plate as explained in Section V.M above based on the combination of Begemann and Verdes. It would have been obvious at the time of the alleged invention to form the modified lamp with modified polygon-shaped, vertical metal tube from aluminum using an extrusion process (thereby meeting the limitations of claims 23 and 24), for the purposes of providing excellent heat dissipation properties and ease of manufacturing as previously described above in Section V.L for claims 23 and 24, as taught by Arndt and Asami. Those analyses are not reproduced here.

See Ex. 1005 at Abstract, 4:5-8; Ex. 1006 at 1:12-14, 4:8-13, 7:8-11, 7:59-64; Ex. 1008 at ¶ 136.

Claims 25 and 26 would be satisfied by the modified lamp of Begemann because the modified polygon-shaped, vertical metal tube would be a tubular member (a hollow tube without outer polygon shape) (claim 25) and would have a polygon cross-section (claim 26) since it would possess an outer polygon shape like that illustrated in for vertical metal cylinder 35 shown in FIG. 3 of Verdes. *See* Ex. 1004 at 3:44-47, 3:51-55, FIG. 3; Ex. 1008 at ¶ 136.

Accordingly, claims 23-26 are obvious in view of Begemann, Verdes, Arndt and Asami.

P. Claims 23-26 are obvious in view of the '722, '678, '819, '539 and '211 patents (Ground 14)

Begemann's protruding threads of lamp cap 2 would have been considered by a POSA to be heat dissipation protrusions as previously explained for claims 1 and 19, and would be present for the modified lamp of Begemann as described in Section V.M above. But should it be determined that Begemann does not disclose heat dissipation protrusions as claimed, then claims 23-26 would be obvious in view of combination of Begemann, Verdes, Arndt, Asami and English since it would have been obvious (as explained for claims 1 and 19) to add the cooling fins of English to the outer surface of the modified polygon-shaped vertical metal tube

described in Section V.M above. *See, e.g.*, Ex. 1002 at 3:56-62, 3:66-4:16; Ex. 1003 at 4:6-9, 6:47-52, 5:6-31.

VI. MANDATORY NOTICES PURSUANT TO 37 C.F.R. § 42.8(A)(1)

Pursuant to 37 C.F.R. § 42.8(a)(1), the mandatory notices identified in 37 C.F.R. § 42.8(b) are provided below as part of this Petition.

A. C.F.R. § 42.8(b)(1): Real Party-In-Interest

Cree, Inc. is the real party-in-interest for Petitioner.

B. C.F.R. § 42.8(b)(2): Related Matters

The '028 patent is currently the subject of a patent infringement lawsuit brought by the alleged assignee of the '028 patent: *OptoLum, Inc. v. Cree, Inc.*, U.S. District Court for the District of Arizona, Civil Action No. 2:16-cv-3828. This judicial matter may affect, or be affected by, decisions made in this proceeding. In addition, Petitioner is concurrently filing another petition for *inter partes* review of the '303 patent, which is the parent of the '028 patent, as Case No. IPR2017-01260.

C. C.F.R. § 42.8(b)(3) and (4): Lead and Back-up Counsel and Service Information

Cree, Inc. provides the following designation of counsel:

Lead Counsel	Backup Counsel
Blaney Harper Reg. No. 33,897 Jones Day 51 Louisiana Ave, N.W. Washington, D.C. 20001	Douglas Pearson Reg. No. 47,851 Jones Day 51 Louisiana Ave, N.W. Washington, D.C. 20001

(202) 879-3939 bharper@jonesday.com	(202) 879-3939 dhpearson@jonesday.com David B. Cochran Reg. No. 39,142 Jones Day North Point, 901 Lakeside Avenue Cleveland, Ohio 44114 (216) 586-3939 dcochran@jonesday.com

Pursuant to 37 C.F.R. § 42.10(b), a Power of Attorney accompanies this Petition. Please address all correspondence to lead and back-up counsel at the Washington, D.C. address above. Cree, Inc. also consents to electronic service by email at the email addresses listed above.

VII. CONCLUSION

For the foregoing reasons, this petition for *Inter Partes* Review of U.S. Patent No. 7,242 ,028 should be granted. Petitioner has established a reasonable likelihood of prevailing with respect to at least one claim of the '028 patent and requests that an *Inter Partes Review* be instituted regarding claims 1-3, 5-8, 13-16, 19-29.

The undersigned representative of Petitioner authorizes the Patent Office to charge the $26,200.00 Petition Fee, along with any additional fees, to Deposit Account 503013, ref: 388838-600011. Twenty two (22) claims are being reviewed, and excess claim fees in the amount of $3200.00 are required.

Date: April 11, 2017

Respectfully submitted,

By: */Douglas H. Pearson/*

Blaney Harper, Reg. No. 33,897
Douglas H. Pearson, Reg. No. 47,851
Jones Day
51 Louisiana Ave, N.W.
Washington, D.C. 20001
(202) 879-3939

David B. Cochran, Reg. No. 39,142
Jones Day
North Point, 901 Lakeside Avenue
Cleveland, Ohio 44114
(216) 586-3939

CERTIFICATION OF COMPLIANCE

This brief complies with the type-volume limitation of 37 C.F.R. § 42.24(a)(1)(i) because the brief contains 13933 words, excluding the parts of the brief exempted by 37 C.F.R. § 42.24(a)(1). The brief has been prepared in a proportionally spaced typeface using Microsoft Word 2007 in 14-point Times New Roman font.

Dated: April 11, 2017

/Douglas H. Pearson/

Douglas H. Pearson
51 Louisiana Avenue, N.W.
Washington, DC 20001
(202) 879-3939

CERTIFICATION OF SERVICE

The undersigned hereby certifies that a copy of the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 7,242,028 including all Exhibits, was served April 11, 2017 via Priority Mail Express service of the USPS directed to the attorney of record for the '028 patent as shown in USPTO PAIR at the following address:

DONALD J. LENKSZUS
PO BOX 3064
CAREFREE, AZ 85377-3064

A courtesy copy has also been provided on April 11, 2017 via e-mail to the Patent Owner's counsel in the concurrent litigation matter at:

ROBERT A. BROOKS (*pro hac vice*)
KIA L. FREEMAN (*pro hac vice*)
KEITH E. TOMS (*pro hac vice*)
MEAD MISIC (*pro hac vice*)
LEAH R. MCCOY (*pro hac vice*)
McCARTER & ENGLISH, LLP
265 FRANKLIN ST.
BOSTON, MA 02110

Respectfully submitted,

Date: April 11, 2017

/Douglas H. Pearson/
Douglas H. Pearson
Reg. No. 47,851