

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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MERCEDES-BENZ USA, LLC and  
MERCEDES-BENZ U.S. INTERNATIONAL, INC.,  
*Petitioners,*

v.

INNOVATIVE DISPLAY TECHNOLOGIES LLC,  
*Patent Owner.*

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*Inter Partes* Review of U.S. Patent No. 7,434,974

Issue Date: October 14, 2008

Patent Title: Light Emitting Panel Assemblies

IPR Case No.: *To Be Assigned*

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**DECLARATION OF MICHAEL J. ESCUTI, PHD**

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## **I. INTRODUCTION**

1. My name is Dr. Michael J. Escuti, and I have been retained by the law firm of King & Spalding LLP on behalf of Mercedes-Benz U.S. International, Inc. and Mercedes-Benz USA, LLC as an expert in the relevant art.

2. I have been asked to provide my opinions and views on the materials I have reviewed in this case related to Ex. 1001, U.S. Patent No. 7,434,974 (“the ’974 Patent”) (“the patent-at-issue”), and the scientific and technical knowledge regarding the same subject matter before and for a period following the date of the first application for the patent-at-issue was filed.

3. I am compensated at the rate of \$330/hour for my work, plus reimbursement for expenses. My compensation has not influenced any of my opinions in this matter and does not depend on the outcome of this proceeding or any issue in it.

4. My opinion and underlying reasoning for this opinion is set forth below.

### **A. Background and Qualifications**

5. I am currently a tenured Associate Professor at North Carolina State University (“NCSU”), in the Department of Electrical and Computer Engineering. As detailed below, I have over 16 years of experience directly relevant to the ’974 Patent, including in the fields of liquid crystal display (“LCD”) technologies, backlight design, optical physics, and electronic materials.

6. I received my Ph.D. in Electrical Engineering from Brown University in Providence, RI, in 2002. My dissertation topic focused on novel LCD systems and

devices, including both experimental and theoretical study. Upon earning my Ph.D., I apprenticed as a Postdoctoral Scholar in the Department of Chemical Engineering at Eindhoven University of Technology (Netherlands), where my research focused on LCDs, novel backlight approaches, diffractive optical films/sheets, and polymer-based organic electronics. Since 2004, I have been on the faculty of NCSU in Raleigh, NC, currently as a tenured Associate Professor in the Department of Electrical and Computer Engineering. I have supervised the graduation of seven Ph.D. and three M.S. students, and currently advise an additional three Ph.D. students. In addition, I have mentored nineteen undergraduate researchers.

7. In 2005, I co-founded ImagineOptix Corporation, which commercializes components, systems, and optical thin-film technology developed within my academic laboratory. The primary markets are LCDs, projectors, and telecommunications hardware. Since its inception, I have been a part-time advisor to the company with the title of Chief Scientific Officer, and in 2013, I joined the Board of Directors.

8. With my students and collaborators, I have authored over 102 publications, including journal articles, refereed conference proceedings, and book chapters. I am a named inventor on 11 issued and 19 pending United States patents, and several additional foreign patents. I have offered 29 invited research presentations.

9. I have received numerous awards and distinctions, including the following:

- a. (2011) Presidential Early Career Award for Scientists and Engineers (“PECASE”), the U.S. Government’s highest award for young researchers;

- b. (2011) Alcoa Foundation Engineering Research Achievement Award, awarded to one faculty NCSU member annually recognizing outstanding research;
  - c. (2010) Faculty Early Career Development (CAREER) Award, from the National Science Foundation (“NSF”);
  - d. (2004) Glenn H. Brown Prize for Outstanding Ph.D. Dissertation, from the International Liquid Crystal Society (“ILCS”);
  - e. (2002) New Focus Award, Top Winner, from the Optical Society of America (“OSA”); (2001) Graduate Student Silver Award, from the Materials Research Society;
  - f. (2001) Sigma Xi Outstanding Graduate Student Research Award, from Brown University chapter;
  - g. (1999) Best Student Paper Award, Society for Information Display;
  - h. Member of the Institute of Electrical and Electronics Engineers (“IEEE”), Society of Photo-optical and Instrumentation Engineers (“SPIE”), OSA, and SID.
10. My research at NCSU over the last ten years has been supported by more than \$8M in external research funds, in part from several government agencies, including the NSF, the United States Air Force Research Laboratory (AFRL), the Defense Advanced Research Projects Agency (DARPA), and the National Aeronautics and Space Administration (NASA). A further part of this support also comes from several

strong partnerships with industry, including Raytheon, Lockheed Martin, Teledyne Scientific & Imaging, Boulder Nonlinear Systems, and ImagineOptix.

11. My central expertise via training and research experience is in LCD system design, materials, technology, and optical modeling. I began working with technologies to improve viewing angle problems in 1998, and in 1999 published my first journal article on this topic (M.J. Escuti, et al., Enhanced Dynamic Response of the In-plane Switching Liquid Crystal Display Mode Through Polymer Stabilization, *Appl. Phys. Lett.*, vol. 75, pp. 3264-3266 (1999)). In 2002, I co-authored an invited chapter reviewing LCD technology (G.P. Crawford and M.J. Escuti, Liquid Crystal Display Technology, in “Encyclopedia of Imaging Science and Technology,” ed. J.P. Hornak (John Wiley & Sons, Inc., 2002)). In 2005, I co-authored a journal article focused on an advanced LCD backlight (C. Sanchez, M.J. Escuti, et al., “An efficient illumination system for LCDs incorporating an anisotropic hologram,” *Appl. Phys. Lett.*, vol. 87, art. no. 094101, (2005)), and I currently am leading multiple projects at NCSU on backlights that are largely unpublished.

12. As a student, I used and reviewed several textbooks and reference books, including those listed below (a-f). Also listed is an additional book I use in the class I teach on liquid crystal displays for undergraduate and graduate students that I developed at NCSU with support from the NSF.

- a. J. A. Castellano, *Handbook of Display Technology*, Academic Press Inc., San Diego (1992);

- b. D. E. Mentley and J. A. Castellano, *Liquid Crystal Display Manufacturing*, Stanford Resources, Inc., San Jose (1994);
  - c. *Liquid Crystals: Applications and Uses* (Vol. 1), edited by B. Bahadur, World Scientific (1995);
  - d. P. Collings and J. Patel, eds., *Handbook of Liquid Crystal Research*, Oxford University Press, New York (1997);
  - e. Pochi Yeh and Claire Gu, *Optics of Liquid Crystal Displays*, Wiley & Sons (1999);
  - f. Ernst Lueder, *Liquid Crystal Displays: Addressing schemes & electro-optical effects*, New York: Wiley (2001);
  - g. Willem den Boer, *Active Matrix Liquid Crystal Displays: Fundamentals & Applications*, Elsevier: Newnes (2005).
13. In my academic research, I direct both applied and fundamental research for applications including efficient LCDs, backlights, and optical films relevant to both. We also study techniques for low-loss fiber optic telecommunications switches, laser beam steering for high energy applications and laser communications, IR/MIR polarization imaging, opto-fluidics, novel diffractive lenses, and vortex beam optics. We routinely use and often fabricate our own devices, backlights, compensation films, and fully functional systems for direct-view and projection-displays and other applications including telecommunications, remote sensing, and laser beam steering. I routinely use commercial ray-tracing software for display system modeling. Over the



last 16 years, I have written and used multiple numerical simulation tools for optical and liquid crystal modeling, including custom code for modeling of optical waves in stratified birefringent media (matrix methods), exact solutions to Maxwell's equations in anisotropic media, and liquid crystal alignment physics.

14. I have served twice as an expert within *inter partes* review proceedings before the U.S. Patent and Trademark Office, both concluding in 2013, where I was deposed. In addition, I have previously served three times as an expert before the U.S. International Trade Commission (“ITC”), beginning in 2011, where I was deposed, and in two of the cases, testified at the hearing. I have also served as an expert in several district court cases.

15. A detailed record of my professional qualifications, including a list of publications, awards, and professional activities, is set forth in my curriculum vitae, attached to this report as Appendix A.

## **B. Information Considered**

16. In addition to my general knowledge gained as a result of my education and experience in this field, I have reviewed and considered, among other things, the ’974 Patent, the prosecution history of the ’974 Patent, and the prior art of record.

17. The full list of information that I have considered in forming my opinions for this report is set forth throughout the report and listed in the attached Appendix B.

## **II. LEGAL STANDARDS**

18. In forming my opinions and considering the patentability of the claims of the

'974 Patent, I am relying upon certain legal principles that counsel has explained to me.

19. I understand that for an invention claimed in a patent to be found patentable, it must be, among other things, new and not obvious in light of what came before it. Patents and publications which predated the invention are generally referred to as "prior art."

20. I understand that in this proceeding the burden is on the party asserting unpatentability to prove it by a preponderance of the evidence. I understand that "a preponderance of the evidence" is evidence sufficient to show that a fact is more likely than not.

21. I understand that in this proceeding, the claims must be given their broadest reasonable interpretation consistent with the specification. The claims after being construed in this manner are then to be compared to information that was disclosed in the prior art.

**A. Person Of Ordinary Skill In The Art**

22. I have been informed that the claims of a patent are judged from the perspective of a hypothetical construct involving "a person of ordinary skill in the art." The "art" is the field of technology to which the patent is related. I understand that the purpose of using a person of ordinary skill in the art's viewpoint is objectivity. Thus, I understand that the question of validity is viewed from the perspective of a person of ordinary skill in the art, and not from the perspective of (a) the inventor, (b)

a layperson, or (c) a person of extraordinary skill in the art. I have been informed that the claims of the patent-at-issue are interpreted as a person of ordinary skill in the art would have understood them in the relevant time period (*i.e.*, when the patent application was filed or earliest effective filing date).

23. It is my opinion that a person of ordinary skill in the art relevant to the '974 patent would have at least an undergraduate degree in physics, optics, electrical engineering, or applied mathematics AND 3 years of work experience (or a graduate degree) in a field related to optical technology.

24. I understand that a “person of ordinary skill is also a person of ordinary creativity, not an automaton” and that would be especially true of anyone developing LCD structures.

## **B. Anticipation**

25. I understand that the following standards govern the determination of whether a patent claim is “anticipated” by the prior art. I have applied these standards in my analysis of whether claims of the '974 Patent were anticipated at the time of the invention.

26. I understand that a patent claim is “anticipated” by a single prior art reference if that reference discloses each element of the claim in a single embodiment. A prior art reference may anticipate a claim inherently if an element is not expressly stated, but only if the prior art necessarily includes the claim limitations.

27. I understand that the test for anticipation is performed in two steps. First, the

claims must be interpreted to determine their meaning. Second, a prior art reference is analyzed to determine whether every claim element, as interpreted in the first step, is present in the reference. If all the elements of a patent claim are present in the prior art reference, then that claim is anticipated and is invalid.

28. I understand that it is acceptable to examine extrinsic evidence outside the prior art reference in determining whether a feature, while not expressly discussed in the reference, is necessarily present within that reference.

### **C. Obviousness**

29. I understand that a claim can be invalid in view of prior art if the differences between the subject matter claimed and the prior art are such that the claimed subject matter as a whole would have been “obvious” at the time the invention was made to a person having ordinary skill in the art.

30. I understand that the obviousness standard is defined at 35 U.S.C. § 103(a). I understand that a claim is obvious over a prior art reference if that reference, combined with the knowledge of one skilled in the art or other prior art references disclose each and every element of the recited claim.

31. I also understand that the relevant inquiry into obviousness requires consideration of four factors:

- a. The scope and content of the prior art;
- b. The differences between the prior art and the claims at issue;
- c. The knowledge of a person of ordinary skill in the pertinent art; and

d. Objective factors indicating obviousness or non-obviousness may be present in any particular case, such factors including commercial success of products covered by the patent claims; a long-felt need for the invention; failed attempts by others to make the invention; copying of the invention by others in the field; unexpected results achieved by the invention; praise of the invention by the infringer or others in the field; the taking of licenses under the patent by others; expressions of surprise by experts and those skilled in the art at the making of the invention; and that the patentee proceeded contrary to the accepted wisdom of the prior art.

32. I understand that when combining two or more references, one should consider whether a teaching, suggestion, or motivation to combine the references exists so as to avoid impermissible hindsight. I have been informed that the application of the teaching, suggestion or motivation test should not be rigidly applied, but rather is an expansive and flexible test. For example, I have been informed that the common sense of a person of ordinary skill in the art can serve as motivation for combining references.

33. I understand that the content of a patent or other printed publication (i.e., a reference) should be interpreted the way a person of ordinary skill in the art would have interpreted the reference as of the effective filing date of the patent application for the '974 Patent. I have assumed that the person of ordinary skill is a hypothetical person who is presumed to be aware of all the pertinent information that qualifies as prior art. In addition, the person of ordinary skill in the art makes inferences and

creative steps. He or she is not an automaton, but has ordinary creativity.

34. I have been informed that the application that issued as the '974 Patent was filed in 2006. However, the application claims priority to a parent application that was filed on June 27, 1995. As a result, I will assume the relevant time period for determining what one of ordinary skill in the art knew is June 27, 1995, the effective filing date for purposes of this proceeding.

#### **D. Claim Construction**

35. I have been informed that a claim subject to *inter partes* review is given its “broadest reasonable construction in light of the specification of the patent in which it appears.” I have been informed that this means that the words of the claim are given their plain meaning from the perspective of one of ordinary skill in the art unless that meaning is inconsistent with the specification. I understand that the “plain meaning” of a term means the ordinary and customary meaning given to the term by those of ordinary skill in the art at the time of the invention and that the ordinary and customary meaning of a term may be evidenced by a variety of sources, including the words of the claims, the specification, drawings, and prior art.

36. I understand that in construing claims “[a]ll words in a claim must be considered in judging the patentability of that claim against the prior art.” (MPEP § 2143.03, citing *In re Wilson*, 424 F.2d 1382, 1385 (CCPA 1970)).

37. I understand that extrinsic evidence may be consulted for the meaning of a claim term as long as it is not used to contradict claim meaning that is unambiguous in

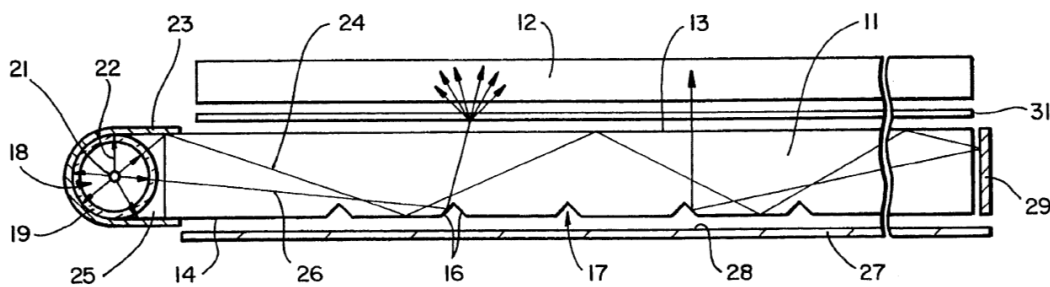
light of the intrinsic evidence. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1324 (Fed. Cir. 2005) (citing *Vitronics Corp. v. Conceptoronic, Inc.*, 90 F.3d 1576, 1583-84 (Fed. Cir. 1996)). I also understand that in construing claim terms, the general meanings gleaned from reference sources must always be compared against the use of the terms in context, and the intrinsic record must always be consulted to identify which of the different possible dictionary meanings is most consistent with the use of the words by the inventor. *See, e.g., Ferguson Beauregard/Logic Controls v. Mega Systems*, 350 F.3d 1327, 1338 (Fed. Cir. 2003) (citing *Brookhill-Wilk 1, LLC v. Intuitive Surgical, Inc.*, 334 F.3d 1294, 1300 (Fed. Cir. 2003)).

### **III. TECHNOLOGY BACKGROUND**

#### **A. Light Emitting Panel Assemblies**

38. The '974 Patent discloses a light emitting panel assembly, also called a light emitting assembly, which according to the '974 Patent, is a device configured to produce a uniform illumination from a surface. This is a type of light box or luminaire, producing surface illumination. *See, e.g., Ex. 1011, U.S. Patent No. 5,160,195* ("Miller"). While these panel assemblies are used in many application contexts, *e.g.,* architectural lighting, signage illumination, and x-ray film viewing, the primary application is in LCDs and the various applications thereof. In the LCD context, a light emitting panel assembly is usually called the "backlight" module, which is important since it generates the light needed by the display, and is primarily responsible for the brightness and power-efficiency of the whole system. The other

major module of an LCD is the “LC panel,” which is non-light emitting and instead modulates light passing through it to form an image, where each individual pixel acts as a shutter controlling how much light can pass through it. *See* Ex. 1012, J. A. Castellano, *Handbook of Display Technology*, Academic Press Inc., San Diego, 1992, at pp. 9-13 and Ch. 8. A typical cross-section of a light emitting panel assembly by the time of the '974 Patent is illustrated in Fig. 2 from Ciupke, where the light emitting panel assembly includes everything below element 12, and where element 12 is the LCD. (Fig. 2 from Ex. 1005, U.S. Patent No. 5,461,547 (“Ciupke”).



**FIG\_2**

39. The principle aim of a light emitting panel assembly is to provide a surface of illumination that is as smooth as possible across its area, *i.e.*, to emit light uniformly from its entire spatial extent and into a desired angle distribution. Unfortunately, there are no bright and efficient light sources that emit inherently from a surface area commensurate with the size of an LCD, so point- and line-shaped light sources are used instead. For example, light-emitting-diodes (LEDs) have small emission areas typically on the order of a few mm<sup>2</sup>, and fluorescent lamps, with either cold- (CCFL) or hot- (HCL) cathodes, can be many cm long but only a few mm wide. The most

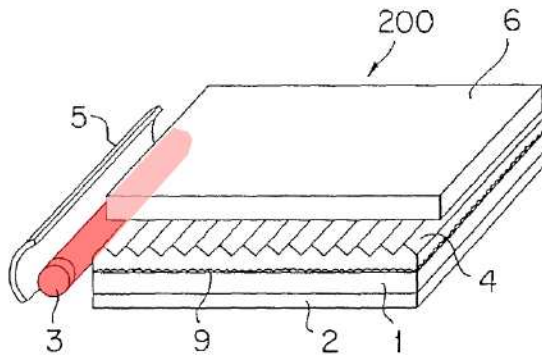


critical engineering challenge for backlights, therefore, is to produce the surface illumination with the target brightness and uniformity at the lowest possible electrical power.

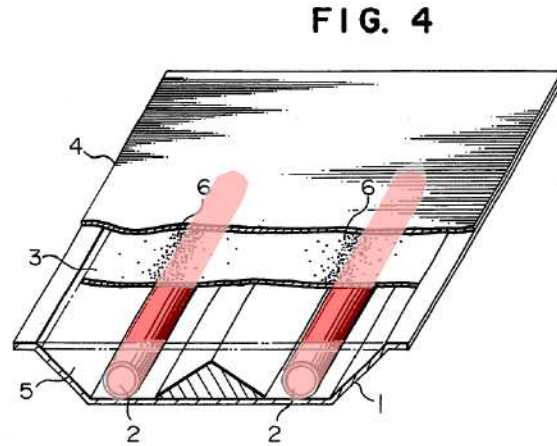
40. Light emitting panel assemblies are classified into two well-known<sup>1</sup> categories: “edge-lit” and “directly back-lit.” *See, e.g.*, Fig. 9 from Ex. 1013, U.S. Patent No. 5,598,280 (“Nishio”), versus Fig. 4 from Ex. 1014, U.S. Patent No. 5,384,658 (“Ohtake”). These two categories are illustrated in Fig. A below, with the light sources highlighted in each case. In the edge-lit category, the light source is at the edge, sending light substantially horizontally (in this illustration), which must then be turned upward to emit upward (in this illustration) through the emitting surface (and toward the display element in this illustration). In the direct back-lit category, the light sources are arranged instead directly below the emitting surface, usually with several films in between. Confusingly, the word “backlight” is commonly applied to both. The ’974 Patent discloses an edge-lit light emitting panel assembly. Edge-lit light emitting panel assemblies are often preferred because they can be physically thinner and lower weight.

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<sup>1</sup>To be clear, when I refer to an element or concept as “well-known” or “known in the prior art,” I particularly mean to say that the element or concept was well-known as of June 27, 1995.



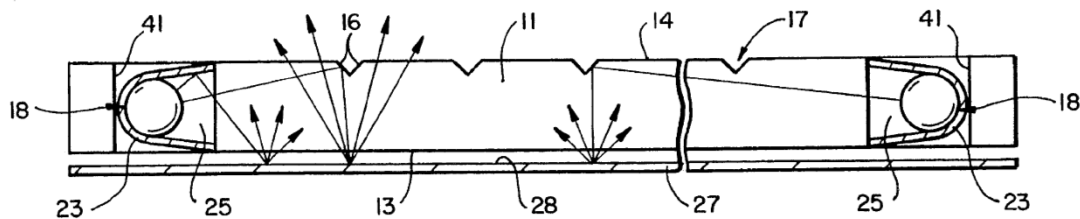
**FIG. 9**



**FIG. 4**

Figure A (annotated Fig. 9 of Ex. 1013, Nishio and Fig. 2 of Ex. 1014, Ohtake)

41. It was known that one or more light sources may be employed. As representative examples, see Ex. 1005, Ciupke, at Fig. 4 below.



**FIG\_4**

## **B. Common Light Control Structures and Films**

42. Many standard optical elements and surfaces within LCDs are used to spatially homogenize and control the angular distribution of emitted light. These include light pipes, transition areas, reflectors, and various types of microstructured deformities (*e.g.*, microprisms, diffusers, and microlenses). *See, e.g.*, Ex. 1015, U.S. Patent No. 5,303,322 (“Winston”). We now discuss each of these.

43. The light pipe, also sometimes called a light guide or wave guide or optical

conductor, accepts light injected from the side and distributes it across the emission area. *See, e.g.*, Ex. 1016, U.S. Patent No. 5,050,946 (“Hathaway”), at Abstract and 1:56-59. The light pipe is typically a transparent planar slab that confines the light within it using the principle of total-internal-reflection, in order to support the persistent goals in LCDs of thinner and lighter displays. *Id.* at 5:66-6:2. In some designs the light pipe has parallel surfaces and in other designs it has a wedge shape. *Id.* at Figs. 1 and 5. Light will generally only escape from the light pipe into the emission direction when disturbed by a structure – for example, a pattern of diffusing spots on the back surface, or microstructures on one or both surfaces. *Id.* at 7:15-22. For example, in the annotated Fig. B of Ex. 1005, Ciupke below, the ray 24 is shown first emitting from the light source 18, entering the light pipe 11, bouncing off the top and bottom surfaces of the light pipe several times, reflecting on the right hand side by the edge reflector 29, hitting one of the groove 17 deformities, and only then emitting from the light pipe toward the LCD. Light pipes were generally known in the prior art. It is important to note that the ’974 Patent employs several terms for the light pipe, including “transparent panel member” (*e.g.*, Ex. 1001, the ’974 Patent, at 1:18-19), “light emitting panel member” (*e.g.*, *id.* at 1:33-34), and “transparent light emitting panel” (*e.g.*, *id.* at 2:66).

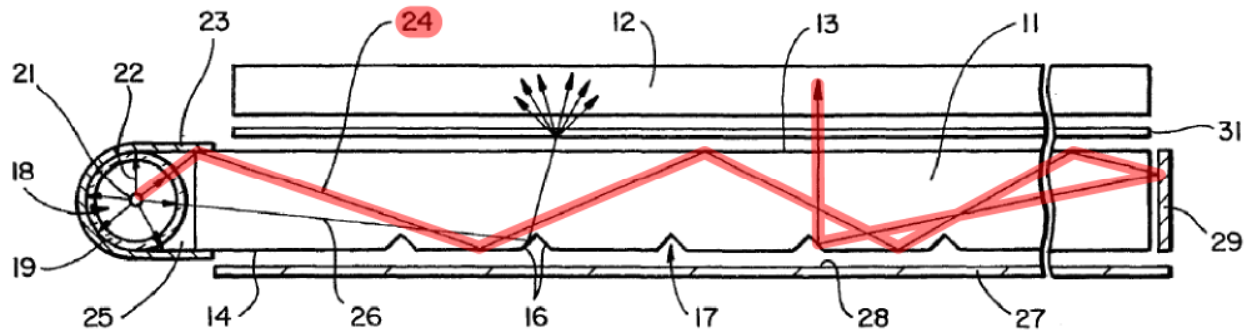


Figure B (annotated Fig. 2 of Ex. 1005, Ciupke)

44. A transition area (or region) is commonly employed between the light source and the light pipe, and is known in the art. Ex. 1001, the '974 Patent, at 2:58-65. This is a structure that usually has at least two functions: to securely position the light source relative to the light pipe, and to spread and transmit light to produce a more uniform input illumination. *See, e.g.*, Ex. 1016, Hathaway, at 6:3-24. The transition area may take many shapes, and is usually formed using a transparent material with a refractive index similar to the light guide. For example, in the annotated Fig. C of Ex. 1005, Ciupke below, the transition area 25 couples the light from the light sources 18 into the light pipe 11. *Cf.* Ex. 1016, Hathaway, at Fig. 11.

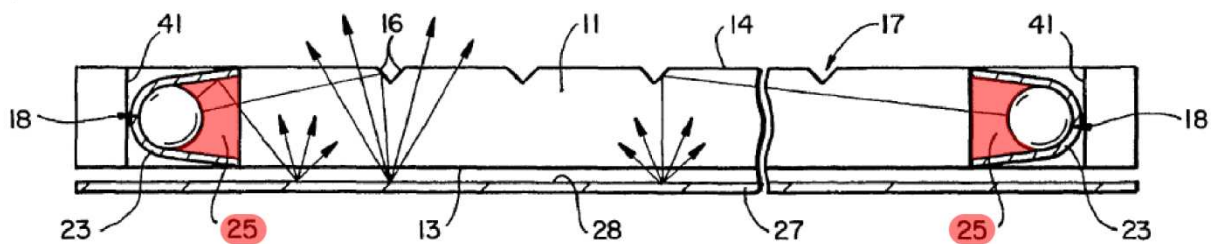
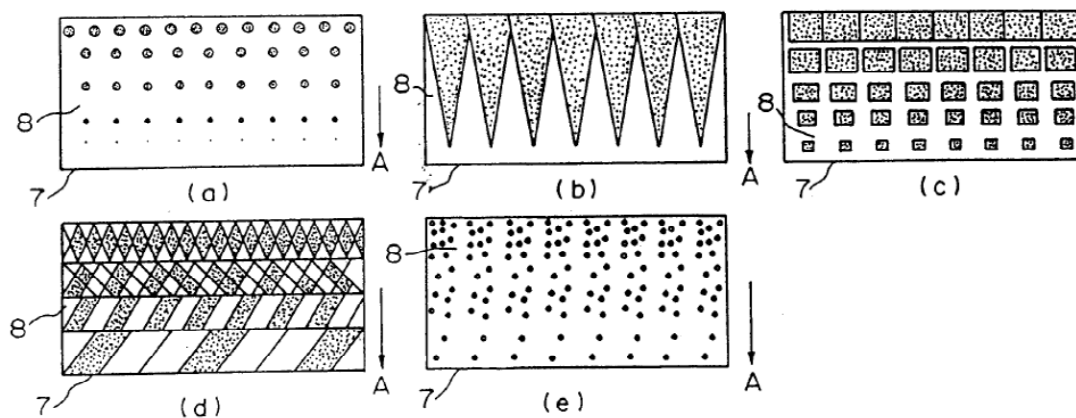


Figure C (annotated Fig. 4 of Ex. 1005, Ciupke)

45. Various types of deformities are employed to control the direction and spatial uniformity of light within light emitting panel assemblies. Two major categories are

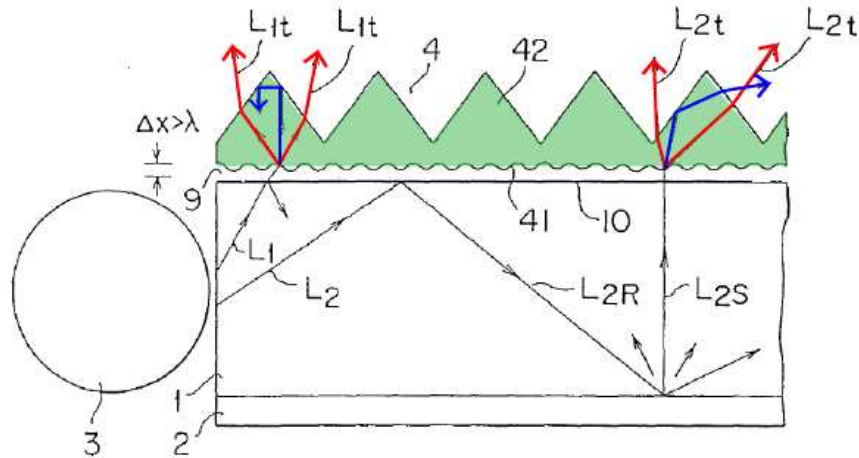
those that are essentially microstructured grooves or protrusions on a surface, or those that involve a highly scattering material painted on a surface or formed into a sheet. It was known to a person of ordinary skill in the art at the time of the '974 Patent that these deformities may be random or regularly arranged, and may have features which vary spatially across the emitting area (*e.g.*, size, density, type, shape, *etc.*). For example, several types of spatial variation in deformities are shown in Fig. 5 of Ex. 1017, European Patent Application Publication No. EP500960 ("Ohe") below, where the light source is positioned at side 7.

FIG.5



46. One of the most common deformities is a microprism, which is a small groove or protrusion with two or more facets. These are shown in Figs. B and C above in paragraphs 43 and 44, respectively, above as elements 17, on either side of the light pipe. When a light ray hits one of these microprisms, its direction can be substantially changed via refraction and/or reflection, nearly without loss. An illustration of both behaviors can be seen in Fig. D below, where I have highlighted the rays refracting

(red) and the rays reflecting (blue) because of the microprisms sheet (green) (Fig. 6 from Ex. 1013, Nishio). In fact, the blue ray on the right side is first reflected and then refracted. In some cases, an entire surface is formed into an array of prisms, either as a surface of the light pipe or as a separate sheet, but this is not required. In this configuration, the slanted surfaces are useful to turn light toward useful viewing directions, *e.g.*, from very oblique angles to on-axis angles, and visa versa. Because a large portion of the light emitted from a typical light pipe system is initially sent along oblique directions, the addition of a microprism sheet typically increases/enhances the brightness of the light emitting panel as seen by a viewer directly observing on-axis. By the early 1990s, the company 3M commercialized many films based on this effect, and the terminology of “brightness enhancement/enhancing film” (BEF) became essentially synonymous with microprism sheets. *See, e.g.*, the extended explanation in Ex. 1018, U.S. Patent No. 5,828,488 (“Ouderkirk”), at 6:63-8:8; and Ex. 1019, 3M product brochure 75-0500-0403-7, “Brightness Enhancement Film (BEF),” 2 pages (1993). Microprism deformities and sheets were generally known in the prior art.



**FIG. 6**

Figure D (annotated Fig. 6 of Ex. 1013, Nishio)

47. A second common deformity is one that causes a diffusing effect, which at least partially randomizes the direction of light, increasing its divergence angle and reducing on-axis brightness. This will tend to blur shadows or brightness variations, making light more uniform. Diffusing deformities may be embodied as nearly any interruption on the surface of a planar optical sheet, including bumps or indentations of nearly any shape, microspheres, or white paint. For example: (i) irregular beads partially embedded on a surface, shown in Fig. E(i); (ii) micro-joints and cracks in the surface (*e.g.*, of a light pipe), shown in Fig. E(ii); (iii) roughened surface with random projections, shown in Fig. E(iii); and (iv) fully embedded particles within the bulk of a polymer binder, shown in Fig. E(iv).

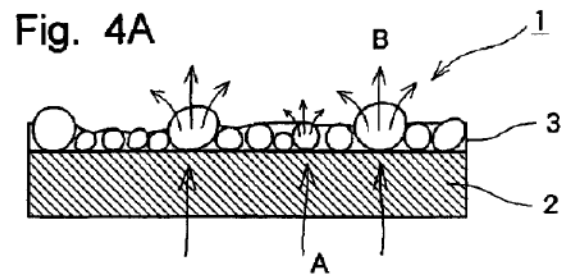


Figure E(i) (Fig. 4A of Ex. 1020,  
U.S. Patent No. 5,706,134 (“Konno”))

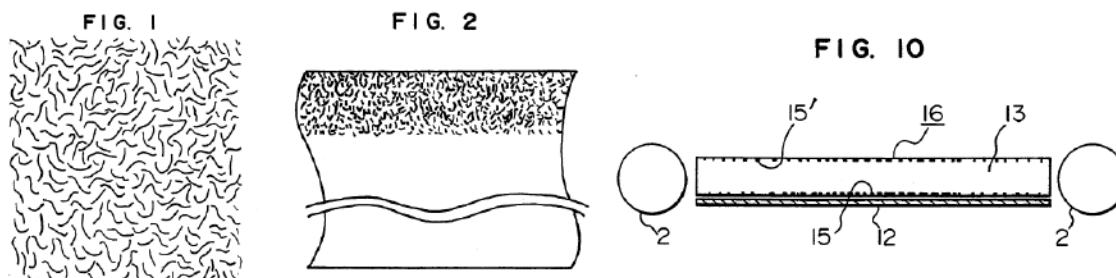


Figure E(ii) (Figs. 1, 2, and 3 of Ex. 1014, Ohtake)

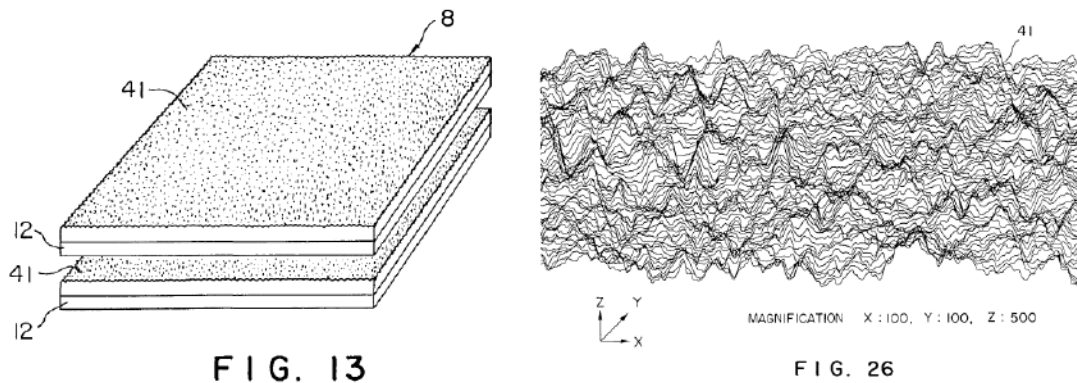


Figure E(iii) (Figs. 13 and 26 of Ex. 1021,  
U.S. Patent No. 5,944,405 (“Takeuchi”))



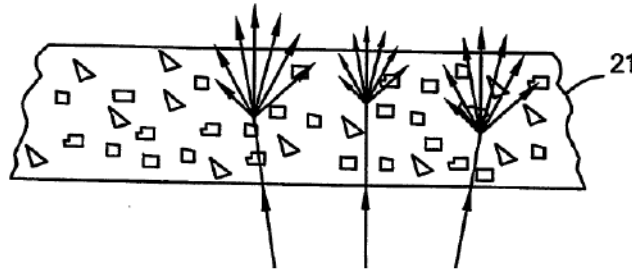


Figure E(iv) (cropped Fig. 5 of Ex. 1022,  
U.S. Patent No. 5,381,309 (“Borchardt”))

48. Diffusing deformities may be arranged directly on either side of a light pipe, as in Figs. B and C, or they may be formed as a separate sheet, as in Fig. B as a transmissive diffuser 31 and Fig. C as a reflector 27 with a diffusing surface 28. Diffusing deformities and sheets were generally known in the prior art.

49. A third common deformity is a microlens, which are small cylindrical or spherical lenslets on a surface, in either a one- or two-dimensional arrangement. These are sometimes called lenticular surfaces. *See, e.g.*, Ex. 1013, Nishio, at 4:1-3 and Fig. 13. They may have a wide range of engineered shapes, including but not limited to convex (*i.e.*, ridges) and/or concave (*i.e.*, valleys) cross-sections. It is common, but not required, to arrange the lenslets into an array with little or no space between them. For example, a 1D array of cylindrical lenslets 42 and a 2D array of spherical lenslets 42 are illustrated in Figs. 13 and 15 below, respectively. Ex. 1013, Nishio. Also shown is a diffusing surface 41 on the opposite side. These may be arranged directly on one or both of sides of a light pipe, or they may be formed into a separate sheet. Microlens deformities and sheets were generally known in the prior art.

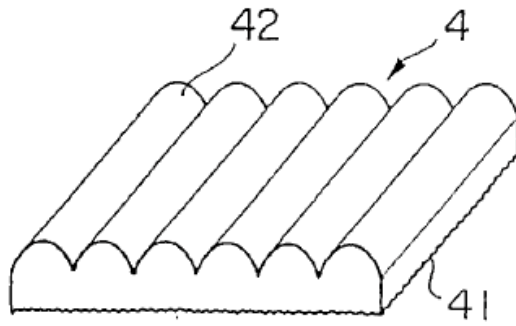


FIG. 13

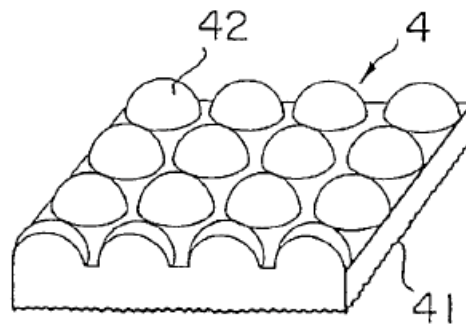


FIG. 15

### C. Low Loss

50. The concept of optical efficiency is pervasive in the context of light emitting panel assemblies. Most generally, it refers to the fraction of optical power arriving at a chosen location and direction, relative to an input optical power. High optical efficiency is generally synonymous with low loss. In general, increasing the efficiency or lowering the loss of any part of a backlight or LCD system enables at least two important advantages: decreasing power consumption for the same brightness, or increasing brightness for the same power consumption.

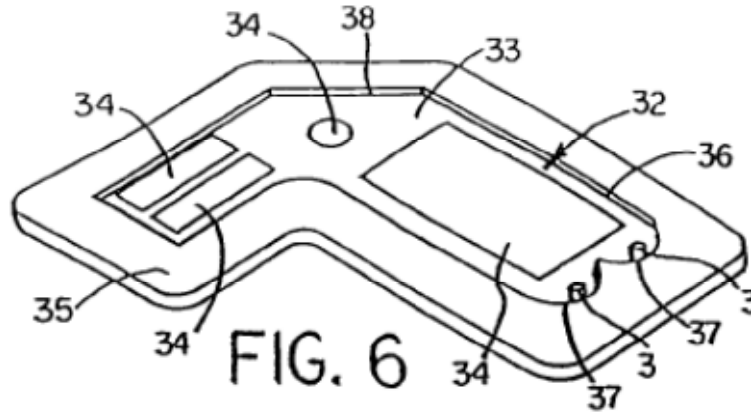
51. It is also common for panel assemblies to include reflective or refractive surfaces for changing the path or a portion of light to increase the efficiency of the panel members. For example, the Fig. 2 above from Ex. 1005, Ciupke shows reflectors 27 and 29 to reflect any light which escapes from the surface back into the light pipe and towards surface 13. *See also* Ex. 1005, Ciupke, at 3:10-14.

## IV. THE '974 PATENT

### A. Background of the '974 Patent

52. The '974 Patent relates generally to light emitting panel assemblies, also called light emitting assemblies in the claims. Ex. 1001, the '974 Patent, at Abstract. Further, the '974 Patent relates to “light emitting panel assemblies each including a transparent panel member for efficiently conducting light, and controlling the light conducted by the panel member to be emitted from one or more light output areas along the length thereof.” *Id.* at 1:18-22. As I previously stated and as the '974 Patent admits, “[l]ight emitting panel assemblies are generally known.” *Id.* at 1:23. The '974 Patent purportedly relates to several different light emitting panel assembly configurations which allegedly provide for better control of light output from the panel assembly and for more “efficient” utilization of light, thereby resulting in greater light output from the panel assembly. *Id.* at 1:25-28.

53. Specifically, the '974 Patent discloses light emitting assemblies including a light emitting panel member received in a cavity or recess in a tray or housing, where the panel member has a pattern of light extracting deformities on or in at least one surface of the panel member to cause light received from at least one LED light source positioned near or against the light entrance surface of the panel member to be emitted from a light emitting surface of the panel member. *Id.* at Abstract. An example of the tray or housing is shown in Fig. 6 of the '974 Patent as element 35.



54. According to the '974 Patent, "the tray or housing acts as an end edge and/or side edge reflector for the panel member to reflect light that would otherwise exit the panel member through the end edge and/or side edge back into the panel member for causing additional light to be emitted from the panel member." *Id.* at Abstract.

55. Also according to the '974 Patent, the panel assembly can include molded posts at one or more corners of the panel which may be used to facilitate mounting of the panel assembly and providing structural support for other parts or components, for example, a display panel such as an LCD panel as desired. *Id.* at 6:45-52.

## **B. Prosecution History (Ex. 1002)**

56. According to the face of the '974 Patent, U.S. Patent Application No. 11/378,080 ("the '080 application"), the application which issued as the '974 Patent, was filed on March 17, 2006. The '974 Patent claims priority to U.S. Patent No. 5,613,751, whose corresponding application was filed on June 27, 1995. Ex. 1001, the '974 Patent, at face of patent. The '080 application was originally filed with 15 claims, 1 of which was an independent claim.

57. The U.S. Patent and Trademark Office (“USPTO”) mailed its first Office Action for the ’080 application on August 28, 2007. The Examiner rejected Claims 1-15 on the ground of non-statutory obviousness-type double patenting as being obvious in view of Claims 1-97 of U.S. Patent No. 5,613,751 and Claims 1-34 of U.S. Patent No. 7,160,015. Ex. 1002, Office Action, Aug. 28, 2007, at 2. The Examiner also provisionally rejected Claims 1-15 on the ground of non-statutory obviousness-type double patenting as being obvious in view of Claims 1-8, 10-17, 19-25, and 28-29 of U.S. Patent Application No. 11/244,473; Claims 1-41 of U.S. Patent Application No. 11/454,822; and Claims 1-30 and 32 of U.S. Patent Application No. 11/245,408. *Id.* at 2. Further, the Examiner rejected Claims 1-4 and 6-7 under 35 U.S.C. § 103(a) as being obvious over U.S. Patent No. 5,027,258 (“Schoniger I”), in view of U.S. Patent No. 5,283,673 (“Kashima”) or U.S. Patent No. 5,381,309 (“Borchardt”). *Id.* at 3. Finally, the Examiner rejected Claims 1-15 under 35 U.S.C. § 103(a) as being obvious over U.S. Patent No. 5,485,354 (“Ciupke”) or U.S. Patent No. 5,390,276 (“Tai”) in view of U.S. Patent No. 5,136,483 (“Schoniger II”). *Id.* at 4.

58. In response, Applicants amended Claims 1, 3, 4, 8, 9, and 11 and cancelled Claims 7, 10, 12, and 14. Ex. 1002, Resp. to Office Action, Nov. 28, 2007, at 5. Also, Applicants added new claims 16-24. *Id.* Additionally, Applicants filed a terminal disclaimer to overcome the rejection of Claims 1-15 on the ground of non-statutory obviousness-type double patenting over Claims 1-97 of U.S. Patent No. 5,613,751 and Claims 1-34 of U.S. Patent No. 7,160,015. *Id.* at 5. Applicants also filed a provision

terminal disclaimer to overcome the rejection of Claims 1-15 on the ground of non-statutory obviousness-type double patenting over claims 1-41 of U.S. Patent Application No. 11/454,822 and Claims 1-30 and 32 of U.S. Patent Application No. 11/245,408. *Id.* at 5-6. To overcome the rejection under 35 U.S.C. § 103(a) of obviousness over Schoniger I in view of Kashima or Borchardt, Applicants argued that Schoniger I does not teach a tray with end walls or side walls that act as end reflectors and side reflectors for a panel member entirely received in a cavity or recess in the tray or housing to reflect light that would otherwise exit the panel member through an end edge and/or side edge of the panel member back into the panel member. *Id.* at 6-7. Applicants finally argued that neither Ciupke nor Tai teach a tray or housing having a cavity or recess in which a panel member is received, and acts as an end edge reflector and/or side edge reflector for the panel member. *Id.* at 7. Further, Applicants argue that neither Ciupke nor Tai have a cavity or recess in which the panel member is entirely received and acts as an end edge reflector and/or side edge reflector for the panel member. *Id.*

59. In a final Office Action, the Examiner rejected Claims 16-24 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,070,431 (“Kitazawa”). Ex. 1002, Office Action, Mar. 6, 2008, at 3. The Examiner allowed Claims 1-6, 8-9, 11, 13, and 15. *Id.*

60. In response, Applicants amended claims 16-24 to depend from allowed Claim 1. Ex. 1002, Resp. to Office Action, Apr. 16, 2008, at 6.

61. The Examiner issued a further Office Action, withdrawing his previous determination of allowability. Ex. 1002, Office Action, May 8, 2008, at 3. The new rejections included: 1) Claims 1-4, 6, 8-9, 11, 16-21, and 23-24 under 35 U.S.C. § 103(a) as obvious over U.S. Patent No. 5,184,888 (“Sakuma”); 2) Claims 1-4, 8-9, 11, 13, and 16-24 under 35 U.S.C. § 103(a) as obvious over U.S. Patent No. 5,283,673 (“Murase”); 3) Claims 1-6, 8-9, 11, 13, 16-21, and 23-24 under 35 U.S.C. § 103(a) as obvious over U.S. Patent No. 5,050,046 (“Tada”) in view of Murase; and 5) Claim 15 under 35 U.S.C. § 103(a) as being obvious over Sakuma or Murase or Tada in view of U.S. Patent No. 5,434,754 (“Li”). *Id.* at 4-6.

62. In response, Applicants amended Claims 1, 4, 16, 17, and 18, cancelled Claims 2, 3, 7, 10, 12, and 14, and added Claims 25-30. Ex. 1002, Resp. to Office Action, Aug. 8, 2008, at 9. Applicants then argued that the newly amended claims were not taught by the cited references because: 1) Sakuma does not teach a tray that provides structural support, the posts are attached to the panel member, not the tray, and there is no air gap between the panel member and additional component; 2) Murase does not teach tabs that provide a mount for mounting a light panel assembly into a larger assembly or device and there is no air gap between the panel member and additional component; 3) Tada does not teach a tray or housing and does not provide a mount for mounting of the assembly into a larger assembly or device and there is no air gap between the panel member and additional component; and 4) Li does not teach reflectors on the light entrance surface of a light emitting panel member. *Id.* at 9-13.

63. The Notice of Allowance was mailed on August 22, 2008, allowing Claims 1, 4-6, 8, 9, 11, 13, and 15-30.

**C. Asserted Claims**

64. My analysis will focus on claims 1, 3-5, 7-11, 13, and 17 of the '974 Patent. The claims themselves will be discussed in detail within the Prior Art Analysis section.

**D. Claim Construction**

65. I have been informed that in my analysis, I should interpret “deformities,” as the term exists in Claims 1, 7, and 13 of the '974 Patent, as “any change in the shape or geometry of a surface and/or coating or surface treatment that causes a portion of the light to be emitted.” This term was specifically defined in the specification of the '974 Patent, as previously discussed. Ex. 1001, the '974 Patent, at 4:38-40.

**V. PRIOR ART ANALYSIS**

66. I now turn to the references applied in the grounds for rejections discussed in Petition for *inter partes* review. In my analysis, I will specifically address the following references:

No.	Reference	Referred To As
1007	U.S. Patent No. 5,619,351	Funamoto
1008	U.S. Patent No. 5,548,271	Tsuchiyama
1009	U.S. Patent No. 5,654,779	Nakayama



**A. U.S. Patent No. 5,619,351 (“Funamoto”)**

67. Funamoto is directed to a surface-type illumination device suitable for providing a backlight in an LCD. Ex. 1007, Funamoto, at Abstract. According to Funamoto, the increased use of surface-type illumination devices with a cylindrical light source and a flat polarizer as backlights for LCD panels in addition to the increased use of LCD panels for color displays calls for the LCD panels to become thinner and lighter with less power consumption. *Id.* at 1:15-38. Some problems Funamoto aimed to solve include overheating and the increased number of necessary driver circuits. *Id.* at 1:42-66. To address these concerns, Funamoto discloses an illumination device for color LCDs that are small, lightweight, with high and uniform brightness, which can also be temperature controlled and without increasing the number of driver circuits needed. *Id.* at 2:3-23.

68. Funamoto discloses a surface-type illumination device including a polarizer which is polygon-shaped and substantially transparent; a diffusion pattern arranged on one side of the polarizer, the diffusion pattern emitting substantially evenly from one side of the polarizer light that is introduced from the illuminant to the other side of the polarizer; and a cylindrically-shaped illuminant bent so that the illuminant faces at least two sides of the polarizer; wherein the edge sandwiched between the at least two sides is processed so that the corner does not protrude, and where the entire assembly is placed within a frame (pink) and case (red) in annotated Figs. 2, 3, 14, and 15 below. *Id.* at 5:46-6:23, 13:39-14:7.

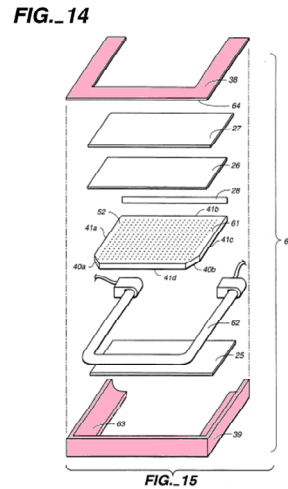
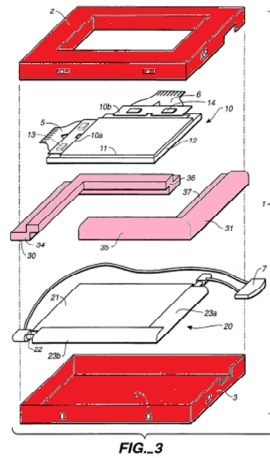
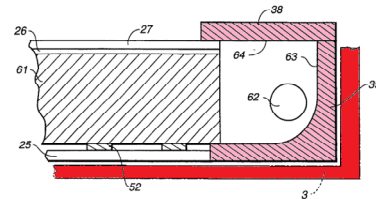
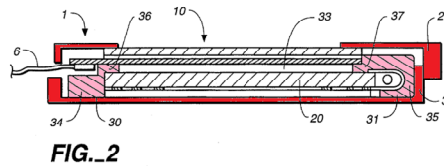


Figure F (annotated Figs. 2, 14, 3, 15 of Ex. 1007, Funamoto)

69. Funamoto teaches several different embodiments of the light emitting panel assemblies. A person of ordinary skill in the art would have been motivated to combine elements of a particular embodiment with other elements of other embodiments disclosed in Funamoto for several reasons. First, the embodiments are detailed within the same disclosure. Ex. 1007, Funamoto, at 5:44, 13:37. Second, Funamoto mentions several times that the disclosure from one embodiment is very similar to that of the other embodiment. For example, “[t]he explanation of the functions of reflection sheet 25, diffusion sheet 26, and prism 27” were omitted in the second embodiment because “they are the same as that explained in the earlier embodiment.” *Id.* at 14:8-10. Additionally, for the second embodiment, “[s]tructures

discussed in the above embodiments, such as those of the reflectors, can be used.” *Id.* at 15:18-19. Finally, Funamoto does not teach that multiple light sources should not or cannot be applied to the first embodiment. Seemingly, when Funamoto describes differences between the embodiments, there is a level of specificity. For example, for the second embodiment, Funamoto calls out that the pattern sheet is omitted because the diffusion sheet is printed on the polarizer. *Id.* at 14:10-12. Therefore, it would be obvious to a person of ordinary skill in the art to alter one embodiment with a feature taught in the same patent but from a different embodiment.

**1. Claims 1, 3-5, 7-11, And 13 Are Obvious In View of Funamoto**

**a. Claim 1**

70. Claim 1 of the '974 Patent recites:

1. A light emitting panel assembly comprising  
at least a light emitting panel member having a light  
entrance surface and a light emitting surface,  
at least one LED light source positioned near or against the  
light entrance surface, and  
a tray or housing having a cavity or recess in which the  
panel member is entirely received,  
wherein the panel member has a pattern of light extracting  
deformities on or in at least one surface to cause light to be  
emitted from the light emitting surface of the panel  
member, and  
the tray or housing includes end walls and side walls that  
act as end edge reflectors and side edge reflectors for the  
panel member to reflect light that would otherwise exit the  
panel member through an end edge and/or side edge back  
into the panel member and toward the pattern of light  
extracting deformities for causing additional light to be  
emitted from the light emitting surface of the panel  
member,  
wherein the tray or housing provides structural support to

the panel member and  
has posts, tabs, or other structural features that provide a  
mount for mounting of the assembly into a larger assembly  
or device.

71. Funamoto discloses the structure and use of a light emitting panel assembly, as can be seen in the disclosure, specifically, “[i]n liquid crystal display 1, illumination device 20 is installed in lower case 3. Above that, liquid crystal display panel 10 is installed using frame 30 and 31.” Ex. 1007, Funamoto, at 5:61-67. The light emitting panel assembly can also be seen in Fig. 2 of Funamoto. Accordingly, Funamoto describes “[a] light emitting panel assembly,” as required by Claim 1 of the ’974 Patent.

72. The light emitting panel member having a light entrance surface and a light emitting surface of the ’974 Patent typically is a transparent planar slab that confines the light within it using total-internal-reflection. Ex. 1001, the ’974 Patent, at 1:19-22; *see also supra*, at ¶43. Within the light emitting device, Funamoto discloses an “[i]llumination device 20 is a surface-type illumination device set up with a cylindrically-shaped fluorescent light 22 at the edge of substantially rectangular **polarizer 21.**” Ex. 1007, Funamoto, at 6:24-26 (emphasis added). Funamoto also recites that “[f]luorescent **light 22**, which is used as the light source of illumination device 20, is in an L-shape, and **is positioned adjacent to edges 41c and 41d** of polarizer 21.” *Id.* at 7:39-41 (emphasis added). The edge surface 41c corresponds to the light entrance surface of the ’974 Patent. Further, the illumination device includes

a “**polarizer 21**, which is substantially rectangular in shape and is missing the corner of edge 40, [a] fluorescent light 22, which encompasses edge 40 in an L-shape, and reflectors 23a and 23b, which cover fluorescent light 22 in the direction of polarizer 21 and efficiently reflect light from fluorescent light 22 to polarizer 21.” *Id.* at 6:34-40 and Fig. 4 (emphasis added). Specifically, “[p]**olarizer 21** is a transparent material whose index of refraction is greater than that of air,” where “[a]n index of refraction equal to or greater than 1.41 is desirable using such materials as acrylic resin, polycarbonate resin, amorphous polyolefine-type resin, and polystyrene resin.” *Id.* at 6:49-53 (emphasis added).

73. A person of ordinary skill in the art would have understood that the element “polarizer 21” of Funamoto is both a transparent optical conductor which accepts light from the light source at its edge surface and emits it along another surface, as required by light emitting panel member of the ’974 Patent because of the polarizer’s index of refraction and positioning relative to the light source. Ex. 1007, Funamoto, at 6:49-53.

74. Moreover, a look at Funamoto’s child patent, U.S. Patent No. 6,108,060 (“the ’060 Patent”) (Ex. 1010) is instructive on this matter. The ’060 Patent is a divisional patent of a divisional of Funamoto. The intervening patent, U.S. Patent No. 5,949,505, also refers to the element in question as the polarizer 21. However, looking closely at the ’060 Patent and its prosecution history (Ex. 1010), I note that the ’060 Patent includes the exact same sentence in Funamoto, but with “polarizer”

replaced with “light guide plate,” (“Illumination device 20 is a surface-type illumination device set up with a cylindrically-shaped fluorescent light 22 at the edge of substantially rectangular **light guide plate 21.**”) Ex. 1010, the ’060 Patent, at 6:31-33 (emphasis added). Therefore, the “polarizer 21” of Funamoto is the same as the light emitting panel member of the ’194 patent. That is, I adopt the definition provided in the primary Funamoto (U.S. Patent No. 5,619,351) and apply it in the analysis, in spite of the term “polarizer”, which must be a translation error in view of the later Funamoto (Ex. 1010, the ’060 Patent).

75. Accordingly, Funamoto discloses “a light emitting panel member having a light entrance surface and a light emitting surface,” as required by Claim 1 of the ’974 Patent.

76. Funamoto discloses an “[i]llumination device 20 is a surface-type illumination device set up with a cylindrically-shaped fluorescent light 22 at the edge of substantially rectangular polarizer 21.” Ex. 1007, Funamoto, at 6:24-26. The fluorescent light 22 of Funamoto serves as a light source. Further, Funamoto recognizes the desired goal lowered power consumption. For example, Funamoto discloses in the “Field of the Invention” section that “[t]his invention relates ... in particular, to a suitable illumination device for use in a notebook computer display that provides high brightness with low power consumption.” *Id.* at 1:6-11. Additionally, when describing one of the embodiments, Funamoto instructs that “because the light conversion efficiency can be raised, power consumption can be

reduced.” *Id.* at 12:66-67.

77. From this teaching, a person of ordinary skill in the art would want to find a light source that would decrease the power consumption of the illumination device. It was well-known at the effective filing date of the '974 Patent (June 27, 1995) that LEDs are commonly known as light sources. *See e.g.*, Ex. 1006, U.S. Patent No. 5,005,108, at 3:15-17 (“Pristash”). Further, it was commonly known by those of ordinary skill in the art that LEDs decrease the power consumption of an illumination device as compared to other light sources, such as incandescent bulbs or fluorescent lamps. *See, e.g.*, Ex. 1023, U.S. Patent No. 4,915,478, at 3:28-38 (“Lenko”). Therefore, the use of an LED as a light source for light emitting panel assemblies is obvious to a person of ordinary skill in the art.

78. Accordingly, Funamoto teaches “at least one LED light source positioned near or against the light entrance surface,” as required by Claim 1 of the '974 Patent.

79. Funamoto discloses an upper case 2 and lower case 3 between which the liquid crystal display panel 10 and illumination device 20 is sandwiched. Ex. 1007, Funamoto, at 5:47-50. In fact, the illumination device 20 is installed into the lower case 3 and the LCD panel 10 is installed above that using frames 30 and 31. *Id.* at 5:61-67. Frames 30 and 31 are other structural features of Funamoto that serve to “protect illumination device 20 and to position it within the case,” as well as “[maintain] a fixed distance for gap 33 between illumination device 20 and liquid crystal display panel 10.” *Id.* at 6:10-17. As discussed above, the case (red) and frame

(pink) can be seen in Figs. 2 and 3 of Funamoto. *See supra*, at Fig. F. The case and frame serve to surround the entire LCD and illumination device, within which the polarizer is contained. Therefore, the panel member is entirely received into the tray or housing of Funamoto.

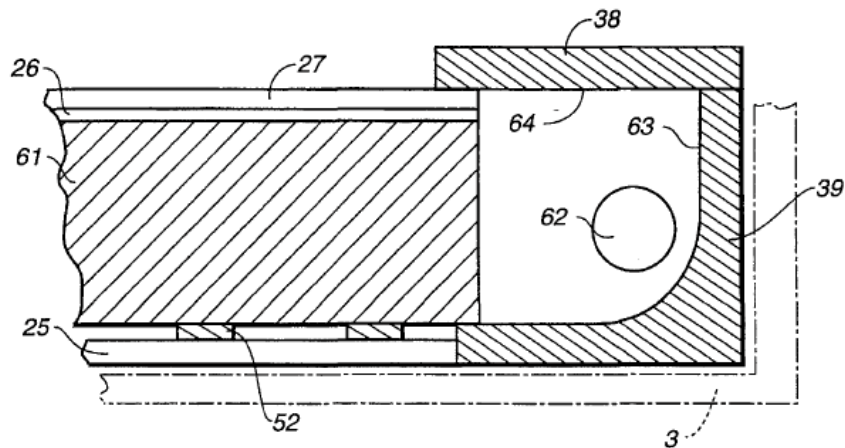
80. In another embodiment, Funamoto discloses the same case structure and function of the previous embodiment. Ex. 1007, Funamoto, at 13:42-44, Fig. 14 (element 3). Funamoto also describes that frames 38 and 39, which are only slightly different from frames 30 and 31, where “[u]pper frame 38 acts as a spacer to secure the gap between liquid crystal display panel 10 and illumination device 60.” *Id.* at 13:53-55. Further, “[w]ithin the U-shaped lower frame 39 of illumination device 60 are enclosed the following in the order from bottom to top, reflecting sheet 25, polarizer 61, diffusion sheet 26, and prism sheet 27.... On top of lower frame 39, which encloses all of these, is the flat, L-shaped upper frame 38.” *Id.* at 13:58-65. As discussed above, the case (red) and frame (pink) can be visualized in Figs. 14 and 15 of Funamoto. *See supra*, at Fig. F. The case and frame serve to surround the entire liquid crystal panel display and illumination device, within which the polarizer is contained. Therefore, the panel member is entirely received into the tray or housing of Funamoto.

81. In both embodiments described in Funamoto, the case and frame, either separately or together meet the limitation of “a tray or housing having a cavity or recess in which the panel member is entirely received.” Accordingly, Funamoto



teaches “a tray or housing having a cavity or recess in which the panel member is entirely received,” as required by Claim 1 of the ’974 Patent

82. Funamoto discloses a pattern of light extracting deformities on the panel member. For example, in the second embodiment Funamoto recites that “the pattern sheet is omitted because the **diffusion sheet 52 is printed on lower surface 61b of polarizer 61.**” Ex. 1007, Funamoto, at 14:10-12 (emphasis added). Funamoto recites further that, “[t]hrough **diffusion pattern 52**, the **light** introduced to polarizer 61 **is diffused and** a uniform light **is released** from upper surface 61a of polarizer 61 **towards the liquid crystal display** panel.” *Id.* at 14:27-41 (emphasis added). The diffusion pattern 52 on the bottom of the polarizer 61 (*i.e.*, the light emitting panel member) is illustrated in part in Fig. 14 below. Each diffuser spot (*e.g.*, labeled 52 in Fig. 14), printed on the surface, is a light extracting deformity according to the ’974 Patent, because it is a coating or surface treatment that causes a portion of the light within polarizer 61 to diffuse in all directions and emit from the panel member. *See also supra*, at ¶47. Furthermore, these diffuser spots are arranged into a grid-like pattern (*e.g.*, shown as a sheet in Figs. 15 and 17 with the same label 52) on the surface of the polarizer 61 (*i.e.*, the light emitting panel member), and cause light to be emitted uniformly toward the liquid crystal display. *Id.* at 14:38-41.



**FIG. 14**

83. Accordingly, Funamoto teaches “the panel member [having] a pattern of light extracting deformities on or in at least one surface to cause light to be emitted from the light emitting surface of the panel member,” as required by Claim 1 of the ’974 Patent.

84. Funamoto discloses means to reflect light back into the panel member that would otherwise exit at the end walls and side walls, and expressly includes the teaching that these may be integrated into the tray or housing. Referring to the first embodiment illustrated in part in Fig. 2, Funamoto recites “[e]dge reflective tape 28 is arranged at the two edges 41a and 41b, which are opposite the edges 41c and 41d where fluorescent light 22 and reflector 23 are installed. . . . **The light that reaches the edges of the opposite side is returned back to polarizer 21.**” Ex. 1007, Funamoto, at 7:60-67 (emphasis added). Edge reflector tape 28 is employed by Funamoto in the second embodiment as well. *Id.* at 13:63-64.

85. Funamoto furthermore recites that “[m]aterials such as white PET sheets,

aluminum, and such can be used for the **edge reflective tape** as well as the reflectors mentioned above. **It is also possible to integrate these into the case or frame as well.**” *Id.* at 7:67-8:4 (emphasis added).

86. Accordingly, Funamoto discloses a “the tray or housing includ[ing] end walls and side walls that act as end edge reflectors and side edge reflectors for the panel member to reflect light that would otherwise exit the panel member through an end edge and/or side edge back into the panel member and toward the pattern of light extracting deformities for causing additional light to be emitted from the light emitting surface of the panel member,” as required by Claim 1 of the ’974 Patent.

87. As previously discussed, Funamoto discloses a case and frame which are used to sandwich the display and the illumination device, to protect the illumination device and position it within the case, and enclose the device. *See supra*, at ¶¶78-80. Accordingly, Funamoto teaches that “the tray or housing provides structural support to the panel member,” as required by Claim 1 of the ’974 Patent.

88. Funamoto discloses that the upper case 2 and lower case 3 are fixed in place by **tooth 4**. Ex. 1007, Funamoto, at 5:50-51. For the assembly, “[i]n liquid crystal display 1, illumination device 20 is installed in lower case 3.” *Id.* at 5:64-66. Then this assembly can be mounted into a larger assembly or device, for example, the mounting of the upper case with the tooth.

89. Additionally, the frames maintain a fixed distance for gap 33 between the illumination device and the LCD panel. *Id.* at 6:10-17, 13:51-65. As is clear from the

figures of Funamoto, the structural features of the frames including “lower halves [sic] 34 and 35,” which support illumination device 20, “and their upper halves [sic] 36 and 37,” which act as spacers between illumination device 20 and liquid crystal display panel 10, allow for proper arrangement of the assembly therein into something larger, for example, lower case 3. *Id.* at 6:10-17.

90. Accordingly, Funamoto teaches that the tray “has posts, tabs, or other structural features that provide a mount for mounting of the assembly into a larger assembly or device,” as required by Claim 1 of the ’974 Patent.

91. As discussed in detail above, every element of Claim 1 of the ’974 Patent is taught by Funamoto.

### **b. Claim 3**

92. Claim 3 of the ’974 Patent recites:

3. The assembly of claim 1 wherein the tray or housing provides a support for supporting and/or positioning a film near the panel member.

93. Funamoto teaches “[t]he assembly of claim 1,” as shown above in ¶¶71-90.

94. Funamoto discloses that the illumination device is sandwiched between the upper case 2 and lower case 3. Ex. 1007, Funamoto, at 5:47-50; *see also* Fig. 2. Additionally, “[w]ithin the U-shaped lower frame 39 of illumination device 60 are enclosed the following in the order from bottom to top, reflecting sheet 25, polarizer 61, diffusion sheet 26, and **prism sheet 27**. . . . On top of lower frame 39, which encloses all of these, is the flat, L-shaped upper frame 38.” *Id.* at 13:51-65 (emphasis

added); *see also* Figs. 14, 15. The prism sheet 27 is a film supported and positioned by the tray or housing that is near the panel member. Accordingly, Funamoto teaches the assembly of Claim 1 “wherein the tray or housing provides a support for supporting and/or positioning a film near the panel member,” as required by Claim 3 of the ’974 Patent.

**c. Claim 4**

95. Claim 4 of the ’974 Patent recites:

4. The assembly of claim 3 wherein the film is at least one of a diffuser and a brightness enhancing film.

96. Funamoto teaches “[t]he assembly of claim 3,” as shown above in ¶¶71-90.

97. Funamoto discloses that the prism sheet 27 “is made up of very small linear prisms lined in a cross-sectional array.” Ex. 1007, Funamoto, at 7:30-34. A prism sheet composed of very small linear prisms is a brightness enhancing film because it redirects off-axis light toward the on-axis direction making the light emitting panel assembly appear brighter. *See supra*, at ¶46. Accordingly, Funamoto teaches the assembly of Claim 3 “wherein the film is at least one of a diffuser and a brightness enhancing film,” as required by Claim 4 of the ’974 Patent.

**d. Claim 5**

98. Claim 5 of the ’974 Patent recites:

5. The assembly of claim 1 further comprising a film positioned near the light emitting surface of the panel member for changing the output ray angle distribution of the emitted light to fit a particular application.

99. Funamoto teaches “[t]he assembly of claim 1,” as shown above in ¶¶71-90.

100. Specifically, as previously discussed, Funamoto discloses the prism sheet is arranged on a diffusion sheet and “is made up of very small linear prisms lined in a cross-sectional array.” Ex. 1007, Funamoto, at 7:30-32. Additionally, “[t]he angle of the light radiating from diffusion sheet 26 is arranged to improve the illuminating intensity of the liquid crystal display panel 10.” *Id.* at 7:32-34. The prism sheet, which is composed of very small linear prisms, or microprisms, inherently functions to control the light output ray angle distribution by redirecting off-axis light toward the on-axis direction making the light emitting panel assembly appear brighter. *See supra*, at ¶46.

101. Accordingly, Funamoto discloses an assembly of Claim 1 comprising “a film positioned near the light emitting surface of the panel member for changing the output ray angle distribution of the emitted light to fit a particular application,” as required by Claim 5 of the ’974 Patent.

**e. Claim 7**

102. Claim 7 of the ’974 Patent recites:

7. A light emitting panel assembly comprising  
at least a light emitting panel member having a light  
entrance surface and a light emitting surface,  
at least one LED light source positioned near or against the  
light entrance surface, and  
a tray or housing having a cavity or recess in which the  
panel member is entirely received,  
wherein the panel member has a pattern of light extracting  
deformities on or in at least one surface to cause light to be

emitted from the light emitting surface of the panel member, and  
the tray or housing includes end walls and side walls that act as end edge reflectors and side edge reflectors for the panel member to reflect light that would otherwise exit the panel member through an end edge and/or side edge back into the panel member and toward the pattern of light extracting deformities for causing additional light to be emitted from the light emitting surface of the panel member,  
wherein the tray or housing has posts, tabs or other structural features that provide a mount or structural support for at least one other part or component, and  
the tray or housing provides structural support to the panel member.

103. As previously discussed in ¶¶71-87, Funamoto teaches the following elements found within Claim 1 of the '974 Patent: "A light emitting panel assembly comprising at least a light emitting panel member having a light entrance surface and a light emitting surface, at least one LED light source positioned near or against the light entrance surface, and a tray or housing having a cavity or recess in which the panel member is entirely received, wherein the panel member has a pattern of light extracting deformities on or in at least one surface to cause light to be emitted from the light emitting surface of the panel member, and the tray or housing includes end walls and side walls that act as end edge reflectors and side edge reflectors for the panel member to reflect light that would otherwise exit the panel member through an end edge and/or side edge back into the panel member and toward the pattern of light extracting deformities for causing additional light to be emitted from the light emitting surface of the panel member... and the tray or housing provides structural

support to the panel member.”

104. In addition to the elements above, Funamoto discloses that the upper case 2 and lower case 3 are fixed in place by tooth 4. Ex. 1007, Funamoto, at 5:50-51. For the assembly, “[i]n liquid crystal display 1, illumination device 20 is installed in lower case 3.” *Id.* at 5:64-66. Tooth 4 can provide structural support to the attachment of the upper case 2 with the lower case 3, within which the illumination device 20 is installed.

105. Additionally, the frames maintain a fixed distance for gap 33 between the illumination device and the LCD panel. *Id.* at 6:10-17, 13:51-65. As is clear from the figures of Funamoto, the structural features of the frames including “lower halves [sic] 34 and 35,” serve as structural support for illumination device 20, “and their upper halves [sic] 36 and 37,” act as spacers between illumination device 20 and LCD panel 10, allow for proper arrangement of the assembly therein into something larger, for example, lower case 3. *Id.* at 6:10-17. Therefore, the frames have structural features that provide structural support for at least one other component, for example, the LCD panel.

106. Accordingly, Funamoto teaches that “the tray or housing [having] posts, tabs or other structural features that provide a mount or structural support for at least one other part or component,” as required by Claim 7 of the ’974 Patent.

107. As discussed in detail above, every element of Claim 7 of the ’974 Patent is taught by Funamoto.



**f. Claim 8**

108. Claim 8 of the '974 Patent recites:

8. The assembly of claim 7 wherein the other part or component is a liquid crystal display.

109. Funamoto discloses “[t]he assembly of claim 7,” as shown above in ¶¶103-106.

110. Further, Funamoto teaches the frames that maintain a fixed distance for gap 33 between the illumination device and the LCD panel. Ex. 1007, Funamoto, at 6:10-17, 13:51-65. As is clear from the figures of Funamoto, the structural features of the frames including “lower halves [*sic*] 34 and 35,” serve as structural support for illumination device 20, “and their upper halves [*sic*] 36 and 37,” act as spacers between illumination device 20 and **liquid crystal display panel 10**, allow for proper arrangement of the assembly therein into something larger, for example, lower case 3. *Id.* at 6:10-17 (emphasis added). Therefore, the frames have structural features that provide structural support for at least one other component, for example, the LCD panel.

111. Accordingly, Funamoto teaches an assembly of Claim 7 “wherein the other part or component is a liquid crystal display,” as required by Claim 8 of the '974 Patent.

**g. Claim 9**

112. Claim 9 of the '974 Patent recites:

9. The assembly of claim 7 wherein the other part or component is a printed circuit.

113. Funamoto discloses “[t]he assembly of claim 7,” as shown above in ¶¶103-106.

114. Funamoto also teaches that “[t]he scanning data that comprises the image is supplied from the host side to each row or column through tape electrode 5 and tape electrode 6. This data is latched by a driver IC which will be described below, is synchronized, and is supplied to LCD panel 10 where the image is formed.” Ex. 1007, Funamoto, at 5:51-56. Additionally, “[a]t side 10a of liquid crystal display panel 10, a plurality of driver ICs 13 are installed for latching pixel data for the rows and sending it to the liquid crystal display panel. Also, at side 10b [of liquid crystal display panel 10, which is adjacent to side 10a, a plurality of driver ICs 14 are installed for latching pixel data for the columns and sending it to the liquid crystal display panel.” *Id.* 6:3-9. The driver IC, which means “integrated circuit,” is a printed circuit because it is responsible for latching and synchronizing the data before it is supplied to the LCD, and must include some type of printed circuit to provide electrical connections to and from the tape electrodes 5, 6 and the IC chips performing this function. As can be seen in annotated Figs. 2 and 3 below, driver IC 14 (orange) and tape electrode 6 (green) are positioned and supported in the assembly by the case (2 and 3) and the frame (34 and 35).

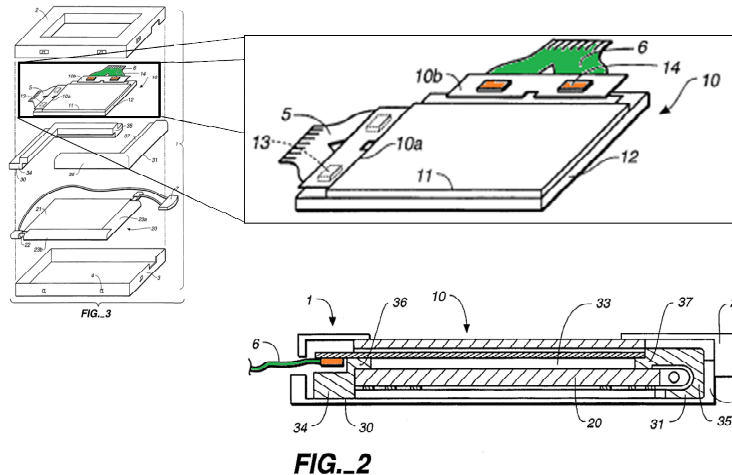


Figure G (annotated Figs. 2 and 3 of Ex. 1007, Funamoto)

115. Accordingly, Funamoto teaches an assembly of Claim 7 “wherein the other part or component is a liquid crystal display,” as required by Claim 9 of the ’974 Patent.

#### h. Claim 10

116. Claim 10 of the ’974 Patent recites:

10. The assembly of claim 7 wherein the film is at least one of a diffuser and a brightness enhancing film.

117. Funamoto teaches “[t]he assembly of claim 7,” as shown above in ¶¶103-106.

118. Funamoto discloses that the prism sheet 27 “is made up of very small linear prisms lined in a cross-sectional array.” Ex. 1007, Funamoto, at 7:30-34. A prism sheet composed of very small linear prisms is a brightness enhancing film because it redirects off-axis light toward the on-axis direction making the light emitting panel assembly appear brighter. *See supra*, at ¶46. Accordingly, Funamoto teaches the assembly of Claim 7 “wherein the film is at least one of a diffuser and a brightness

enhancing film,” as required by Claim 10 of the ’974 Patent.

**i. Claim 11**

119. Claim 11 of the ’974 Patent recites:

11. The assembly of claim 7 further comprising a film positioned near the light emitting surface of the panel member for changing the output ray angle distribution of the emitted light to fit a particular application.

120. Funamoto teaches “[t]he assembly of claim 7,” as shown above in ¶¶103-106.

121. Specifically, as previously discussed, Funamoto discloses the prism sheet is arranged on a diffusion sheet and “is made up of very small linear prisms lined in a cross-sectional array.” Ex. 1007, Funamoto, at 7:30-32. Additionally, “[t]he angle of the light radiating from diffusion sheet 26 is arranged to improve the illuminating intensity of the liquid crystal display panel 10.” *Id.* at 7:32-34. The prism sheet, which is composed of very small linear prisms, or microprisms, inherently functions control the light output ray angle distribution by redirecting off-axis light toward the on-axis direction making the light emitting panel assembly appear brighter. *See supra*, at ¶46.

122. Accordingly, Funamoto discloses an assembly of Claim 7 comprising “a film positioned near the light emitting surface of the panel member for changing the output ray angle distribution of the emitted light to fit a particular application,” as required by Claim 11 of the ’974 Patent.

**j. Claim 13**

123. Claim 13 of the ’974 Patent recites:

13. A light emitting panel assembly comprising

at least a light emitting panel member having a light entrance surface and a light emitting surface,  
at least one LED light source positioned near or against the light entrance surface, and  
a tray or housing having a cavity or recess in which the panel member is entirely received,  
wherein the panel member has a pattern of light extracting deformities on or in at least one surface to cause light to be emitted from the light emitting surface of the panel member, and  
the tray or housing includes end walls and side walls that act as end edge reflectors and side edge reflectors for the panel member to reflect light that would otherwise exit the panel member through an end edge and/or side edge back into the panel member and toward the pattern of light extracting deformities for causing additional light to be emitted from the light emitting surface of the panel member, and  
an additional component overlaying the panel member, the panel member having at least one of a tab, hole, cavity, or protrusion that positions the tray or housing relative to the panel member.

124. As previously discussed in ¶¶71-90, Funamoto teaches the elements found within Claim 7 of the '974 Patent: "A light emitting panel assembly comprising at least a light emitting panel member having a light entrance surface and a light emitting surface, at least one LED light source positioned near or against the light entrance surface, and a tray or housing having a cavity or recess in which the panel member is entirely received, wherein the panel member has a pattern of light extracting deformities on or in at least one surface to cause light to be emitted from the light emitting surface of the panel member, and the tray or housing includes end walls and side walls that act as end edge reflectors and side edge reflectors for the panel member

to reflect light that would otherwise exit the panel member through an end edge and/or side edge back into the panel member and toward the pattern of light extracting deformities for causing additional light to be emitted from the light emitting surface of the panel member.”

125. In addition to the elements above, Funamoto discloses “[i]n liquid crystal display 1, illumination device 20 is installed in lower case 3. Above that, **liquid crystal display panel 10** is installed using frame 30 and 31.” Ex. 1007, Funamoto, at 5:64-67 (emphasis added); *see also* Fig. 2. Additionally, frames 30 and 31 maintain a fixed distance between illumination device 20 and liquid crystal display 10 where the frames’ upper halves 36 and 37 act as spacers between illumination device 20 and liquid crystal display panel 10. *Id.* at 6:10-17. Accordingly, Funamoto discloses the light emitting panel assembly with “an additional component overlaying the panel member,” as required by Claim 13 of the ’974 Patent.

126. Funamoto also discloses that two corners of the polarizer 61 are removed “in order to install U-shaped fluorescent light 62 with an appropriate gap 42 at the polarizer.” *Id.* at 14:12-15. Specifically, “[t]he corners of edge 40b, which is between edges 41c and 41d, and edge 40a, which is between edges 41a and 41d, are removed so that they do not stick out. In this way, fluorescent light 62 can be installed with fixed gap 42 near edge 41, and the incident efficiency towards polarizer 61 maintained at a high level. Also, damage to fluorescent light 62 due to such things as thermal expansion and shock can be prevented.” *Id.* at 14:16-23. Funamoto also contemplated

that the shape of the corner removed are triangles but “it is of course possible to use other shapes as well.” *Id.* at 14:26-27.

127. Funamoto therefore teaches that the panel member can be altered or shaped in such a way as to conform to other parts of the assembly, such as a light source. A person of ordinary skill in the art would understand that if the panel member of Funamoto was not altered to form a cavity to fit with the light source, then the assembly, including the panel member itself, would not fit into the tray, composed of the case and frame, properly. Additionally, because Funamoto contemplates that the alteration can be many possible shapes, then a person of ordinary skill in the art would know to try a hole or cavity or protrusion, if necessary, in order to have the panel member fit into the tray properly. Accordingly, Funamoto discloses “the panel member having at least one of a tab, hole, cavity, or protrusion that positions the tray or housing relative to the panel member,” as required by Claim 13 of the ’974 Patent.

128. As discussed in detail above, every element of Claim 13 of the ’974 Patent is taught by Funamoto.

#### **B. U.S. Patent No. 5,548,271 (“Tsuchiyama”)**

129. Tsuchiyama discloses a data display radio pager including an LCD provided with at least one backlight LED for illuminating the LCD, and a backlight structure for accommodating, together with the backlight LED, at least one alert LED for alerting a user of the radio pager to an incoming call in the LCD. Ex. 1008, Tsuchiyama, at 1:58-62. According to Tsuchiyama, locating an alert LED of a pager

next to the LCD on a pager casing is problematic because this would make the card type pagers undesirably thicker and larger. *Id.* at 1:39-47. To solve this problem, Tsuchiyama discloses a backlight assembly including a backlight 32A has a rectangular saucer-like reflection frame 36 and a light conducting plate 38 which are formed integrally with each other. *Id.* at 3:32-34. The light conducting plate 38 is formed with openings 38a and 38b at opposite ends thereof, and the backlight LEDs 12a and alert LEDs 12b are securely received in the openings 38a and 38b, respectively. *Id.* at 3:34-38. A diffusion sheet 40 is positioned on the light conducting plate 38, and the backlight 32A is located at the rear of the LED 12 for illuminating it, as shown in FIG. 3B. *Id.* at 3:38-40.

130. Notably, a comparison of Fig. 4 of Tsuchiyama showing rectangular saucer-like reflection frame (36, in red), the accompanying cavity or recess formed (in light blue) and the light conducting plate (38, in blue) with Fig. 6 of the '974 patent, which shows an embodiment of the tray (35, in red), cavity, or recess (36, in light blue) and the panel (33, in blue), shown annotated below, reveals the almost identical structures disclosed in the two patents.



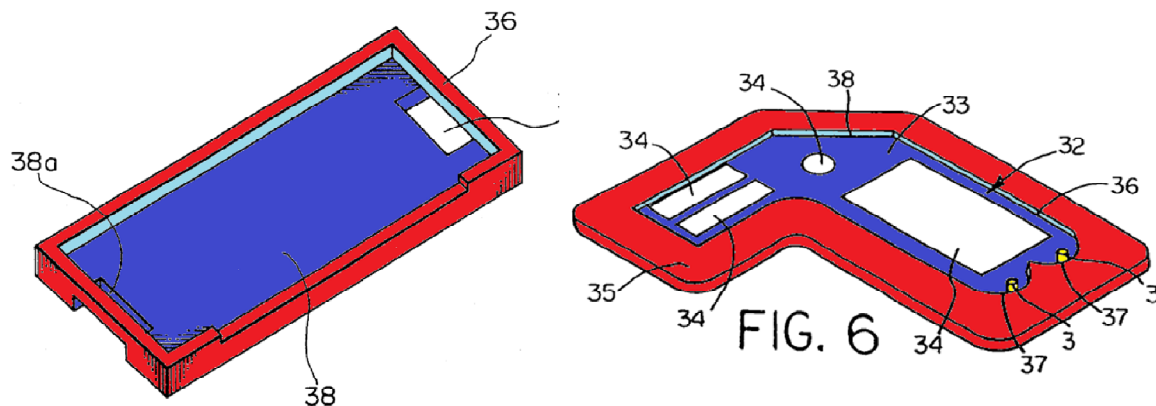


Figure H (annotated Fig. 4 of Ex. 1009, Tsuchiyama and Fig. 6 of Ex. 1001, the '974 Patent)

131. As previously discussed, Funamoto discloses a light emitting assembly directed to be thinner and lighter. Ex. 1007, Funamoto, at 1:15-38, 2:3-23. Tsuchiyama discloses a light emitting assembly aimed at keeping the device thin and small, providing a miniature configuration. *Id.* at 1:41-47, 3:50-51. A person of ordinary skill in the art would have been motivated to combine the teachings of Tsuchiyama with the teachings of Funamoto because they are both directed to a thinner and smaller device. Tsuchiyama in view of Funamoto teaches each and every element of Claims 1, 3-5, 7-8, 10-11, and 13 of the '974 Patent.

**1. Claims 1, 3-5, 7-8, 10-11, And 13 Are Obvious Over Tsuchiyama In View Of Funamoto**

**a. Claim 1**

132. Claim 1 of the '974 Patent recites:

1. A light emitting panel assembly comprising  
at least a light emitting panel member having a light  
entrance surface and a light emitting surface,  
at least one LED light source positioned near or against the  
light entrance surface, and

a tray or housing having a cavity or recess in which the panel member is entirely received,  
wherein the panel member has a pattern of light extracting deformities on or in at least one surface to cause light to be emitted from the light emitting surface of the panel member, and  
the tray or housing includes end walls and side walls that act as end edge reflectors and side edge reflectors for the panel member to reflect light that would otherwise exit the panel member through an end edge and/or side edge back into the panel member and toward the pattern of light extracting deformities for causing additional light to be emitted from the light emitting surface of the panel member,  
wherein the tray or housing provides structural support to the panel member and has posts, tabs, or other structural features that provide a mount for mounting of the assembly into a larger assembly or device.

133. Tsuchiyama discloses “[a] data display radio pager of the present invention comprises an LCD provided with at least one backlight LED for illuminating the LCD, and a backlight structure for accommodating, together with the backlight LED, at least one alert LED for alerting a user of the radio pager to an incoming call in the LCD.” Ex. 1008, Tsuchiyama, at 1:57-62. The structure disclosed by Tsuchiyama, although called a data display radio pager, is more generally considered a light emitting panel assembly. Accordingly, Tsuchiyama teaches “[a] light emitting panel assembly,” as required by Claim 1 of the ’974 Patent.

134. Next, Tsuchiyama discloses “a rectangular saucer-like reflection frame 36 and a **light conducting plate 38** which are formed integrally with each other,” where “[t]he light conducting plate 38 is formed with openings 38a and 38b at opposite ends

thereof” for the placement of backlight LEDs 12a and alert LEDs 12b.” *Id.* at 3:32-40 (emphasis added).

135. The light conducting plate 38 acts as a panel member in Tsuchiyama because it has a light entrance surface and an emitting surface and functions as a light pipe. *See supra*, at ¶43. Accordingly, Tsuchiyama teaches “at least a light emitting panel member having a light entrance surface and a light emitting surface,” as required by Claim 1 of the ’974 Patent.

136. Tsuchiyama teaches that “[t]he **backlight LEDs 12a** and alert LEDs 12b are securely received in the openings 38a and 38b, respectively.” *Id.* at 3:34-38 (emphasis added). Accordingly, Tsuchiyama teaches “at least one LED light source positioned near or against the light entrance surface,” as required by Claim 1 of the ’974 Patent.

137. Next, Tsuchiyama discloses “a rectangular saucer-like **reflection frame 36** and a **light conducting plate 38** which **are formed integrally with each other.**” *Id.* at 3:32-34 (emphasis added). Because, here, the reflective tray or housing 36 is integral with the transparent panel member 38, the panel member must be entirely received into the tray or housing. Accordingly, Tsuchiyama teaches “a tray or housing having a cavity or recess in which the panel member is entirely received,” as required by Claim 1 of the ’974 Patent.

138. Tsuchiyama does not explicitly disclose the panel member having a pattern of light extracting deformities. A person of ordinary skill in the art would have been motivated to combine the assembly of Tsuchiyama with the deformities of Funamoto

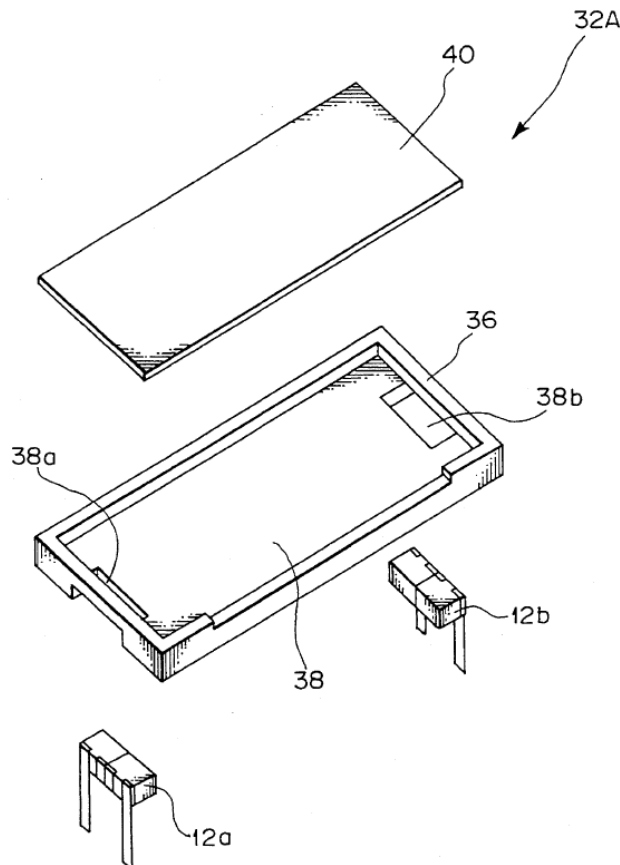
because the deformities are used to control characteristics of the light, including output, uniformity, etc. *See* Ex. 1001, the '974 Patent, at 5:2-7. Because a person of ordinary skill in the art would desire such control over and uniformity of the light in the light assemblies of both Tsuchiyama and Funamoto, one would have been motivated to add the deformities of Funamoto to the assembly of Tsuchiyama. Further, given the objectives of Tsuchiyama, the panel member would necessarily have deformities. If no deformities were present on or in the light conducting plate 38 of Tsuchiyama, then the light input from the side would be nearly completely trapped inside and lost eventually to absorption, nearly no light could emit from the upper surface. As previously described, Funamoto discloses the panel member has a pattern of light extracting deformities on or in at least one surface to cause light to be emitted from the light emitting surface of the panel member. *See supra*, at ¶82.

139. Accordingly, Tsuchiyama in view of Funamoto teaches “the panel member has a pattern of light extracting deformities on or in at least one surface to cause light to be emitted from the light emitting surface of the panel member,” as required by Claim 1 of the '974 Patent.

140. As previously discussed, Tsuchiyama discloses “a rectangular saucer-like **reflection** frame 36 and a **light conducting plate 38** which **are formed integrally with each other.**” Ex. 1008, Tsuchiyama, at 3:32-34 (emphasis added). As illustrated in Fig. 4 below, the reflective frame 36 surrounds the entire light conducting plate 38, except for the openings 38a and 38b into which the LEDs are inserted. This

surrounding reflective frame 36 necessarily includes end and side walls that act as end and side edge reflectors. The light reflected by the end and side edge walls can only be redirected back into the light conducting plate in Tsuchiyama. Furthermore, a person of ordinary skill would understand that combining the reflective tray of Tsuchiyama with the pattern of deformities of Funamoto would cause the light redirected into the panel member to necessarily interact with the pattern of deformities, and would result in additional light to be emitted from the panel member. Accordingly, Tsuchiyama teaches that the “the tray or housing includes end walls and side walls that act as end edge reflectors and side edge reflectors for the panel member to reflect light that would otherwise exit the panel member through an end edge and/or side edge back into the panel member and toward the pattern of light extracting deformities for causing additional light to be emitted from the light emitting surface of the panel member,” as required by Claim 1 of the '974 Patent.

*Fig. 4*



141. Tsuchiyama teaches “a rectangular saucer-like reflection frame 36 and a light conducting plate 38 which are **formed integrally** with each other.” *Id.* at 3:32-34 (emphasis added). Accordingly, Tsuchiyama teaches that “the tray or housing provides structural support to the panel member,” as required by Claim 1 of the ’974 Patent.

142. Tsuchiyama teaches a 1) rectangular saucer-like reflection frame 36 and a light conducting plate 38 which are formed integrally with each other; 2) openings 38a and 38b at opposite ends of the light conducting plate 38; and 3) backlight LEDs 12a and alert LEDs 12b securely received in the openings 38a and 38b. *Id.* at 3:32-40. The

openings 38a and 38b are structural features in the tray that allow the mounting of the backlight assembly into a larger assembly or device, such as the pager device of Tsuchiyama. Accordingly, Tsuchiyama teaches the tray having “posts, tabs, or other structural features that provide a mount for mounting of the assembly into a larger assembly or device,” as required by Claim 1 of the ’974 Patent.

143. As discussed in detail above, every element of Claim 1 of the ’974 Patent is taught by Tsuchiyama in view of Funamoto.

**b. Claim 3**

144. Claim 3 of the ’974 Patent recites:

3. The assembly of claim 1 wherein the tray or housing provides a support for supporting and/or positioning a film near the panel member.

145. Tsuchiyama in view of Funamoto discloses “[t]he assembly of claim 1,” as shown above in ¶¶133-143.

146. Further, Tsuchiyama teaches “[a] **diffusion sheet 40** is positioned on the light conducting plate 38,” and “rectangular saucer-like reflection frame 36 and a light conducting plate 38 which are formed integrally with each other.” Ex. 1008, Tsuchiyama, 3:32-39 (emphasis added). Accordingly, Tsuchiyama in view of Funamoto discloses the assembly of Claim 1 “wherein the tray or housing provides a support for supporting and/or positioning a film near the panel member,” as required by Claim 3 of the ’974 Patent.

**c. Claim 4**

147. Claim 4 of the '974 Patent recites:

4. The assembly of claim 3 wherein the film is at least one of a diffuser and a brightness enhancing film.

148. Tsuchiyama in view of Funamoto discloses “[t]he assembly of claim 3,” as shown above in ¶¶145-146.

149. Further, Tsuchiyama teaches “[a] **diffusion sheet 40** is positioned on the light conducting plate 38,” and “rectangular saucer-like reflection frame 36 and a light conducting plate 38 which are formed integrally with each other.” Ex. 1008, Tsuchiyama, at 3:32-39 (emphasis added). Diffusion sheet 40 is a diffuser. Accordingly, Tsuchiyama in view of Funamoto discloses the assembly of Claim 1 “wherein the film is at least one of a diffuser and a brightness enhancing film,” as required by Claim 4 of the '974 Patent.

**d. Claim 5**

150. Claim 5 of the '974 Patent recites:

5. The assembly of claim 1 further comprising a film positioned near the light emitting surface of the panel member for changing the output ray angle distribution of the emitted light to fit a particular application.

151. Tsuchiyama in view of Funamoto discloses “[t]he assembly of claim 1,” as shown above in ¶¶133-142.

152. Further, Tsuchiyama teaches “[a] **diffusion sheet 40** is positioned on the light conducting plate 38,” and “rectangular saucer-like reflection frame 36 and a light



conducting plate 38 which are formed integrally with each other.” Ex. 1008, Tsuchiyama, at 3:32-39 (emphasis added). A person of ordinary skill in the art understands that a diffusion sheet or diffuser is a film that can change the output ray distribution of emitted light to fit a particular application because the diffuser inherently functions control the light output ray angle distribution by redirecting off-axis light toward the on-axis direction making the light emitting panel assembly appear brighter. Accordingly, Tsuchiyama in view of Funamoto teaches the assembly of Claim 1 “further comprising a film positioned near the light emitting surface of the panel member for changing the output ray angle distribution of the emitted light to fit a particular application,” as required by Claim 5 of the ’974 Patent.

**e. Claim 7**

153. Claim 7 of the ’974 Patent recites:

7. A light emitting panel assembly comprising  
at least a light emitting panel member having a light  
entrance surface and a light emitting surface,  
at least one LED light source positioned near or against the  
light entrance surface, and  
a tray or housing having a cavity or recess in which the  
panel member is entirely received,  
wherein the panel member has a pattern of light extracting  
deformities on or in at least one surface to cause light to be  
emitted from the light emitting surface of the panel  
member, and  
the tray or housing includes end walls and side walls that  
act as end edge reflectors and side edge reflectors for the  
panel member to reflect light that would otherwise exit the  
panel member through an end edge and/or side edge back  
into the panel member and toward the pattern of light  
extracting deformities for causing additional light to be

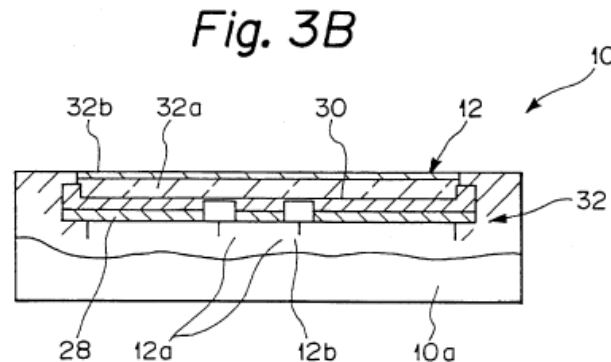
emitted from the light emitting surface of the panel member,  
wherein the tray or housing has posts, tabs or other structural features that provide a mount or structural support for at least one other part or component, and the tray or housing provides structural support to the panel member.

154. As previously discussed in ¶¶133-143, Tsuchiyama in view of Funamoto teaches the elements found within Claim 1 of the '974 Patent: "A light emitting panel assembly comprising at least a light emitting panel member having a light entrance surface and a light emitting surface, at least one LED light source positioned near or against the light entrance surface, and a tray or housing having a cavity or recess in which the panel member is entirely received, wherein the panel member has a pattern of light extracting deformities on or in at least one surface to cause light to be emitted from the light emitting surface of the panel member, and the tray or housing includes end walls and side walls that act as end edge reflectors and side edge reflectors for the panel member to reflect light that would otherwise exit the panel member through an end edge and/or side edge back into the panel member and toward the pattern of light extracting deformities for causing additional light to be emitted from the light emitting surface of the panel member... and the tray or housing provides structural support to the panel member."

155. In addition to the elements above, Tsuchiyama teaches a 1) rectangular saucer-like reflection frame 36 and a light conducting plate 38 which are formed integrally with each other; 2) openings 38a and 38b at opposite ends of the light conducting

plate 38; and 3) backlight LEDs 12a and alert LEDs 12b securely received in the openings 38a and 38b. *Id.* at 3:32-40. The openings 38a and 38b are structural features in the tray that provide structural support for the LEDs that go within the openings. Additionally, the structural features provide a place for the LEDs to fit into the panel member and tray.

156. In another embodiment, Tsuchiyama shows an LCD 12 to fit on top of the assembly, as seen in Fig. 3B of Tsuchiyama.



157. It would be obvious to a person of skill in the art that the LCD would be positioned on top of the embodiment depicted in Fig. 4 of Tsuchiyama as well. It would be necessary for all the elements to be positioned properly within the assembly, including having the LEDs fit properly within the structural elements, in order to have the LCD positioned on top of the entire assembly.

158. Accordingly, Tsuchiyama teaches the tray or housing having “posts, tabs or other structural features that provide a mount or structural support for at least one other part or component,” as required by Claim 7 of the ’974 Patent.

159. As discussed in detail above, every element of Claim 7 of the '974 Patent is taught by Tsuchiyama in view of Funamoto.

**f. Claim 8**

160. Claim 8 of the '974 Patent recites:

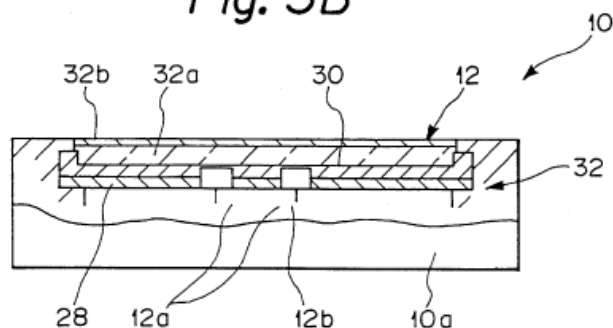
8. The assembly of claim 7 wherein the other part or component is a liquid crystal display.

161. Tsuchiyama in view of Funamoto discloses “[t]he assembly of claim 7,” as shown above in ¶¶154-159.

162. Further, Tsuchiyama teaches a 1) rectangular saucer-like reflection frame 36 and a light conducting plate 38 which are formed integrally with each other; 2) openings 38a and 38b at opposite ends of the light conducting plate 38; and 3) backlight LEDs 12a and alert LEDs 12b securely received in the openings 38a and 38b. *Id.* at 3:32-40. The openings 38a and 38b are structural features that provide structural support for the LEDs that go within the openings and provide a place for the LEDs to fit into the panel member and tray. Furthermore, Tsuchiyama teaches the interaction of the assembly within the context of the LCD (“As shown in FIGS. 3A and 3B, the backlight 32 is received in the casing 10a of the pager 10 and extends along the rear of the LCD 12.... As a result, the light illuminates the LCD 12 from the rear uniformly.”) Ex. 1008, Tsuchiyama, at 2:41-51.

163. In another embodiment, Tsuchiyama shows an LCD 12 to fit on top of the assembly, as seen in Fig. 3B of Tsuchiyama.

*Fig. 3B*



164. It would be obvious to a person of skill in the art that the LCD would be positioned on top of the embodiment depicted in Fig. 4 of Tsuchiyama as well. It would be necessary for all the elements to be positioned properly within the assembly, including having the LEDs fit properly within the structural elements, in order to have the LCD positioned on top of the entire assembly.

165. Accordingly, Tsuchiyama in view of Funamoto teaches the assembly of Claim 7 “wherein the other part or component is a liquid crystal display,” as required by Claim 8 of the ’974 Patent.

**g. Claim 10**

166. Claim 10 of the ’974 Patent recites:

10. The assembly of claim 7 wherein the film is at least one of a diffuser and a brightness enhancing film.

167. Tsuchiyama in view of Funamoto teaches “[t]he assembly of claim 7,” as shown above in ¶¶154-159.

168. Further, Tsuchiyama teaches “[a] **diffusion sheet 40** is positioned on the light conducting plate 38,” and “rectangular saucer-like reflection frame 36 and a light

conducting plate 38 which are formed integrally with each other.” Ex. 1008, Tsuchiyama, at 3:32-39 (emphasis added). Diffusion sheet 40 is a diffuser, and is shown in Fig. 4 as fitting directly into a recess within the reflection frame 36 integral with the light conducting plate 38. Accordingly, Tsuchiyama in view of Funamoto teaches the assembly of Claim 7 “wherein the film is at least one of a diffuser and a brightness enhancing film,” as required by Claim 10 of the ’974 Patent.

#### **h. Claim 11**

169. Claim 11 of the ’974 Patent recites:

11. The assembly of claim 7 further comprising a film positioned near the light emitting surface of the panel member for changing the output ray angle distribution of the emitted light to fit a particular application.

170. Tsuchiyama in view of Funamoto teaches “[t]he assembly of claim 7,” as shown above in ¶¶154-159.

171. Further, Tsuchiyama teaches “[a] **diffusion sheet 40** is positioned on the light conducting plate 38,” and “rectangular saucer-like reflection frame 36 and a light conducting plate 38 which are formed integrally with each other.” Ex. 1008, Tsuchiyama, at 3:32-39 (emphasis added). A person of ordinary skill in the art understands that a diffusion sheet or diffuser is a film that can change the output ray distribution of emitted light to fit a particular application because the diffuser inherently functions control the light output ray angle distribution by redirecting off-axis light toward the on-axis direction making the light emitting panel assembly appear

brighter. Accordingly, Tsuchiyama in view of Funamoto discloses an assembly of Claim 7 comprising “a film positioned near the light emitting surface of the panel member for changing the output ray angle distribution of the emitted light to fit a particular application,” as required by Claim 11 of the '974 Patent.

**i. Claim 13**

172. Claim 13 of the '974 Patent recites:

13. A light emitting panel assembly comprising  
at least a light emitting panel member having a light  
entrance surface and a light emitting surface,  
at least one LED light source positioned near or against the  
light entrance surface, and  
a tray or housing having a cavity or recess in which the  
panel member is entirely received,  
wherein the panel member has a pattern of light extracting  
deformities on or in at least one surface to cause light to be  
emitted from the light emitting surface of the panel  
member, and  
the tray or housing includes end walls and side walls that  
act as end edge reflectors and side edge reflectors for the  
panel member to reflect light that would otherwise exit the  
panel member through an end edge and/or side edge back  
into the panel member and toward the pattern of light  
extracting deformities for causing additional light to be  
emitted from the light emitting surface of the panel  
member, and  
an additional component overlaying the panel member,  
the panel member having at least one of a tab, hole, cavity,  
or protrusion that positions the tray or housing relative to  
the panel member.

173. As previously discussed in ¶¶133-143, Tsuchiyama in view of Funamoto teaches the elements found within Claim 7 of the '974 Patent: “A light emitting panel assembly comprising at least a light emitting panel member having a light entrance

surface and a light emitting surface, at least one LED light source positioned near or against the light entrance surface, and a tray or housing having a cavity or recess in which the panel member is entirely received, wherein the panel member has a pattern of light extracting deformities on or in at least one surface to cause light to be emitted from the light emitting surface of the panel member, and the tray or housing includes end walls and side walls that act as end edge reflectors and side edge reflectors for the panel member to reflect light that would otherwise exit the panel member through an end edge and/or side edge back into the panel member and toward the pattern of light extracting deformities for causing additional light to be emitted from the light emitting surface of the panel member.”

174. In addition to the elements above, Tsuchiyama discloses “[a] diffusion sheet 40 is positioned on the light conducting plate 38.” Ex. 1008, Tsuchiyama, at 3:32-40. As seen in Fig. 4 of Tsuchiyama, the diffusion sheet 40 is overlaying panel member 38. Accordingly, Tsuchiyama in view of Funamoto discloses “an additional component overlaying the panel member,” as required by Claim 13 of the ’974 Patent.

175. Tsuchiyama also discloses a 1) rectangular saucer-like reflection frame 36 and a light conducting plate 38 which are formed integrally with each other; 2) openings 38a and 38b at opposite ends of the light conducting plate 38; and 3) backlight LEDs 12a and alert LEDs 12b securely received in the openings 38a and 38b. *Id.* at 3:32-40. The openings 38a and 38b are structural features in the panel member that allow tray/panel member and LEDs to be positioned properly. Accordingly, Tsuchiyama



teaches “the panel member having at least one of a tab, hole, cavity, or protrusion that positions the tray or housing relative to the panel member,” as required by Claim 13 of the ’974 Patent.

176. As discussed in detail above, every element of Claim 13 of the ’974 Patent is taught by Tsuchiyama in view of Funamoto.

**C. U.S. Patent No. 5,654,779 (“Nakayama”)**

177. Nakayama discloses an LCD device wherein at least a part of the light guiding board can be removed from the lighting unit section or lighting means can be removed from the LCD panel section without removing the frames and without the need of varying the outer dimensions and thickness of the device, utilizing light with higher efficiency and with lighter weight removable portions. Ex. 1009, Nakayama, at 2:12-24.

178. As previously discussed, Funamoto discloses a light emitting assembly directed to be thinner and lighter. Ex. 1007, Funamoto, at 1:15-38, 2:3-23. A person of ordinary skill in the art would have been motivated to combine Funamoto and Nakayama because both patents are directed to achieving higher efficiency for light emitting panel assemblies.

**1. Claims 13 and 17 are Obvious In View Of Funamoto and Nakayama**

179. Claim 13 of the ’974 Patent recites:

13. A light emitting panel assembly comprising  
at least a light emitting panel member having a light

entrance surface and a light emitting surface,  
at least one LED light source positioned near or against the  
light entrance surface, and  
a tray or housing having a cavity or recess in which the  
panel member is entirely received,  
wherein the panel member has a pattern of light extracting  
deformities on or in at least one surface to cause light to be  
emitted from the light emitting surface of the panel  
member, and  
the tray or housing includes end walls and side walls that  
act as end edge reflectors and side edge reflectors for the  
panel member to reflect light that would otherwise exit the  
panel member through an end edge and/or side edge back  
into the panel member and toward the pattern of light  
extracting deformities for causing additional light to be  
emitted from the light emitting surface of the panel  
member, and  
an additional component overlaying the panel member,  
the panel member having at least one of a tab, hole, cavity,  
or protrusion that positions the tray or housing relative to  
the panel member.

180. Funamoto discloses the structure and use of a light emitting panel assembly, as can be seen in the disclosure, specifically, “[i]n liquid crystal display 1, illumination device 20 is installed in lower case 3. Above that, liquid crystal display panel 10 is installed using frame 30 and 31.” Ex. 1007, Funamoto, at 5:61-67. The light emitting panel assembly can also be seen in Fig. 2 of Funamoto. Accordingly, Funamoto describes “[a] light emitting panel assembly,” as required by Claim 13 of the ’974 Patent.

181. The light emitting panel member having a light entrance surface and a light emitting surface of the ’974 Patent typically is a transparent planar slab that confines the light within it using total-internal-reflection. Ex. 1001, the ’974 Patent, at 1:19-22;

*see also supra*, at ¶43. Within the light emitting device, Funamoto discloses an “[i]llumination device 20 is a surface-type illumination device set up with a cylindrically-shaped fluorescent light 22 at the edge of substantially rectangular **polarizer 21.**” Ex. 1007, Funamoto, at 6:24-26 (emphasis added). Funamoto also recites that “[f]luorescent **light 22**, which is used as the light source of illumination device 20, is in an L-shape, and **is positioned adjacent to edges 41c** and 41d of polarizer 21.” *Id.* at 7:39-41 (emphasis added). The edge surface 41c corresponds to the light entrance surface of the ’974 Patent. Further, the illumination device includes a “**polarizer 21**, which is substantially rectangular in shape and is missing the corner of edge 40, [a] fluorescent light 22, which encompasses edge 40 in an L-shape, and reflectors 23a and 23b, which cover fluorescent light 22 in the direction of polarizer 21 and efficiently reflect light from fluorescent light 22 to polarizer 21.” *Id.* at 6:32-40 and Fig. 4 (emphasis added). Specifically, “[p]**olarizer 21** is a transparent material whose index of refraction is greater than that of air,” where “[a]n index of refraction equal to or greater than 1.41 is desirable using such materials as acrylic resin, polycarbonate resin, amorphous polyolefine-type resin, and polystyrene resin.” *Id.* at 6:49-53 (emphasis added).

182. A person of ordinary skill in the art would have understood that the element “polarizer 21” of Funamoto is both a transparent optical conductor which accepts light from the light source at its edge surface and emits it along another surface, as required by light emitting panel member of the ’974 Patent because of the polarizer’s

index of refraction and positioning relative to the light source. Ex. 1007, Funamoto, at 6:49-53.

183. Moreover, a look at Funamoto's child patent, U.S. Patent No. 6,108,060 ("the '060 Patent") (Ex. 1010) is instructive on this matter. The '060 Patent is a divisional patent of a divisional of Funamoto. The intervening patent, U.S. Patent No. 5,949,505, also refers to the element in question as the polarizer 21. However, looking closely at the '060 Patent and its prosecution history (Ex. 1010), I note that the '060 Patent includes the exact same sentence in Funamoto, but with "polarizer" replaced with "light guide plate," ("Illumination device 20 is a surface-type illumination device set up with a cylindrically-shaped fluorescent light 22 at the edge of substantially rectangular **light guide plate 21.**") Ex. 1010, the '060 Patent, at 6:31-33 (emphasis added). Therefore, the "polarizer 21" of Funamoto is the same as the light emitting panel member of the '194 patent. That is, I adopt the definition provided in the primary Funamoto (U.S. Patent No. 5,619,351) and apply it in the analysis, in spite of the term "polarizer", which must be a translation error in view of the later Funamoto (Ex. 1010, the '060 Patent).

184. Accordingly, Funamoto discloses "a light emitting panel member having a light entrance surface and a light emitting surface," as required by Claim 13 of the '974 Patent.

185. Funamoto discloses an "[i]llumination device 20 is a surface-type illumination device set up with a cylindrically-shaped fluorescent light 22 at the edge of

substantially rectangular polarizer 21.” Ex. 1007, Funamoto, at 6:24-26. The fluorescent light 22 of Funamoto serves as a light source. Further, Funamoto recognizes the desired goal lowered power consumption. For example, Funamoto discloses in the “Field of the Invention” section that “[t]his invention relates ... in particular, to a suitable illumination device for use in a notebook computer display that provides high brightness with low power consumption.” *Id.* at 1:6-11. Additionally, when describing one of the embodiments, Funamoto instructs that “because the light conversion efficiency can be raised, power consumption can be reduced.” *Id.* at 12:66-67.

186. From this teaching, a person of ordinary skill in the art would want to find a light source that would decrease the power consumption of the illumination device. It was well-known at the effective filing date of the '974 Patent (June 27, 1995) that LEDs are commonly known as light sources. *See e.g.*, Ex. 1006, Pristash, at 3:15-21. Further, it was commonly known by those of ordinary skill in the art that LEDs decrease the power consumption of an illumination device as compared to other light sources, such as incandescent bulbs or fluorescent lamps. *See, e.g.*, Ex. 1023, Lenko, at 3:28-38. Therefore, the use of an LED as a light source for light emitting panel assemblies is obvious to a person of ordinary skill in the art.

187. Accordingly, Funamoto teaches “at least one LED light source positioned near or against the light entrance surface,” as required by Claim 13 of the '974 Patent.

188. Funamoto discloses an upper case 2 and lower case 3 between which the liquid

crystal display panel 10 and illumination device 20 is sandwiched. Ex. 1007, Funamoto, at 5:47-50. In fact, the illumination device 20 is installed into the lower case 3 and the LCD panel 10 is installed above that using frames 30 and 31. *Id.* at 5:61-67. Frames 30 and 31 are other structural features of Funamoto that serve to “protect illumination device 20 and to position it within the case,” as well as “[maintain] a fixed distance for gap 33 between illumination device 20 and liquid crystal display panel 10.” *Id.* at 6:10-17. As discussed above, the case (red) and frame (pink) can be seen in Figs. 2 and 3 of Funamoto. *See supra*, at Fig. F. The case and frame serve to surround the entire LCD and illumination device, within which the polarizer is contained. Therefore, the panel member is entirely received into the tray or housing of Funamoto.

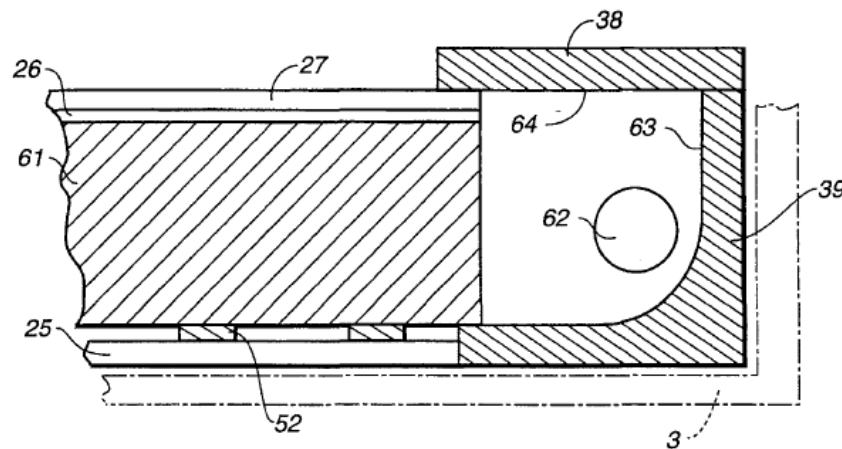
189. In another embodiment, Funamoto discloses the same case structure and function of the previous embodiment. Ex. 1007, Funamoto, at 13:42-44, Fig. 14 (element 3). Funamoto also describes that frames 38 and 39, which are only slightly different from frames 30 and 31, where “[u]pper frame 38 acts as a spacer to secure the gap between liquid crystal display panel 10 and illumination device 60.” *Id.* at 13:53-55. Further, “[w]ithin the U-shaped lower frame 39 of illumination device 60 are enclosed the following in the order from bottom to top, reflecting sheet 25, polarizer 61, diffusion sheet 26, and prism sheet 27.... On top of lower frame 39, which encloses all of these, is the flat, L-shaped upper frame 38.” *Id.* at 13:58-65. As discussed above, the case (yellow) and frame (orange) can be visualized in Figs. 14 and

15 of Funamoto. *See supra*, at Fig. 1. The case and frame serve to surround the entire liquid crystal panel display and illumination device, within which the polarizer is contained. Therefore, the panel member is entirely received into the tray or housing of Funamoto.

190. In both embodiments described in Funamoto, the case and frame, either separately or together meet the limitation of “a tray or housing having a cavity or recess in which the panel member is entirely received,” as required by Claim 13 of the ’974 Patent.

191. Funamoto discloses a pattern of light extracting deformities on the panel member. For example, in the second embodiment Funamoto recites that “the pattern sheet is omitted because the **diffusion sheet 52 is printed on lower surface 61b of polarizer 61.**” Ex. 1007, Funamoto, at 14:10-12 (emphasis added). Funamoto recites further that, “[t]hrough **diffusion pattern 52**, the **light** introduced to polarizer 61 is **diffused and** a uniform light **is released** from upper surface 61a of polarizer 61 **towards the liquid crystal display panel.**” *Id.* at 14:38-41 (emphasis added). The diffusion pattern 52 on the bottom of the polarizer 61 (*i.e.*, the light emitting panel member) is illustrated in part in Fig. 14 below. Each diffuser spot (*e.g.*, labeled 52 in Fig. 14), printed on the surface, is a light extracting deformity according to the ’370 Patent, because it is a coating or surface treatment that causes a portion of the light within polarizer 61 to diffuse in all directions and emit from the panel member. *See also supra*, at ¶45. Furthermore, these diffuser spots are arranged into a grid-like

pattern (*e.g.*, shown as a sheet in Figs. 15 and 17 with the same label 52) on the surface of the polarizer 61 (*i.e.*, the light emitting panel member), and cause light to be emitted uniformly toward the liquid crystal display. *Id.* at 14:38-41.



**FIG. 14**

192. Accordingly, Funamoto teaches “the panel member [having] a pattern of light extracting deformities on or in at least one surface to cause light to be emitted from the light emitting surface of the panel member,” as required by Claim 13 of the ’974 Patent.

193. Funamoto discloses means to reflect light back into the panel member that would otherwise exit at the end walls and side walls, and expressly includes the teaching that these may be integrated into the tray or housing. Referring to the first embodiment illustrated in part in Fig. 2, Funamoto recites “[e]dge reflective tape 28 is arranged at the two edges 41a and 41b, which are opposite the edges 41c and 41d where fluorescent light 22 and reflector 23 are installed. . . . **The light that reaches the edges of the opposite side is returned back to polarizer 21.**” Ex. 1007,



Funamoto, at 7:60-67 (emphasis added). Edge reflector tape 28 is employed by Funamoto in the second embodiment as well. *Id.* at 13:63-64.

194. Funamoto furthermore recites that “[m]aterials such as white PET sheets, aluminum, and such can be used for the **edge reflective tape** as well as the reflectors mentioned above. **It is also possible to integrate these into the case or frame as well.**” *Id.* at 7:67-8:4 (emphasis added).

195. Accordingly, Funamoto discloses a “the tray or housing includ[ing] end walls and side walls that act as end edge reflectors and side edge reflectors for the panel member to reflect light that would otherwise exit the panel member through an end edge and/or side edge back into the panel member and toward the pattern of light extracting deformities for causing additional light to be emitted from the light emitting surface of the panel member,” as required by Claim 13 of the ’974 Patent.

196. Further, Funamoto teaches that above the illumination device 20 installed in the lower case 3, an **LCD panel 10** is installed using frame 30 and 31. Ex. 1007, Funamoto, at 5:64-67. The frames that maintain a fixed distance for gap 33 between the illumination device and the LCD panel. *Id.* at 6:10-17, 13:51-65. As is clear from the figures of Funamoto, the structural features of the frames including “lower halves [sic] 34 and 35,” serve as structural support for illumination device 20, “and their upper halves [sic] 36 and 37,” act as spacers between illumination device 20 and **liquid crystal display panel 10**, allow for proper arrangement of the assembly therein into something larger, for example, lower case 3. *Id.* at 6:10-17. Therefore, the frames

have structural features that provide structural support for at least one other component, for example, the LCD panel. Accordingly, Funamoto teaches “an additional component overlaying the panel member,” as required by Claim 13 of the ’974 Patent.

197. Funamoto also discloses that two corners of the polarizer 61 are removed “in order to install U-shaped fluorescent light 62 with an appropriate gap 42 at the polarizer.” *Id.* at 14:12-15. Specifically, “[t]he corners of edge 40b, which is between edges 41c and 41d, and edge 40a, which is between edges 41a and 41d, are removed so that they do not stick out. In this way, fluorescent light 62 can be installed with fixed gap 42 near edge 41, and the incident efficiency towards polarizer 61 maintained at a high level. Also, damage to fluorescent light 62 due to such things as thermal expansion and shock can be prevented.” *Id.* at 14:16-23. Funamoto also contemplated that the shape of the corner removed are triangles but “it is of course possible to use other shapes as well.” *Id.* at 14:26-27.

198. Funamoto therefore teaches that the panel member can be altered or shaped in such a way as to conform to other parts of the assembly, such as a light source. A person of ordinary skill in the art would understand that if the panel member of Funamoto did not altered to fit with the light source, then the assembly, including the panel member itself, would not fit into the tray, composed of the case and frame, properly. Additionally, because Funamoto contemplates that the alteration can be many possible shapes, then a person of ordinary skill in the art would know to try a

hole or cavity or protrusion, if necessary, in order to have the panel member fit into the tray properly. Accordingly, Funamoto discloses “the panel member having at least one of a tab, hole, cavity, or protrusion that positions the tray or housing relative to the panel member,” as required by Claim 13 of the ’974 Patent.

199. Nakayama supplies this element as well. Nakayama discloses “the **outer light guiding part 4a** is attached to the lamp holders 10a and 10b and, therefore, also functions as a rigid member linking the lamp holders 10a and 10b on opposite sides.” Ex. 1009, Nakayama, at 4:22-25 (emphasis added). “Since the outer light guiding part 4a serves as a rigid member connecting the lamp holders 10a and 10b, the light guiding board is supported with higher strength.” *Id.* at 5:10-12.

200. Further, Nakayama includes “[t]he **inner light guiding part 4b** is held on its lower side (rear side) by holding members 14a and 14b mounted on the frame 1b, as shown in FIG. 1(b).” *Id.* at 4:26-30 (emphasis added). Finally, Nakayama ties the light guiding parts to the panel member itself by disclosing that “[o]f the light rays produced by the lamps 5a and 5b that pass through the **outer light guiding part 4a** and are incident on the **inner light guiding part 4b**, those upwardly reflected by the light scattering processing part 12 and the pattern of the reflector sheet 13 on the lower side of the inner light guiding part 4b are rendered uniform and applied to the liquid crystal display panel 2 by a diffusing plate 27.” *Id.* at 4:63-5:3 (emphasis added). Therefore, the light guiding parts 4a and 4b are actually part of the light guiding board 4, as is evident from the numbering of the elements and the functionality of the light

guiding parts in relation to the light guiding board.

201. The light guiding parts have cavities and protrusions in order to position the tray relative to the panel member, as can be clearly seen in annotated Fig. 1a below, encircled in red. Clearly, the cavities and protrusions in 4a and 4b allow for a precise fitting of the panel member with the tray.

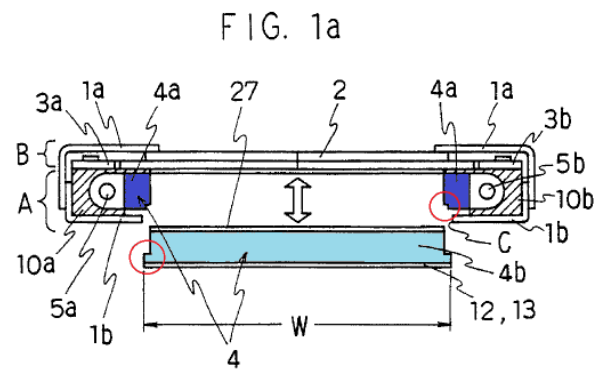
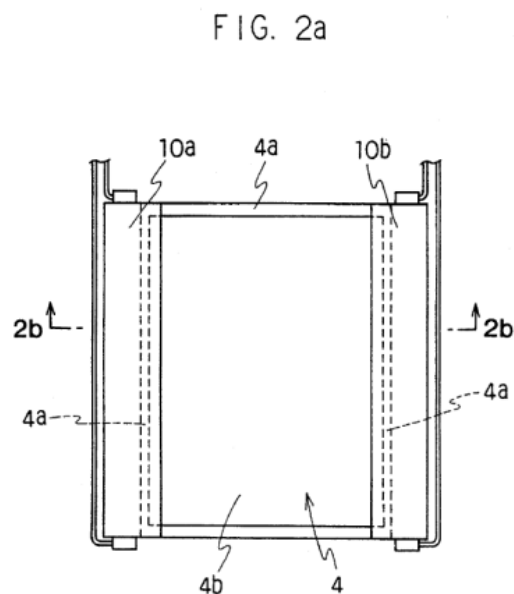


Figure I (annotated Fig. 1a of Ex. 1009, Nakayama)

202. This conclusion is supported by viewing Nakayama's assembly from another angle, as seen in Fig. 2a below.



203. One of ordinary skill in the art would be motivated to combine Funamoto with Nakayama. Nakayama is directed to an LCD device where part of the light guiding board can be removed without varying the outer dimensions and thickness of the device. Ex. 1009, Nakayama, at 2:12-18. In Nakayama, an “object of the present invention [is] to provide a liquid crystal display device that utilizes light with higher efficiency.” *Id.* at 2:19-21; *see also* 3:10-13, 3:19-23. This is similar to the objective in Funamoto. Funamoto is directed to LCD panels that were thinner and lighter with less power consumption. Ex. 1007, Funamoto, at 1:15-38. Funamoto and Nakayama therefore both disclose the objective of increased light efficiency. One of ordinary skill in the art would have been motivated to combine the elements of Funamoto and Nakayama for a light emitting panel assembly because the objectives of the two patents are related.

204. Accordingly, Funamoto in view of Nakayama teaches the panel member having at least one of a tab, hole, cavity, or protrusion that positions the tray or housing relative to the panel member, as required by Claim 13 of the '974 Patent.

205. As discussed in detail above, every element of Claim 13 of the '974 Patent is taught by Funamoto in view of Nakayama.

**a. Claim 17**

206. Claim 17 of the '974 Patent recites:

17. A light emitting panel assembly comprising  
at least a light emitting panel member having a light  
entrance surface and a light emitting surface,

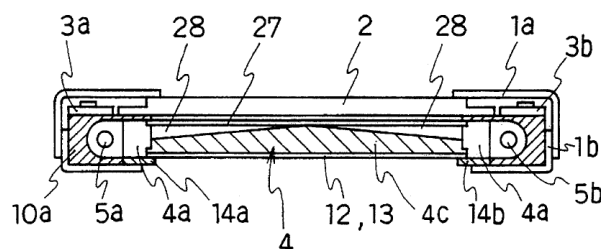
at least one LED light source positioned near or against the light entrance surface, and  
a tray or housing having a cavity or recess in which the panel member is entirely received,  
wherein the panel member has a pattern of light extracting deformities on or in at least one surface to cause light to be emitted from the light emitting surface of the panel member, and  
the tray or housing includes end walls and side walls that act as end edge reflectors and side edge reflectors for the panel member to reflect light that would otherwise exit the panel member through an end edge and/or side edge back into the panel member and toward the pattern of light extracting deformities for causing additional light to be emitted from the light emitting surface of the panel member, and  
an additional component overlying the panel member,  
the panel member having at least one of a tab, hole, cavity or protrusion that positions the additional component relative to the panel member,  
wherein the at least one of a tab, hole, cavity, or protrusion holds the additional component away from the panel member to create an air gap between the panel member and the additional component.

207. As previously discussed in ¶¶178-204, Funamoto in view of Nakayama teaches the elements found within Claim 13 of the '974 Patent: “A light emitting panel assembly comprising at least a light emitting panel member having a light entrance surface and a light emitting surface, at least one LED light source positioned near or against the light entrance surface, and a tray or housing having a cavity or recess in which the panel member is entirely received, wherein the panel member has a pattern of light extracting deformities on or in at least one surface to cause light to be emitted from the light emitting surface of the panel member, and the tray or housing includes

end walls and side walls that act as end edge reflectors and side edge reflectors for the panel member to reflect light that would otherwise exit the panel member through an end edge and/or side edge back into the panel member and toward the pattern of light extracting deformities for causing additional light to be emitted from the light emitting surface of the panel member, and an additional component overlying the panel member.”

208. In addition to the elements above, Nakayama discloses “an **inner light guiding part 4c has a beveled shape** so that the thickness increases from the opposite ends and is fitted into the outer light guiding member toward the center. The way of holding the inner light guiding part 4c within the frame 1b is the same as in Embodiment 1 and so the description is omitted.” Ex. 1009, Nakayama, at 5:19-24 (emphasis added). Additionally, “FIG. 5 is a sectional view showing the structure of one embodiment of a liquid crystal display device according to the second aspect of the present invention. Since the basic structure is similar to Embodiment 1, descriptions of common parts are omitted.” *Id.* at 5:14-18.

FIG. 5



209. As previously discussed, a person of ordinary skill in the art would understand that the light guiding parts, here specifically inner light guiding part 4c, are part of the light guiding board 4, which is clear from the numerical naming of the elements and their function. *See supra*, at ¶200. The inner light guiding part is beveled, a protrusion, and allows for proper placement of the elements above, including light diffusion plate 27, the lamp holders 10a and 10b, and LCD 2. Accordingly, Funamoto in view of Nakayama discloses “the panel member having at least one of a tab, hole, cavity or protrusion that positions the additional component relative to the panel member,” as required by Claim 17 of the ’974 Patent.

210. Nakayama also discloses that “[o]f the light rays emitted from the lamps 5a and 5b, those passing through the inner light guiding part 4c and directed upward by the light scattering processing part 12 or reflector sheet 13 disposed on the lower side of the inner light guiding part 4c and those passing through a **vacancy 28** and reflected upward by the inclined upper surface of the inner light guiding part 4c are added together, diffused by the diffusing plate 27, and applied to the liquid crystal display panel 2 as uniform light.” Ex. 1009, Nakayama, at 5:26-35. Inner light guiding part 4c, a protrusion, is part of the light guiding board 1. As can be seen from Fig. 5 above, the vacancy 28 is an air gap between light guiding plate 4 and light diffusion plate 27. Accordingly, Funamoto in view of Nakayama discloses “the at least one of a tab, hole, cavity, or protrusion holds the additional component away from the panel member to create an air gap between the panel member and the additional component,” as



required by Claim 17 of the '974 Patent.

211. As discussed in detail above, every element of Claim 17 of the '974 Patent is taught by Funamoto in view of Nakayama.


## **VI. SUPPLEMENTATION**

212. This declaration, along with the attached appendices, is based on my present assessment of material and information currently available to me.

213. I hereby declare that all statements made herein of my own knowledge are true and that all statements made herein on information and belief are believed to be true. Further, these statements were made with the knowledge that willful false statements and the like so made are punishable by fine, imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the above-identified patent.

Dated: 3 Dec 2014

Respectfully submitted,

By:   
Michael J. Escuti, Ph.D.

# APPENDIX A

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### Professional Preparation

- 2002 PhD in Electrical Engineering, Brown University  
*Dissertation: "Structured Liquid Crystal/Polymer Composites as Photonic Crystal Switches and LCD Innovations" – Advisor: Dr. Gregory P. Crawford*
- 1999 MSc in Electrical Engineering, Brown University
- 1997 BS (magna cum laude) in Electrical & Computer Engineering, Drexel University

### Professional Experience

- 2010-present Associate Professor, Dept. Electrical & Computer Engineering, NC State Univ
- 2005-present Chief Science Officer, ImagineOptix Corporation
- 2004-2010 Assistant Professor, Dept. Electrical & Computer Engineering, NC State Univ
- 2002-2004 Post-Doc, Dept. Functional Polymers, Eindhoven Univ of Tech (Netherlands)

### Honors and Awards

- 2011 Presidential Early Career Award for Scientists and Engineers (PECASE)
- 2011 Alcoa Foundation Engineering Research Achievement Award, NC State Univ
- 2010 Faculty Early Career Development (CAREER) Award, National Science Foundation
- 2004 Glenn Brown Award for Outstanding PhD Dissertation, International Liquid Crystal Soc
- 2003 First Prize – Art & Liquid Crystals Competition, European Conf. Liquid Crystals
- 2002 OSA/New Focus Student Award, Top Winner, CLEO/QELS Conference
- 2001 Graduate Student Silver Award, Materials Research Soc. Fall Meeting
- 2001 Sigma Xi Outstanding Graduate Student Research Award, Brown University
- 2000 Citation of Excellence in Science Education, RI House of Representatives
- 1999 Best Student Paper Award, Society for Information Display, International Symposium
- 1997 Citation of Excellence in Engineering Design, Drexel University

### Publications and Patents Summary

Inventor on 11 issued US patents and 19 US patent applications, and 40 foreign patents and patent applications. Authored 39 journal articles, 64 refereed conference proceedings, 29 invited research presentations, and 1 book contribution. As of June 2014 per ISI Web of Knowledge™ (across journal papers): Accumulated Citations 756, and h-index 15

### External and Internal Sponsored Research Activities

External Funding: ~ \$ 8M (overall), ~ \$ 6.8M (to NCSU), ~ \$ 6.5M (as PI/co-PI)  
Prime Sponsors (Gov't): Natl Science Foundation, NASA, US Air Force Research Lab, DARPA  
Industry Partners, Sponsors: Raytheon, SAIC, Boulder Nonlinear Sys, ImagineOptix, Teledyne

### Expert Witness Experience

- Closed 2014: Patent dispute, before Dist Court of Delaware (Civil Action No. 12-cv-214-LPS)  
Technology: LCD system technologies  
Supporting: Vizio et al (Defendants) v Graphics Properties Holdings  
Firm: Thomas Whitelaw  
Role: Supported infringement analysis; settlement prior to expert reports

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- Closed 2013: Inter Partes Review, US Patent & Trademark Office (IPR2013-00066 & -00068)  
 Technology: LCD system, active-matrix / TFT substrate  
 Supporting: Semiconductor Energy Lab Co Ltd (Patent Owner) v Chimei Innolux  
 Firm: Steptoe & Johnson  
 Role: Written declarations, deposition; settlement prior to hearing
- Closed 2013: Patent dispute, before District Court of New Jersey (Civil Action No. 12-952)  
 Technology: Optical Data Storage, CD/DVD/Blu-ray-Disc, Holograms  
 Supporting: Samsung et al (Defendants) v Voxpath RS LLC  
 Firm: Greenberg Traurig  
 Role: Conducting lab testing
- Closed 2012: Patent dispute, before US International Trade Commission (ITC No. 337-TA-836)  
 Technology: LCD system technologies  
 Supporting: LG Electronics et al (Respondents) v Graphics Properties Holdings  
 Firm: Greenberg Traurig  
 Role: Expert reports, witness statements, extensive lab testing, deposition; settlement prior to hearing
- Closed 2012: Patent dispute, before US International Trade Commission (ITC No. 337-TA-805)  
 Technology: LCD backlights  
 Supporting: LG Display, LG Electronics et al (Respondents) v Ind Tech Res Instr  
 Firm: Steptoe & Johnson  
 Role: Expert reports, witness statements, deposition, extensive lab testing, testified at hearing
- Closed 2011: Patent dispute, before US International Trade Commission (ITC No. 337-TA-749)  
 Technology: LCD optics, viewing angle compensation  
 Supporting: Thomson (Complainants) v Chimei Innolux, AU Optronics, et al  
 Firm: Kirkland & Ellis  
 Role: Expert reports, witness statements, deposition, tutorial, testified at hearing

**Advisory Board Memberships**

- 2013-present Member, Board of Directors, ImagineOptix Corporation  
 2008-present Member, Laser & Photonics Technology Advisory Board,  
 Central Carolina Community College

**Teaching and Mentoring Experience**

I have previously graduated 5 PhD and 3 MST students as Chair, and currently advise 3 PhD and 0 MST students. I have directed 17 undergraduate researchers, and mentor 2 Post-Docs. Classes Taught: ECE-200 (Intro to Electrical Circuits, Signals, Sys), ECE-303 (Electromagnetic Fields), ECE-492K (Optical Comm), ECE-592S (LCDs & Organic Electronics), E-304 (Intro to Nano-Science & Tech)

**Professional Memberships**

SPIE – International Society for Optical Engineering (2000-present), IEEE – Institute of Electrical and Electronics Engineers (1996-present), ILCS – International Liquid Crystal Society (2002-present), SID – Society for Information Display (1999-2002, 2006-present), OSA – Optical Society of America (2000-present), MRS – Materials Research Society (2001-2005)

**Invited Book Chapter**

1. G.P. Crawford and M.J. Escuti, "Liquid Crystal Display Technology", in *Encyclopedia of Imaging Science and Technology*, ed. J.P. Hornak, (John Wiley & Sons, Inc., 2002).

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**Journal Publications (peer-reviewed)**

- 1) Y. Liu, M. Miskiewicz, M.J. Escuti, J. Genzer, and M.D. Dickey, "Three-dimensional folding of pre-strained polymer sheets via absorption of laser light", *Journal of Applied Physics*, **vol. 115**, no. 20, num. 204911, 2014.
- 2) M.N. Miskiewicz and M.J. Escuti, "Direct-Writing of Complex Liquid Crystal Patterns," *Optics Express*, **vol. 22**, no. 10, pp. 12691-12706, 2014.
- 3) M.W. Kudenov, M.N. Miskiewicz, M.J. Escuti, and J. Coward, "Polarization Spatial Heterodyne Interferometer: Model and Calibration", *Optical Engineering*, **vol. 53**, no. 4, num. 044104, 2014.
- 4) B. Gökce, Y. Li, M.J. Escuti, and K. Gundogdu, "Femtosecond pulse shaping using the geometric phase", *Optics Letters*, **vol. 39**, no. 6, pp. 1521-1524, 2014.
- 5) M.N. Miskiewicz, S. Schmidt, and M.J. Escuti, "A 2D FDTD Algorithm for Whole-Hemisphere Incidence on Periodic Media", *IEEE Transactions on Antennas and Propagation*, **vol. 62**, no. 3, pp. 1348-1353, 2014.
- 6) A. Dudley, Y. Li, T. Mhlanga, M.J. Escuti, and A. Forbes, "Generating and measuring nondiffracting vector Bessel beams", *Optics Letters*, **vol. 38**, no. 17, pp. 3429-3432, 2013.
- 7) R.K. Komanduri, K.F. Lawler, and M.J. Escuti, "Multi-twist retarders: broadband retardation control using self-aligning reactive liquid crystal layers", *Optics Express*, **vol. 21**, no. 1, pp. 404-420, 2013.
- 8) Y. Li, J. Kim, M.J. Escuti, "Orbital angular momentum generation and mode transformation with high efficiency using forked polarization gratings," *Applied Optics*, **vol. 51**, no. 34, pp. 8236-8245, 2012.
- 9) M.W. Kudenov, M.N. Miskiewicz, M.J. Escuti, and E. Dereniak, "Spatial heterodyne interferometry with polarization gratings", *Optics Letters*, **vol. 37**, no. 21, pp. 4413-4415, 2012.
- 10) J. Kim, R.K. Komanduri, K.F. Lawler, D.J. Kekas, and M.J. Escuti, "Efficient and monolithic polarization conversion system based on a polarization grating", *Applied Optics*, **vol. 51**, no. 20, pp. 4852-4857, 2012.
- 11) M. Kudenov, M.J. Escuti, N. Hagen, E. Dereniak, and K. Oka, "Snapshot imaging Mueller matrix polarimeter using polarization gratings," *Optics Letters*, **vol. 37**, no. 8, pp. 1367-1369, 2012.
- 12) J. Kim, C. Oh, S. Serati, and M.J. Escuti, "Wide-angle, nonmechanical beam steering with high throughput utilizing polarization gratings," *Applied Optics* **50**, no. 17, pp. 2636-2639, 2011.
- 13) M. Kudenov, M.J. Escuti, E. Dereniak, and K. Oka, "White light channeled imaging polarimeter using broadband polarization gratings" *Applied Optics* **50**, no. 15, 2283-2293, 2011.
- 14) E. Nicolescu, C. Mao, A. Fardad, and M.J. Escuti, "Polarization-independent variable optical attenuator using liquid crystal polarization gratings," *IEEE Journal of Lightwave Technology*, **vol. 28**, no. 21, pp. 3121-3127, 2010.
- 15) E. Nicolescu and M.J. Escuti, "Polarization-independent tunable optical filters using bilayer polarization gratings," *Applied Optics*, **vol. 49**, no. 20, pp. 3900-3904, 2010.
- 16) C. Packham, M. Escuti, J. Ginn, C. Oh, I. Quijano, and G. Boreman, "Polarization Gratings: A Novel Polarimetric Component for Astronomical Instruments," *Publications of the Astronomical Society of the Pacific*, **vol. 122**, no. 898, pp. 1471-1482, 2010.
- 17) C. Oh, J. Kim, J.F. Muth, S. Serati, and M.J. Escuti, "High-Throughput, Continuous Beam Steering Using Rotating Polarization Gratings", *IEEE Photonics Technology Letters*, **vol. 22**, no. 4, pp. 200-202, 2010.
- 18) R.K. Komanduri and M.J. Escuti, "Highly Efficient Reflective Liquid Crystal Polarization Gratings," *Applied Physics Letters*, **vol. 95**, art. num. 091106, 2009.
- 19) P.F. McManamon, P.J. Bos, M.J. Escuti, J. Heikenfeld, S. Serati, H. Xie, and E.A. Watson, "A Review of Phased Array Steering for Narrowband Electro-Optical Systems," *Proceedings of the IEEE*, **vol. 97**, no. 6, pp. 1078-1096, 2009.

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- 20) C Oh and MJ Escuti, "Achromatic diffraction from polarization gratings with high efficiency," *Optics Letters*, **vol. 33**, pp. 2287-2289, 2008.
- 21) C. Sanchez, F. Verbakel, M.J. Escuti, C.W.M. Bastiaansen, and D.J. Broer, "Printing of Monolithic Polymeric Micro-Structures using Reactive Mesogens," *Advanced Materials*, **vol. 20**, no. 1, pp. 74-78, 2008.
- 22) C. Oh and M.J. Escuti, "Numerical Analysis of Polarization Gratings Using the Finite-Difference Time-Domain Method," *Physical Review A*, **vol. 76**, no. 4, num. 043815, 2007.
- 23) R.K. Komanduri and M.J. Escuti, "Elastic Continuum Analysis of the Liquid Crystal Polarization Grating," *Physical Review E*, **vol. 76**, no. 2, num. 021701, 2007.
- 24) R.K. Komanduri, W.M. Jones, C. Oh, and M.J. Escuti, "Polarization-Independent Modulation for Projection Displays Using Small-Period LC Polarization Gratings," *Journal of the Society for Information Display*, **vol. 15**, no. 8, pp. 589-594, 2007.
- 25) C. Oh and M.J. Escuti, "Time-domain analysis of periodic anisotropic media at oblique incidence: an efficient FDTD implementation," *Optics Express*, **vol. 14**, no. 24, pp. 11870-11884, 2006.
- 26) B.-J. de Gans, C. Sánchez, D. Kozodaev, M.J. Escuti, C. Bastiaansen, D.J. Broer, and U.S. Schubert, "Optimizing photo-embossed gratings: A gradient library approach," *Journal of Combinatorial Chemistry*, **vol. 8**, no. 2, pp. 228-236, 2006.
- 27) C. Sanchez, M.J. Escuti, C. van Heesch, C. Bastiaansen, and D.J. Broer, "TiO<sub>2</sub> nanoparticle-photopolymer composites for volume holographic recording," *Advanced Functional Materials*, **vol. 15**, no. 10, pp. 1623-1629, 2005.
- 28) C. Sanchez, M.J. Escuti, C. van Heesch, C. Bastiaansen, and D.J. Broer, "An efficient illumination system for LCDs incorporating an anisotropic hologram," *Applied Physics Letters*, **vol. 87**, no. 9, art. no. 094101, 2005.
- 29) C. Sánchez, B.-J. de Gans, D. Kozodaev, A. Alexeev, M.J. Escuti, C. van Heesch, T. Bel, U.S. Schubert, C. Bastiaansen, and D.J. Broer, "Photoembossing of periodic relief structures using polymerization induced diffusion: A combinatorial study," *Advanced Materials*, **vol. 17**, no. 21, pp. 2567-2571, 2005.
- 30) M.J. Escuti and G.P. Crawford, "Holographic Photonic Crystals," *Optical Engineering*, **vol. 43**, no. 9, pp. 1973-1987, 2004.
- 31) M.J. Escuti and G.P. Crawford, "Mesoscale three-dimensional lattices formed in polymer dispersed liquid crystals: a diamond-like face centered cubic," *Molecular Crystals and Liquid Crystals*, **vol. 421**, pp. 23-36, 2004.
- 32) M.J. Escuti, J. Qi, and G.P. Crawford, "A tunable face-centered-cubic photonic crystal formed in holographic-polymer dispersed liquid crystals," *Optics Letters*, **vol. 28**, no. 7, pp. 522-524, 2003. Highlighted in the "News" section of the July 2003 issue of *Scientific American*.
- 33) M.J. Escuti, J. Qi, G.P. Crawford, "Two-dimensional tunable photonic crystal formed in a liquid crystal/polymer composite: threshold behavior and morphology," *Applied Physics Letters*, **vol. 83**, no. 7, pp. 1331-1333, 2003. Selected to appear in the *Virtual Journal of Nanoscale Science & Technology*.
- 34) M.J. Escuti and G.P. Crawford, "Polymer Dispersed Liquid Crystals as Tunable Photonic Crystals," *Polymer News*, **vol. 28**, pp. 205-212, 2003.
- 35) M.J. Escuti, D.R. Cairns, and G.P. Crawford, "Optical-strain characteristics of anisotropic polymer films fabricated from a liquid crystal diacrylate," *Journal of Applied Physics*, **vol. 95**, no. 5, pp. 2386-2390, 2004.
- 36) M. Vilfan, B. Zalar, A. K. Fontecchio, M. Vilfan, M.J. Escuti, G.P. Crawford, and S. Zumer, "Deuteron NMR study of molecular ordering in a holographic-polymer-dispersed liquid crystal," *Physical Review E*, **vol. 66**, no. 2, 021710, 2002.
- 37) M.J. Escuti, P. Kossyrev, G.P. Crawford, T. Fiske, J. Colegrove, and L. Silverstein, "Expanded viewing-angle reflection from diffuse holographic-polymer dispersed liquid crystal films," *Applied Physics Letters*, **vol. 77**, no. 26, pp. 4262-4264, 2000.

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- 38) M.J. Escuti, C.C. Bowley, G.P. Crawford, and S. Zumer, "Enhanced dynamic response of the in-plane switching liquid crystal display mode through polymer stabilization," *Applied Physics Letters*, **vol. 75**, no. 21, pp. 3264-3266, 1999.
- 39) M.J. Escuti, C.C. Bowley, G.P. Crawford, and S. Zumer, "A model of the fast-switching polymer-stabilized in-plane-switching configuration," *Journal of the SID*, **vol. 7**, no. 4, pp. 285-288, 1999.

## Conference Proceedings (peer-reviewed)

- 1) K.J. Hornburg, R.K. Komanduri, and M.J. Escuti, "Multiband retardation control using multi-twist retarders," *Proc. SPIE - Polarization: Measurement, Analysis, and Remote Sensing XI*, **vol. 9099**, art. no. 90990Z, 2014.
- 2) F. Snik, J. Craven-Jones, M.J. Escuti, S. Fineschi, D. Harrington, A. De Martino, D. Mawet, J. Riedi, and J.S. Tyo, "An overview of polarimetric sensing techniques and technology with applications to different research fields," *Proc. SPIE - Polarization: Measurement, Analysis, and Remote Sensing XI*, **vol. 9099**, art. no. 90990B, 2014.
- 3) B.D. Maione, D.A. Luo, M.W. Kudenov, M.J. Escuti, and M.N. Miskiewicz, "Birefringent snapshot imaging spatial heterodyne spectrometer," *Proc. SPIE - Polarization: Measurement, Analysis, and Remote Sensing XI*, **vol. 9099**, art. no. 90990M, 2014.
- 4) A. Dudley, Y. Li, T. Mhlanga, M.J. Escuti, and A. Forbes, "Generating and measuring non-diffracting vector Bessel beams," *Proc. SPIE - Complex Light and Optical Forces VIII*, **vol. 8843**, art. no. 89990K, 2014.
- 5) M.W. Kudenov, M.N. Miskiewicz, M.J. Escuti, and J. Coward, "Compact spatial heterodyne interferometer using polarization gratings," *Proc. SPIE - Polarization Science and Remote Sensing VI*, **vol. 8873**, art. no. 88730Q, 2013.
- 6) Y. Li, A. Dudley, T. Mhlanga, M.J. Escuti, and A. Forbes, "Generating and analyzing non-diffracting vector vortex beams," *Proc. SPIE - Laser Beam Shaping XIV*, **vol. 8843**, art. no. 884305, 2013.
- 7) M.W. Kudenov, S. Mallik, M.J. Escuti, N. Hagen, K. Oka, and E.L. Dereniak, "Snapshot imaging Mueller matrix instrument," *Proc. SPIE - Electro-Optical Remote Sensing, Photonic Technologies, and Applications VII; and Military Applications in Hyperspectral Imaging and High Spatial Resolution Sensing*, **vol. 8897**, art. no. 88970S, 2013.
- 8) F. Snik, G. Otten, M. Kenworthy, M.N. Miskiewicz, M.J. Escuti, C. Packham, and J. Codona, "The vector-APP: a broadband apodizing phase plate that yields complementary PSFs," *Proc. SPIE - Modern Technologies in Space- and Ground-based Telescopes and Instrumentation II*, **vol. 8450**, art. no. 84500M, 2012.
- 9) J. Buck, S. Serati, L. Hosting, R. Serati, H. Masterson, M.J. Escuti, J. Kim, and M.N. Miskiewicz, "Polarization gratings for non-mechanical beam steering applications," *Proc. SPIE - Acquisition, Tracking, Pointing, and Laser Systems Technologies XXVI*, **vol. 8395**, art. no. 83950F, 2012.
- 10) M.N. Miskiewicz, J. Kim, Y. Li, R.K. Komanduri, and M.J. Escuti, "Progress on large-area polarization grating fabrication," *Proc. SPIE - Acquisition, Tracking, Pointing, and Laser Systems Technologies XXVI*, **vol. 8395**, art. no. 8395-15, 2012.
- 11) M.N. Miskiewicz, P.T. Bowen, and M.J. Escuti, "Efficient 3D FDTD analysis of arbitrary birefringent and dichroic media with obliquely incident sources," *Proc. SPIE - Physics and Simulation of Optoelectronic Devices XX*, **vol. 8255**, art. no. 82550W, 2012.
- 12) J. Kim, R.K. Komanduri, and M.J. Escuti, "A compact holographic recording setup for tuning pitch using polarizing prisms," *Proc. SPIE - Practical Holography XXVI: Materials and Applications*, **vol. 8281**, art. no. 82810R, 2012.
- 13) Y. Li, J. Kim, and M.J. Escuti, "Broadband orbital angular momentum manipulation using liquid crystal thin films," *Proc. SPIE - Complex Light and Optical Forces VI*, **vol. 8274**, art. no. 827415, 2012.

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- 14) R.K. Komanduri, J. Kim, K.F. Lawler, and M.J. Escuti, "Multi-twist retarders for broadband polarization transformation," *Proc. SPIE - Emerging Liquid Crystal Technologies VII*, **vol. 8279**, art. no. 82790E, 2012.
- 15) M.W. Kudenov, M.J. Escuti, E.L. Dereniak, and K. Oka, "Spectrally broadband channeled imaging polarimeter using polarization gratings," *Proc. SPIE - Polarization Science and Remote Sensing*, **vol. 8160**, art. no. 816031, 2011.
- 16) E. Seo, H.C. Kee, Y. Kim, S. Jeong, H. Choi, S. Lee, J. Kim, R.K. Komanduri, and M.J. Escuti, "Polarization Conversion System Using A Polymer Polarization Grating," *SID Symposium Digest*, **vol. 42**, pp. 540-543, 2011.
- 17) Y. Li, J. Kim, M.J. Escuti, "Experimental realization of high-efficiency switchable optical OAM state generator and transformer," *Proc. SPIE - Laser Beam Shaping XII*, **vol. 8130**, art. no. 813015, 2011.
- 18) (invited) R.K. Komanduri, K.F. Lawler, and M.J. Escuti, "A liquid crystal shutter for unpolarized broadband light," *Proc. SPIE - Acquisition, Tracking, Pointing, and Laser Systems Technologies XXV*, **vol. 8052**, art. no. 805227, 2011.
- 19) J. Kim, M.N. Miskiewicz, S. Serati, and M.J. Escuti, "Demonstration of large-angle nonmechanical laser beam steering based on LC polymer polarization gratings," *Proc. SPIE - Acquisition, Tracking, Pointing, and Laser Systems Technologies XXV*, **vol. 8052**, art. no. 805229, 2011.
- 20) J. Kim and M.J. Escuti, "High-efficiency quasi-ternary design for nonmechanical beam-steering utilizing polarization gratings," *Proc. SPIE - Advanced Wavefront Control: Methods, Devices, and Applications VIII*, **vol. 7816**, art. no. 781614, 2010.
- 21) Y. Li and M.J. Escuti, "Orbital angular momentum controlling using forked polarization gratings," *Proc. SPIE - Laser Beam Shaping XI*, **vol. 7789**, art. no. 778914, 2010.
- 22) J. Kim and M.J. Escuti, "Demonstration of polarization grating imaging spectropolarimeter (PGIS)," *Proc. SPIE - Polarization: Measurement, Analysis, and Remote Sensing IX*, **vol. 7672**, art. no. tbd, 2010.
- 23) C. Oh, J. Kim, J.F. Muth, and M.J. Escuti, "A New Beam Steering Concept: Risley Gratings," *Proc. SPIE - Advanced Wavefront Control: Methods, Devices, and Applications VII*, **vol. 7466**, art. no. 746619, 2009.
- 24) J. Kim and M.J. Escuti, "Demonstration of The Polarization Grating Imaging Spectropolarimeter," *Proc. SPIE - Imaging Spectrometry XIV*, **vol. 7457**, art. no. 745716, 2009.
- 25) R.K. Komanduri, C. Oh, and M.J. Escuti, "Polarization Independent Projection Systems Using Thin Film Polymer Polarization Gratings and Standard Liquid Crystal Microdisplays," *SID Symposium Proceedings*, **vol. 40**, pp. 487-490, 2009.
- 26) C. Oh, R.K. Komanduri, B.L. Conover, and M.J. Escuti, "Polarization-Independent Modulation Using Standard Liquid Crystal Microdisplays and Polymer Polarization Gratings," *International Display Research Conference*, **vol. 28**, pp. 298-301, 2008.
- 27) B.L. Conover, and M.J. Escuti, "Laboratory teaching modules on organic electronics and liquid crystal displays for undergraduate and graduate education," *Proc. MRS - Symposium H: Physics and Technology of Organic Semiconductor Devices*, art. no. H8.3, 2008.
- 28) C. Packham, M.J. Escuti, G. Boreman, I. Quijano, J.C. Ginn, B. Franklin, D.J. Axon, J.H. Hough, T.J. Jones, P.F. Roche, M. Tamura, C.M. Telesco, N. Levenson, J.M. Rodgers, and J.P. McGuire, "Design of a mid-IR polarimeter for SOFIA," *Proc. SPIE - Ground-based and Airborne Instrumentation for Astronomy II*, **vol. 7014**, art. no. 70142H, 2008.
- 29) B.L. Conover and M.J. Escuti, "Anisotropic Particle Motion In Optical Landscapes Modeled Via The T-Matrix Optical Scattering Approach," *Proc. SPIE - Optical Trapping and Optical Micromanipulation V*, **vol. 7038**, art. no. 703819, 2008.
- 30) R.W. Going, B.L. Conover, and M.J. Escuti, "Electrostatic Force And Torque Description Of Generalized Spheroidal Particles In Optical Landscapes," *Proc. SPIE - Optical Trapping and Optical Micromanipulation V*, **vol. 7038**, art. no. 703826, 2008.



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- 31) C. Oh and M.J. Escuti, "Electrically Switchable Achromatic Liquid Crystal Polarization Gratings On Reflective Substrates," *Proc. SPIE - Liquid Crystals XII*, **vol. 7050**, art. no. 705019, 2008.
- 32) J. Kim, C. Oh, M.J. Escuti, L. Hosting, and S. Serati, "Wide-Angle Nonmechanical Beam-Steering Using Thin Liquid Crystal Polarization Gratings," *Proc. SPIE - Advanced Wavefront Control: Methods, Devices, and Applications VI*, **vol. 7093**, art. no. 709302, 2008.
- 33) J. Kim and M.J. Escuti, "Snapshot Imaging Spectropolarimeter Utilizing Polarization Gratings," *Proc. SPIE - Imaging Spectrometry XIII*, **vol. 7086**, art. no. 708603, 2008.
- 34) E. Nicolescu and M.J. Escuti, "Polarization-Independent Tunable Optical Filters Based On Bilayer Polarization Gratings," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 7050**, art. no. 705018, 2008.
- 35) R.K. Komanduri, C. Oh and M.J. Escuti, "Reflective Liquid Crystal Polarization Gratings With High Efficiency And Small Pitch," *Proc. SPIE - Liquid Crystals XII*, **vol. 7050**, art. no. 70500J, 2008.
- 36) R.K. Komanduri, C. Oh, M.J. Escuti, and D.J. Kekas, "Late-News Paper: Polarization-Independent Liquid Crystal Microdisplays," *Society for Information Display Symposium Digest*, **vol. 39**, pp. 236-239, 2008.
- 37) E. Nicolescu and M.J. Escuti, "Portable Spectrophotometer Based on Polarization Independent Tunable Optical Filters," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 6661**, art. no. 666105, 2007.
- 38) E. Nicolescu and M.J. Escuti, "Polarization-Independent, Tunable Optical Filters Based On Liquid Crystal Polarization Gratings," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 6654**, art. no. 665405, 2007.
- 39) R.L. Kellogg and M.J. Escuti, "DAZLE: A New Approach to Adaptive Imaging," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 6714**, art. no. 67140H, 2007.
- 40) C. Oh and M.J. Escuti, "Achromatic Polarization Gratings as Highly Efficient, Thin-Film, Polarizing Beamsplitters for Broadband Light," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 6682**, art. no. 668211, 2007.
- 41) C. Oh and M.J. Escuti, "Achromatic Diffraction Using Reactive Mesogen Polarization Gratings," *Society for Information Display Symposium Digest*, **vol. 38**, pp. 1401-1404, 2007.
- 42) M.J. Escuti and W.M. Jones, "A Polarization-Independent Liquid Crystal Spatial-Light-Modulator," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 6332**, art. no. 63320M, 2006.
- 43) M.C. Ozturk and M.J. Escuti, "A New Introductory Course On Signals, Circuits and Systems," *American Society for Engineering Education Annual Conference*, **vol. 2532**, art. no. 2473, 2006.
- 44) M.J. Escuti, C. Oh, C. Sanchez, C. Bastiaansen, and D.J. Broer, "Simplified Spectropolarimetry Using Reactive Mesogen Polarization Gratings," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 6302**, art. no. 630207, 2006.
- 45) B.L. Conover and M.J. Escuti, "The response of particles with anisotropic shape within an optical landscape and laminar flow," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 6326**, art. no. 632614, 2006.
- 46) C. Oh, R. Komanduri, and M.J. Escuti, "Finite-difference-time-domain analysis of polarization gratings," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 6326**, art. no. 632638, 2006.
- 47) C. van Heesch, C. Sanchez, M.J. Escuti, D.J. Broer, and C. Bastiaansen, "Holographic phase gratings in back and frontlights for liquid crystal displays," *Proceedings of the SPIE - Optics & Photonics Conference*, **vol. 6355**, art. no. 635501, 2006.
- 48) W.M. Jones, C. Oh, R. Komanduri, and M.J. Escuti, "Polarization-Independent Modulation for Projection Displays Using Small-Period LC Polarization Gratings," *International Display Research Conference*, **vol. 26**, art. no. 12.5, 2006.

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**Invited Research Presentations**

- 1) 2014 *Lorentz Center Workshop* at Leiden (Netherlands), "Creating Arbitrary Optical Axis Patterns Via Direct-Write Lithography for Geometric Phase Holograms and Patterned Retarders", at the international workshop on Polarimetric Techniques & Technology
- 2) 2014 *Merck Chemical Ltd* at Chilworth (England), "Geometric Phase Holograms & Multi-Twist Retarders", at the Advanced Technologies R&D Group

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- 3) 2014 *University of Toronto* at Toronto (Canada), "Geometric Phase Holograms and Multi-Twist Retarders," at the Dunlap Institute for Astronomy & Astrophysics
- 4) 2013 *American Chemical Society* at New Orleans (LA), "On patterning liquid crystal monomers into perfect geometric phase holograms," in Liquid Crystals and Polymers Session
- 5) 2012 *OSA Frontiers in Optics* at Rochester (NY), "Geometric Phase Holograms - Fabricating Generalized Polarization Gratings Enabling Arbitrary Wavefront Control with Perfect Efficiency," in Optical Design and Unconventional Polarization Session
- 6) 2012 *Microsoft Research* at Redmond (WA), "Polarization gratings & multi-twist retarders: 'perfect' wavefront manipulation & 'fully' tailorable broadband retardation control"
- 7) 2012 *Eindhoven University of Technology* at Eindhoven (Netherlands), "Polarization Gratings and Other Liquid Crystal Devices", in the Chemical Engineering Department
- 8) 2012 *Leiden University* at Leiden (Netherlands), "Geometric Phase Holograms & Multi-Twist Retarders", in the Astronomy Department
- 9) 2012 *European Patent Office* in Munich (Germany), "Innovation and Success in University/Industry Partnership: the technology and story of commercialization of functional polymer optics"
- 10) 2012 *St. Petersburg State University, Invited Research Seminar*, in St. Petersburg (Russia), "Liquid Crystal Polarization Gratings as 'perfect' diffractive elements via the geometric phase: fundamental insights, novel photonic devices, and commercialization", Physics Department
- 11) 2012 *NCSU, Physics Department Colloquium* in Raleigh (NC), "Polarization gratings and beyond: how liquid crystals + holography = 'perfect' wavefront manipulation"
- 12) 2012 *US Air Force Research Laboratory (AFRL)* at Dayton (OH), "Liquid Crystal Polarization Gratings – review and prospects of their use in visible thru infrared applications".
- 13) 2012 *SPIE Photonics West* at San Diego (CA), "Liquid Crystals in Diffraction Gratings Review," in Liquid Crystals Session
- 14) 2011 *SPIE Defense, Security, & Sensing* at Orlando (FL), "A liquid crystal shutter for unpolarized broadband light," Acquisition, Tracking, Pointing, and Laser Systems Technologies Session
- 15) 2011 *SPIE Defense, Security, & Sensing* at Orlando (FL), "LC polarization gratings: performance review and prospects for visible through longwave infrared applications," Acquisition, Tracking, Pointing, and Laser Systems Technologies Session
- 16) 2010 *University of Arizona Invited Research Seminar* at Tucson (AZ), "Polarization Gratings – Novel Efficient Optical Elements," College of Optical Sciences
- 17) 2010 *SPIE Optics & Photonics* at San Diego (CA), "Liquid Crystal Polarization Gratings With Large Diffraction Angles - Efficiency and Polarization Trends and Compensation," Liquid Crystal Switches, Modulators, Lasers Session
- 18) 2008 *SPIE Optics & Photonics* at San Diego (CA), "Polarization Freedom For Liquid Crystal Devices," Liquid Crystal Switches, Modulators, Lasers Session
- 19) 2007 *SPIE Optics & Photonics* at San Diego (CA), "DAZLE: A New Approach to Adaptive Imaging", Atmospheric and Space Optical Systems Session
- 20) 2006 *BASF Invited Research Seminar* at Ludwigshafen (Germany), "Switchable and Polymer Polarization Gratings for Displays and Other Systems"
- 21) 2006 *International Liquid Crystal Conference* at Keystone (CO), "Polarization-Independent Modulation and Simplified Spectropolarimetry Using LC Polarization Gratings", Novel Devices and Applications Session

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- 22) 2006 OSA/SPIE *Optics in the Southeast Conference* at Charlotte (NC), “Anisotropic Gratings for Polarization-Independent Modulation & Simplified Spectropolarimetry”, Micro- and Nano-Optics Section
- 23) 2006 *Brown University Invited Seminar* at Providence (RI), “Polarization-Independent Modulation and Other Tricks with LC Polarization Gratings”
- 24) 2006 *Kent State University, Liquid Crystal Institute Invited Seminar* at Kent (OH), “Reactive and Switchable LC Polarization Gratings”
- 25) 2005 *North Carolina Photonics Consortium* at Raleigh (NC), “Polarization Gratings in Photonics: the Hidden uncovered by the Asymmetric”
- 26) 2004 *International Liquid Crystal Conference* at Ljubljana (Slovenia), Invited ILCS Award Talk: “Structured LC/Polymer Composites as Tunable Photonic Crystals”
- 27) 2002 *American Chemical Society Annual Meeting* at Boston (MA), “Switchable Photonic Lattices with Polymer Dispersions of Liquid Crystals”
- 28) 2002 *Josef Stefan Institute Invited Seminar, Univ of Ljubljana* (Slovenia), “Holographic-PDLCs and Novel Structures from Reactive Mesogens”
- 29) 2000 *Brownbag Research Seminar, NASA Glenn Research Center* at Cleveland (OH), “Investigations into Bulk and Polymer Dispersed Liquid Crystals in Microgravity”

**US Patents Issued**

- 1) US Patent No. 8,610,853
- 2) US Patent No. 8,537,310
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- 5) US Patent No. 8,475,033
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- 9) US Patent No. 8,064,035
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**US Patent Applications**

- 1) US Patent Application No. 20140078298
- 2) US Patent Application No. 20130335683
- 3) US Patent Application No. 20130130156
- 4) US Patent Application No. 20130077040
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- 14) US Patent Application No. 20090074356
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19) US Patent Application No. 20030214690

**Foreign Patents and Applications**

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# APPENDIX B

## Information Considered

Description
U.S. Patent No. 7,300,194
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