

UNITED STATES PATENT AND TRADEMARK OFFICE

**BEFORE THE PATENT TRIAL AND APPEAL BOARD
CURRENT LIGHTING SOLUTIONS, LLC**

PETITIONER

v.

**JIAXING SUPER LIGHTING ELECTRIC
APPLIANCE CO., LTD.**

PATENT OWNER

PATENT 10,295,125

DECLARATION OF R. JACOB BAKER, PH.D., P.E.

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LIST OF DOCUMENTS CONSIDERED

Exhibit	Shorthand	Description
1001	'125 Patent	U.S. Patent No. 10,295,125
1002	Baker	Declaration of R. Jacob Baker, Ph.D., P.E.
1003	Appendix B	C.V. of R. Jacob Baker, Ph.D., P.E.
1004	'125 Prosecution History	Prosecution History of U.S. Patent No. 10,295,125
1005	Takahashi	U.S. Patent No. 9,271,354
1006	Shimasaki	U.S. Patent No. 8,833,965
1007	Guang	U.S. Patent No. 9,338,853
1008	Takigami	U.S. Patent No. 6,365,841
1009	Robertson	U.S. Patent No. 7,114,830
1010	Van Der Wel	U.S. Patent No. 9,146,017
1011	Wilcox	U.S. Patent No. 9,726,330
1012	Luk	U.S. Patent No. 6,846,094
1013	Demuynck	U.S. Patent No. 9,328,874
1014	Kamada	U.S. Patent No. 7,948,001
1015	Jing	Chinese Patent No. CN203036295U to Jing Certified Translation
1016		Draft Litigation Stipulation
1017	<i>CH Lighting</i> Action Claim Constructions	Claim Construction Order, <i>Jiaxing Super Lighting Electric Appliance Co., Ltd. et al. v. CH Lighting Technology Co., Ltd. et al</i> , Case No. 6:20-cv-00018, Dkt. 57 (W.D. Tex. October 24, 2020)
1018	Bisberg	U.S. Patent No. 8,558,255
1019	Nakamura	U.S. Patent No. 6,331,891
1020	Kawabata	U.S. Patent No. 8,591,057
1021	Kawashima	U.S. Patent App. Pub. No. 2014/0218908
1022	'711 Prosecution History	Prosecution History of U.S. Patent No 9,609,711
1023	Lerman	U.S. Patent No. 8,461,602
1024	Litigation Scheduling Order	Scheduling Order, <i>Jiaxing Super Lighting Electric Appliance Co., Ltd. v. Current Lighting Solutions, LLC</i> , No. 6:22-cv-00534, Dkt. 31 (W.D. Tex. Dec. 12, 2020)

DECLARATION OF R JACOB BAKER

1. My name is R. Jacob Baker. I am over the age of twenty-one (21) years, of sound mind, and capable of making the statements set forth in this Declaration. I am competent to testify about the matters set forth herein. All the facts and statements contained herein are within my personal knowledge and they are, in all things, true and correct.

2. I have been asked by Current Lighting Solutions, LLC to submit this declaration in support of its challenge to the validity of certain claims of U.S. Patent No. 10,295,125 (the “’125 Patent”).

I. PROFESSIONAL BACKGROUND

3. My qualifications generally are set forth in my Curriculum Vitae, which is attached as Appendix B. Appendix B also includes a list of the publications I have authored and a list of the other cases in which I have testified during the last four years.

4. I have been working as an Engineer since 1985 and I have been teaching Electrical and Computer Engineering courses since 1991. I am currently a Professor of Electrical and Computer Engineering at the University of Nevada, Las Vegas (“UNLV”). I am the named inventor on over 150 U.S. patents resulting from my industry work.

5. I received B.S. and M.S. degrees in Electrical Engineering from UNLV in 1986 and 1988, respectively. I received my Ph.D. in Electrical Engineering from the University of Nevada, Reno, in 1993.

6. My doctoral research, culminating in the award of a Ph.D., investigated the use of power MOSFETs in the design of very high peak power, and high-speed, instrumentation. I developed techniques to reliably stack power MOSFETs to switch higher voltages, that is, greater than 1,000 V and 100 Amps of current with nanosecond switching times. This work was reported in the paper entitled “Transformerless Capacitive Coupling of Gate Signals for Series Operation of Power MOSFET Devices,” published in the IEEE Transactions on Power Electronics. The paper received the Best Paper Award in 2000.

A. Industry Experience

7. I have done technical and expert witness consulting for over 200 companies and their subsidiaries since I started working as an engineer in 1985. From 1985 to 1993, I worked for EG&G Energy Measurements and the Lawrence Livermore National Laboratory designing nuclear diagnostic instrumentation for underground nuclear weapon tests at the Nevada test site. During this time, I designed, and oversaw the fabrication of, over 30 electronic and electro-optic instruments, including high-speed cable and fiber-optic receiver/transmitters, PLLs,

frame and bit-syncs, data converters, streak-camera sweep circuits, Pockel's cell drivers, micro-channel plate gating circuits, charging circuits for battery backup of equipment for recording test data, and analog oscilloscope electronics.

8. My work during this time, as one example, had a direct impact on my doctoral research work using power MOSFETs, subsequent publishing efforts, and industry designs. In addition to the 2000 Best Paper Award from the IEEE Power Electronics Society, I published several other papers in related areas while working in industry. I hold a patent, Patent No. 5,874,830, in the area of power supply design, titled, "Adaptively biased voltage regulator and operating method," which was issued on February 23, 1999. I have designed dozens of linear and switching power supplies for commercial products and scientific instrumentation.

9. I am a licensed Professional Engineer and have extensive industry experience in circuit design, fabrication, and manufacture of Dynamic Random Access Memory (DRAM) semiconductor integrated circuit chips, Phase-Change Random Access Memory (PCRAM) chips, and CMOS Image Sensors (CISs) at Micron Technology, Inc. ("MTI") in Boise, Idaho. I spent considerable time working on the development of flash memory chips while at MTI. My efforts resulted in more than a dozen patents relating to flash memory. One of my projects at MTI included the development, design, and testing of circuit design techniques for a multi-level

cell (MLC) flash memory using signal processing. This effort resulted in higher-density memories for use in solid-state drives and flash memory cards having an ATA interface that are ubiquitous in consumer electronics, including cameras and data storage systems. Further, the use of higher-density memory can result in fewer changes in the flash translation layer for logical-to-physical addressing, less need for garbage collection, and larger data segments that can improve a computing system's performance. Another project I worked on at MTI focused on the design of buffers for high-speed double-data rate DRAM, which resulted in around 10 U.S. patents in buffer design. Among many other experiences, I led the development of the delay locked loop (DLL) in the late 1990s so that MTI DRAM products could transition to the DDR memory protocol, used in mobile and non-mobile (server, desktop, cell phones, tablets, etc.) computing systems as main computer memory, for addressing and controlling accesses to memory via interprocess communications (IPC) with the memory controller (MC). I provided technical assistance with MTI's acquisition of Photobit during 2001 and 2002, including transitioning the manufacture of CIS products into MTI's process technology. Further, I did consulting work at Sun Microsystems and then Oracle on the design of memory modules during 2009 and 2010. This work entailed the design of low-power, high-speed, and wide

interconnection methods with the goal of transmitting data to/from the memory module and the MC at higher speeds.

10. I have extensive experience in the development of instrumentation and commercial products in a multitude of areas including: integrated electrical/biological circuits and systems, array (memory, imagers, and displays) circuit design, CMOS analog and digital circuit design, diagnostic electrical and electro-optic instrumentation for scientific research, CAD tool development and online tutorials, low-power interconnect and packaging techniques, design of communication/interface circuits (to meet commercial standards such as USB, firewire, DDR, PCIe, SPI, etc.), circuit design for the use and storage of renewable energy, and power electronics. For example, a part of my research at Boise State, for many years, focused on the use of Thru-Silicon-Vias (TSVs), aka Thru-Wafer Vias (TWVs), for high-density packaging. These packaging techniques were utilized in the memory module development work I did with Sun Microsystems and Oracle. As another example, I designed circuitry for use in implementing Universal Serial Bus (USB) interface circuits while I did consulting at Tower Semiconductor. I designed PCI communication circuits for IPC between a Graphics Processor Unit (GPU) and memory while consulting for Rendition, Inc.

11. My current research work is focused in part on the design of integrated circuits for wireless sensing using LIDAR (Light Detection And Ranging). I have worked with several companies in the development of these circuits and systems including Freedom Photonics, Aerius Photonics, and FLIR. In the early 1990s, I worked on wireless systems for wideband impulse radar while at Lawrence Livermore Laboratory. Further, part of my research for several years focused on the digitization of IQ channels using delta-sigma modulation. The knowledge and experience gained from this effort are reflected in my textbook CMOS Mixed-Signal Circuit Design and a presentation, which I have presented at several universities and companies, http://cmosedu.com/jbaker/papers/talks/BP_DSM_talk.pdf.

B. Academic Experience

12. I was an adjunct faculty member in the Electrical Engineering departments of UNLV and UNR from 1991-1993. From 1993 to 2000, I served on the faculty at the University of Idaho as an Assistant Professor and then as a tenured Associate Professor of Electrical Engineering. In 2000, I joined a new Electrical and Computer Engineering program at Boise State University (“BSU”), where I served as department chair from 2004 to 2007. At BSU, I helped establish graduate programs in Electrical and Computer Engineering including, in 2006, the university’s second Ph.D. degree. In 2012, I re-joined the faculty at UNLV. Over the

course of my career as a professor, I have advised more than 100 masters and doctoral students.

13. I have been recognized for my contributions as an educator in the field. While at Boise State University, I received the President's Research and Scholarship Award (2005), Honored Faculty Member recognition (2003), and Outstanding Department of Electrical Engineering Faculty recognition (2001). In 2007, I received the Frederick Emmons Terman Award (the "Father of Silicon Valley"). The Terman Award is bestowed annually upon an outstanding young electrical/computer engineering educator in recognition of the educator's contributions to the profession. In 2011, I received the IEEE Circuits and Systems Education Award. I received the Tau Beta Pi Outstanding Electrical and Computer Engineering Professor Award every year it was awarded while I have been back at UNLV.

14. I have authored several books and papers in the electrical and computer engineering area. My published books include CMOS Circuit Design, Layout, and Simulation (Baker, R.J., Wiley-IEEE, ISBN: 9781119481515 (4th ed., 2019)) and CMOS Mixed-Signal Circuit Design (Baker, R.J., Wiley-IEEE, ISBN: 9780470290262 (2nd ed., 2009) and ISBN: 9780471227540 (1st ed., 2002)). I co-authored DRAM Circuit Design: Fundamental and High-Speed Topics (Keeth, B., Baker, R.J., Johnson, B., and Lin, F., Wiley-IEEE, ISBN: 9780470184752 (2008)),

DRAM Circuit Design: A Tutorial (Keeth, B. and Baker, R.J., Wiley-IEEE, ISBN: 0-7803-6014-1 (2001)), and CMOS Circuit Design, Layout and Simulation (Baker, R.J., Li, H.W., and Boyce, D.E., Wiley - IEEE, ISBN: 9780780334168 (1998)). I contributed as an editor and co-author on several other electrical and computer engineering books.

C. Other Relevant Experience

15. I have performed technical and expert witness consulting for more than 200 companies and their subsidiaries and given more than 50 invited talks at conferences, companies, and universities. Further, I am the author or co-author of more than 100 papers and presentations in the areas of electrical and computer engineering design, fabrication, and packaging.

16. I currently serve, or have served, as a volunteer on the IEEE Press Editorial Board (1999-2004); as editor for the Wiley-IEEE Press Book Series on Microelectronic Systems (2010-2018); as the Technical Program Chair of the 2015 IEEE 58th International Midwest Symposium on Circuits and Systems (MWSCAS 2015); on the IEEE Solid-State Circuits Society (SSCS) Administrative Committee (2011-2016); as a Distinguished Lecturer for the SSCS (2012-2015); the Technology Editor (2012-2014) and Editor-in-Chief (2015-2020) for IEEE Solid-State Circuits Magazine; and IEEE Kirchhoff Award Committee (2020-2023). These meetings,

groups, and publications are intended to allow researchers to share and coordinate research. My active participation in these meetings, groups, and publications allowed me to see what other researchers in the field have been doing.

17. In addition to the above, I am an IEEE Fellow for contributions to semiconductor memory design and a member of the honor societies Eta Kappa Nu and Tau Beta Pi.

II. COMPENSATION

18. My work on this matter is being billed at my standard hourly rate of \$655. I am also being reimbursed for reasonable expenses I incur in relation to my services. My compensation is not dependent on my testimony or the outcome of any proceeding.

III. LEGAL CONSIDERATIONS

19. I am not an attorney. My understanding of the law is based on information provided by counsel for Current.

A. Obviousness

20. I understand that a claimed invention is obvious and, therefore, not patentable if the subject matter claimed would have been obvious to a person of ordinary skill in the art at the time that the patent was filed (a “POSITA”), which I have been asked to treat as September 28, 2014. I understand that there must be

some articulated reasoning with some rational underpinning to support a conclusion of obviousness. I further understand that rationales that may support a conclusion of obviousness include:

- a) simply arranging old elements in a way in which each element performs the same function it was known to perform, and the arrangement yields expected results;
- b) merely substituting one known element for another known element in the field, and the substitution yields no more than a predictable result;
- c) combining elements in a way that was “obvious to try” because of a design need or market pressure, where there was a finite number of identified, predictable solutions;
- d) whether design incentives or other market forces in a field prompted variations in a work that were predictable to a POSITA;
- e) that some teaching, suggestion, or motivation would have led a POSITA to modify the prior art or to combine prior art references to arrive at the claimed invention, among other rationales.

B. Claim Interpretation

21. I understand that a claim term is given the meaning that the term would have to a POSITA at the time the patent is filed, which generally is the ordinary and customary meaning of the term. I further understand that the ordinary and customary

meaning of a term may be evidenced by a variety of sources, including the words of the claims themselves, the specification, the prosecution history, and extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art.

22. I understand that a patent holder is entitled to provide alternate definitions of words in common usage, but if the patent holder uses a term that is in common usage without providing an alternate definition, then that term should generally be understood as having its common meaning.

C. POSITA

23. I have been asked to provide my opinions regarding the knowledge and understanding of a POSITA at the time that the '125 Patent was filed.

24. I understand that the factors considered in determining the ordinary level of skill in the art include: (a) the type of problems encountered in the art; (b) prior art solutions to those problems; (c) the rapidity with which innovations are made; (d) the sophistication of the technology; and (e) the education level of active workers in the field.

25. I understand that a POSITA is not a specific real individual, but rather a hypothetical individual having qualities based on the factors above. This hypothetical person has knowledge of all prior art in the relevant field. I also

understand that a POSITA is a person of ordinary creativity, not an automaton. Therefore, a POSITA has and applies common sense to modify or combine references in the prior art, and can also find any teaching, suggestion, or motivation, whether to modify or combine, whether explicit or implicit.

26. As of September 28, 2014, it is my opinion that a POSITA as to the '125 Patent would have had a Bachelor's degree in electrical engineering, or an equivalent field, as well as at least 1-2 years of academic or industry experience in lighting design, including knowledge of LEDs and related technology for driving LEDs. A person of ordinary skill in the art with a higher level of education may have fewer years of academic or industry experience, or vice versa. A POSITA would have been familiar with the field of technology described in §V below. The prior art and the '125 Patent also evidence this level of ordinary skill. Here, the background described in §V and the prior art described herein demonstrate that a POSITA would have been familiar with various aspects of LED lighting device design.

27. With over 35 years of experience in the semiconductor circuit design field, I am well acquainted with the level of ordinary skill required to design semiconductor circuit products, including LED lighting and power supply circuitry. I have direct experience in this field, and I am capable of rendering an informed opinion on the level of ordinary skill in the art as of September 28, 2014.

IV. BASIS FOR OPINIONS

28. My opinions are based on my education, training, and experience as well as items that I reviewed to prepare my opinions, including the '125 Patent and at least the portions cited herein of the publications listed in the table at the beginning of this declaration. All of my opinions are from the perspective of a POSITA as of September 28, 2014.

V. FIELD OF TECHNOLOGY

A. LED Tube Lamps

29. LED tube lamps are LED lighting devices which can be used in place of fluorescent tube lamps. LED light sources have been known for decades. *See generally*, E. Fred Schubert, *Light-Emitting Diodes*, Second Edition (Cambridge University Press, 2006). Consumer interest in LED lamps increased in the mid-2010s due to improved energy efficiency and longer life span. Accordingly, persons of ordinary skill in the art would have understood the need to continue improving the cost-effectiveness, lifespan, reliability, and energy efficiency of LED tube lamps.

30. LED light sources can be disposed inside tubes made to fit into existing fluorescent light sockets or fixtures. *See, e.g.*, U.S. Patent No. 9,338,853 to Guang (EX1007), filed September 17, 2014, at 4:16-19 (“Arrays of LEDs can be fitted in tubes that are physically compatible replacement [sic] for fluorescent tubes, using the same sockets for their electrodes to fit into.”). Typically, such LED tube lamps

include end caps on each end of the lamp tube with electrode pins for connecting the LED tube lamp to a lighting fixture and to an external electrical power source. *See id.* at 7:39-46.

31. LED lamp tubes can be formed with a diffusion treatment applied to the tube, and persons of skill in the art would have understood that there are several methods of diffusing light from LED tube lamps. For example, U.S. Patent No. 9,271,354 to Takahashi (EX1006), filed August 13, 2014, and discussed in greater detail below, discloses several methods of providing diffusion to a lamp tube, including “applying silica, calcium carbonate, or the like to the inner surface of the case 320 [lamp tube],” and providing “a light diffusion sheet or light diffusion film”, using a “lens structure”, or “printing a dot pattern to at least one of at least one of the inner surface and the outer surface of the case 320.” Takahashi at 7:18-45. A POSITA would have understood that, while these methods have their differences, they all serve a similar purpose in diffusing light from LED tube lamps. The general advantage of diffusion is that it creates a uniform or smooth light output from LED tube lamps. *See, e.g.* U.S. Patent No 9,146,017 to Van Der Wel (EX1010), filed April 14, 2011 and published October 27, 2011, at 2:7-14 (teaching smooth light output as an advantage of diffusion). A POSITA would also have understood that

diffusion can lessen discomfort from viewing the LED tube lamp because the light is less directed, or focused.

32. While diffusion treatment in general is advantageous for these reasons, a POSITA would have understood that diffusion films and sheets have particular advantages over other diffusion treatments, including ease of processing and manufacturing to get a precise thickness for the diffusion film, to diffuse light precisely to a given level. *See, e.g.,* Van Der Wel, 2:14-19, 6:60-7:11. A POSITA would have understood that it would be desirable for LED tube lamps to be manufactured so that each LED tube lamp in a manufacturing run would diffuse light to the same degree, increasing manufacturing consistency. Another advantage of diffusion films is that they can be rolled into a tube and inserted into a lamp tube. Van Der Wel, 2:50-55; 6:36-39. A POSITA would have recognized that this rolled structure increases the safety of a lamp tube by providing additional insulation from electrical components (*see* Van Der Wel, 5:55-67, 7:16-22) and can be easier to manufacture (*See* Van Der Wel, 2:65-67) . Diffusion films can also be manufactured and assembled inexpensively. *See* Van Der Wel, 1:32-34).

33. LED lighting technology presents numerous advantages over fluorescent and incandescent lighting. For example, LED lighting technology has “lower energy consumption, longer life, improved robustness, [and] smaller size”

than fluorescent and incandescent lights. Guang at 4:13-62. These advantages of LED lighting can also make LED lighting technology a more cost-effective lighting solution than fluorescent and incandescent lights. *See id.* LED tube lamps also generally do not need toxic chemicals like lead or mercury to operate, unlike many fluorescent lamps. *Id.* at 4:8-10; *see also* Demuynck, 6:60-65 (teaching numerous LED lamp advantages, including lack of toxic chemicals).

B. LED Light Strips

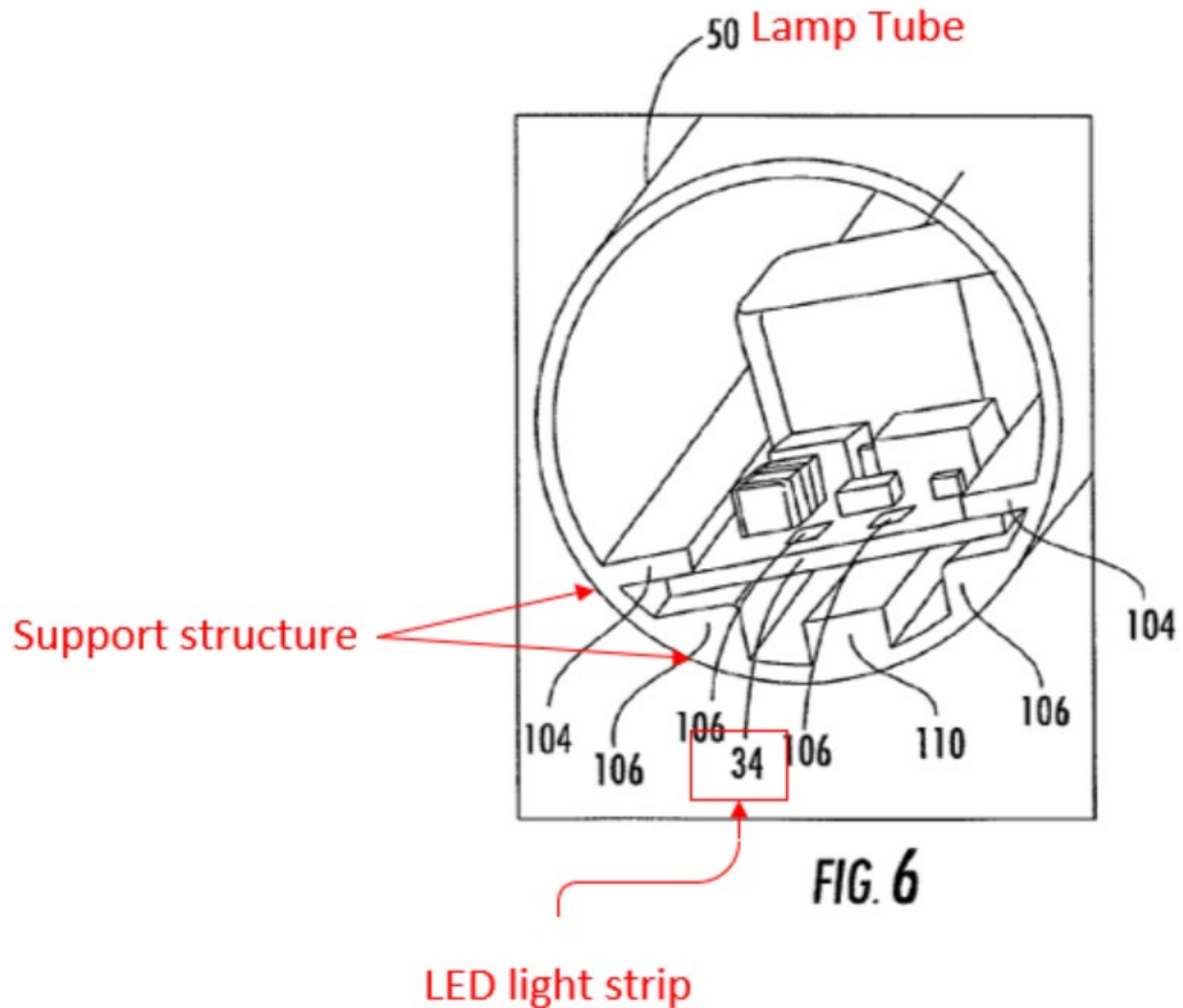
34. LED light sources for use in tube lamps are typically mounted on LED light strips in arrays. These light strips can be made of any material suitable for mounting electrical components, including traditional printed circuit board materials—rigid boards or chips made of resin or another dielectric material, with a metal foil or other thin conductor patterned into wiring paths disposed on the surface of the board. *See, e.g.*, U.S. Patent No. 8,833,965 to Shimasaki (EX1006), filed September 11, 2012, at 4:40-44 (disclosing various substrate materials and the use of foil on a substrate to form wiring layers). LED light strips can be formed on a single long substrate running the length of the tube, or on smaller substrates connected together. *See id.* at 3:11-16.

35. In addition to traditional circuit boards, a common configuration for LED light strips is for the LED light sources to be mounted onto a flexible circuit

board or strip because this enables the LED light strip to be used in lighting applications with various different shapes. For example, U.S. Patent No. 6,846,094 to Luk (EX1012), issued January 25, 2005, teaches the use of a flexible LED light strip arranged in a helical structure and arranged within a flexible tube: “light-emitting diodes in different colors can be mounted onto a flexible circuit board that is twisted into a helix and inserted into a flexible tubular housing.” Luk at 1:63-66. This patent further discloses that during manufacturing, LEDs would be mounted onto the flexible circuit board arranged in a flat mode before forming the flexible light strip into a helix. *Id.* at 6:44-54. Such flexible LED light strips can be “made of a flexible electrically non-conductive and high-temperature resistant plastic material such as, for example, polyimide.” *Id.*; *see also* U.S. Patent No. 9,328,874 to Demuynck (EX1013), filed June 30, 2014, at 7:58-61 (“The LED board 34 may comprise a flex circuit comprising a flexible layer of a dielectric material such as a polyimide, polyester or other material to which a layer of copper or other electrically conductive material is applied such as by adhesive.”). From these teachings, a POSITA would have understood that flexible circuit boards for LED lighting applications were well-known in the art and provided a versatile substrate for mounting LED light sources.

36. A POSITA would have understood that LED light strips for LED tube lamps can be arranged in numerous ways within the lamp tube of the LED tube lamp. For example, LED light strips can be disposed directly on an inner circumferential surface of the lamp tube. U.S. Patent No. 9,726,330 to Wilcox (EX1011), filed March 25, 2014, teaches that a “substrate 20 [LED light strip] such as the flex circuit 20a or PCB FR4 board may be mounted directly to the tube 2 [lamp tube].” Wilcox at 10:46-48. Wilcox also teaches that “the substrate 20 [LED light strip] may be mounted directly to the tube 2 using an adhesive.” *Id.* at 10:48-49. A POSITA would have understood that using an adhesive is a cost-effective way to secure the LED light strip to a surface of the light tube. Another example, taught by Demuynck, is that “the LED board 34 [LED light strip] may be supported on a separate support member where the support member may be made of a rigid, thermally conductive material such as aluminum that physically supports the LED board.” Demuynck at 8:9-14. The benefit of this structure is that heat from the LED light strip could be thermally conducted away from the LED light strip and that it would be supported within the tube. In another embodiment, Demuynck teaches that “the enclosure 50 [lamp tube] may be provided with a support structure 102 where the support structure supports the LED board 34 [LED light strip] in the enclosure 50.” Demuynck further teaches that “support structure 102 comprises supports 104 and 106 that are fixed to

the interior surface 50a of the enclosure 50 such that the LED board 34 may be retained by the supports 104,106 in a desired position in the enclosure 50.” Demuynck, 10:44-50; *see also* FIG. 6 (annotated below).



Other methods were also known, including Luk's helical structure discussed above in paragraph 35. Luk at 1:63-66; *see also* Van Der Wel at 6:5-39 (teaching an LED strip attached to a transparent carrier foil, rolled into a tube, and inserted into the

lamp tube). From these teachings, a POSITA would have understood that there are many ways of disposing an LED light strip within and on the inner surface of a lamp tube, each with the benefit of supporting and securing the LED light strip in place. Selection of one method over another would have been merely a simple substitution of one known technique for attaching an LED light strip to a lamp tube with another known technique for attaching an LED light strip to a lamp tube. A POSITA would further recognize the results of such a substitution would yield the predictable result of an LED tube lamp having LED light sources mounted on an interior of the lamp tube.

37. A POSITA would have been familiar with manufacturing methods for LED light strips. For example, U.S. Patent No. 8,558,255 to Bisberg (EX1018), filed May 2, 2013, and issued October 15, 2013, teaches methods of aligning and mounting LED chips to PCBs, including a “self-aligning solder reflow” process and the use of “fiducial marks” by which a human or machine vision system might align and mount LED chips to a PCB. Bisberg at 7:10-55. Bisberg teaches that a solder reflow process “is particularly effective for smaller LED chips (e.g., LED chips with length and/or width less than 250 microns),” but that alternatively, solder for mounting LED chips could be “plated, or formed by deposition and etching, onto traces.” *Id.* at 7:56-8:5. The motivation to use smaller LED chips, according to

Bisberg, is that they can produce light more efficiently than larger LED chips, and produce less light per chip, which lessens discomfort from viewing the LED chips directly. *See id.* at 12:50-65. The use of small LED chips means that more chips are needed to produce the same amount of light as larger chips, which can increase manufacturing costs, but automated processes in LED manufacturing can compensate for the increased cost. *See id.* at 1:21-45 (teaching cost concerns from larger chips); 13:14-16 (teaching automated pick and place equipment to mount LED chips). A POSITA would also have recognized that other manufacturing techniques are available. *See, e.g.*, U.S. Patent No. 6,331,891 to Nakamura (EX1019), issued December 18, 2001 (teaching a device for positioning and soldering semiconductor devices to a substrate).

C. LED Power Supplies

38. LED tube lamps, and indeed most LED lighting applications that receive external electrical power from standard AC power outlets, typically have a power supply circuit that provides power to the LED light sources. *See, e.g.*, Guang at 5:4-15 (“Most LED fixtures drawing from AC wall receptacle power must have a driver circuitry that includes a power converter with at least a current-limiting resistor.”) Power supply circuits, also known as driver circuits, are typically needed to regulate and maintain a constant current and voltage for the LEDs because LEDs,

like other diodes, experience exponential changes in current with changes in voltage, which can potentially damage or destroy LEDs. *Id.*

39. A POSITA would have understood that several components are typically found in such power supplies, either individually or in combination. For example, Kawabata (U.S. Patent No. 8,591,057, filed November 19, 2009 and issued November 26, 2013) (EX1020) teaches “a circuit converting alternating current supplied from a commercial power supply into direct current and supplying the current to the LEDs as a constant current. The circuit includes a plurality of power supply parts.” Kawabata at 1:29-36. Kawabata teaches that these power supply parts “include an AC/DC converter [or rectifier] for converting alternating current into direct current.” *Id.* at 4:42-44; *see also* 11:51-61 (including a capacitor and a resistor). Other examples of power supply components were also known in the art. *See, e.g.*, Takahashi at 6:55-65 (teaching an LED drive circuit 360 including “a constant power output circuit”); Guang at 6:26-7:6 (teaching a driver circuit including a rectifier circuit, a filter circuit with a resistor and inductor in parallel, and a step-down constant current circuit);

40. In summary then, power supplies for LED lighting were known to a POSITA before the '125 Patent to have AC/DC converters, (*e.g.*, rectifiers using

bridge circuits), constant-current circuits, and filtering elements like capacitors or inductors.

41. A POSITA would also have recognized that power supply circuits for LED tube lamps could be disposed in numerous locations according to the design needs of a given LED tube lamp, including in housings, luminaires, or fixtures outside of the lamp tube (*see, e.g.*, Shimasaki at 3:39-61; U.S. Patent App. Pub. No. 2014/0218908 to Kawashima (EX1021), published August 7, 2014, at ¶[0049]), inside the lamp tube (*see, e.g.*, Kawabata at 11:51-61 and FIGs. 7-9), or inside one or both of the end caps (*see, e.g.*, Guang at 7:7-9; Takahashi at 8:12-19). Disposing a power supply circuit in any of these locations would have been a simple substitution of known elements from one known location to another, because in each instance the power supply would need to be electrically connected to the external electrical power and the LED light strip internally. The predictable result of this substitution would be LED tube lamps driven by power supplies

D. Reflective Solder Resists

42. The use of solder resist layers in LED lighting applications is a well-known technique for increasing the light output efficiency of LED lighting devices. For example, U.S. Patent No. 7,948,001 to Kamada (EX1014), issued May 24, 2011, teaches that “a resist layer 26 made of a white colored resin is also laminated on the

surface of the insulating substrate 22a, opposite to the heat transfer plate 21 side, to cover part of the patterned conductors 23, 23 and to cover a portion of the insulating substrate 22a where the patterned conductors 23, 23 are not formed (*see* FIG. 3). Therefore, light incident on the surface of the resist layer 26 from the side of the LED chip 10 is reflected therefrom so that absorption of the light from the LED chip 10 through the wiring board 22 surface opposite to the heat transfer plate 21 side can be prevented, which can increase the light output efficiency and thus can increase the optical output.” Kamada at 7:9-35. From these teachings, a POSITA would have understood that incorporating a resist layer on the surface of an LED lighting device provides several benefits, such as improved light output efficiency and preventing light absorption through the substrate on which the LED light sources (i.e., LED chips) are disposed. A POSITA would also have understood that a resist layer is a protective layer in that it covers patterned conductors or wiring layers and offers a degree of protection against damage and corrosion to the conductors or wiring layers.

43. A POSITA would also have understood that such a resist layer could be applied before mounting LED elements onto the wiring layers of the board, leaving openings to expose mounting regions for the LED elements to be mounted onto. *See* Kamada at 7:36-42 (describing apertures in the resist layer through which

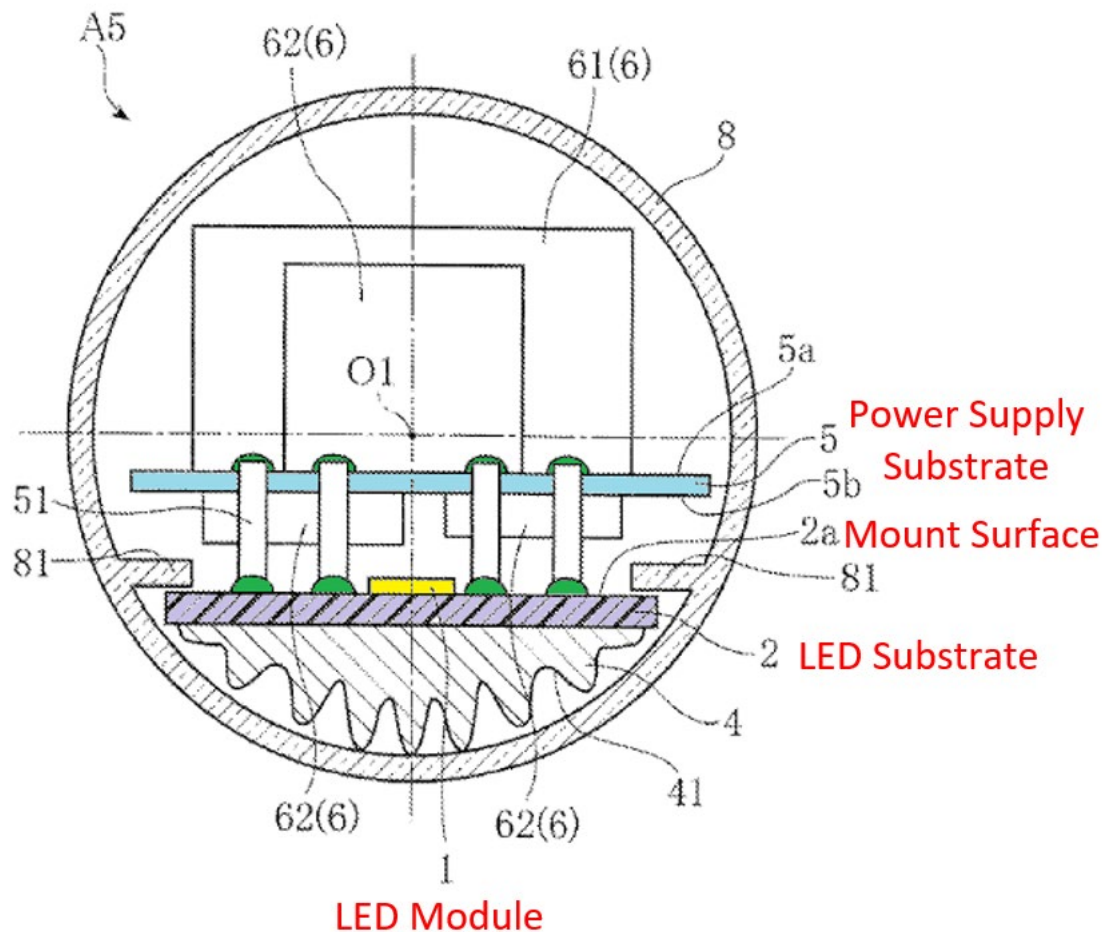
LED chips are mounted). In many general electronics applications, resist layers are applied to base substrates and printed circuit boards (PCBs) before electric components, such as surface mount devices (SMDs), are mounted. *See, e.g.*, U.S. Patent No. 6,365,841 to Takigami (EX1008), filed on July 17, 1998. issued April 2, 2002 (discussed in greater detail in Section VII.E below). In such applications, openings are left in the resist layer to expose lands onto which SMDs can be soldered or otherwise mounted and electrically connected to the PCB, and the resist prevents solder beads from forming in undesired locations or creating undesired solder bridges (electrical shorts) between component leads. A POSITA would have understood that this feature of solder resists would be desirable in LED lighting applications to enable cleaner mounting of LED chips.

E. Use of Solder Pads to Connect LED Arrays to Power Supplies

44. Connecting LED arrays or light strips to a power supply using electrical connections established using solder pads would have been well-known to a POSITA. For example, FIG. 9 of Kawabata (U.S. Patent No. 8,591,057, issued November 26, 2013), reproduced below with annotations, shows LED light sources (1) arranged on a mounting surface 2a of an LED substrate (i.e., an LED light strip) and connected to a power supply disposed on power supply substrate (5) via leads

51 soldered to solder pads (shown in green) on the mounting surface (2a) and the power supply substrate (5). See Kawabata at FIGs. 7-9, 11:6-61

FIG.9



45. A POSITA would also have understood that soldering pads are one of multiple methods for forming electrical connections between the an LED light strip and a power supply, including pin connectors, through-holes, and couplings. For example, U.S. Patent No. 8,461,602 to Lerman, filed January 31, 2011 and issued June 11, 2013 (EX1023), teaches a that for a string of LED chips (LED light strip),

there are “many ways to electrically connect to the various conductors on the substrates.” Lerman at 23:15-16. Lerman teaches “an end of a sheet or strip . . . where the ends of conductor 314 . . . are exposed,” and further teaches that “[t]he ends of the exposed portions of the conductors 314 . . . are thickly plated with copper, gold, silver, or other suitable material to provide *connection pads 317 for solder bonding or for any other form of connector* (e.g., a resilient clip connector) to electrically connect the anode and cathode of the end LED chip 56 to another string or to a power supply.” Lerman at 23:17-31 (emphasis added), FIG. 30A.

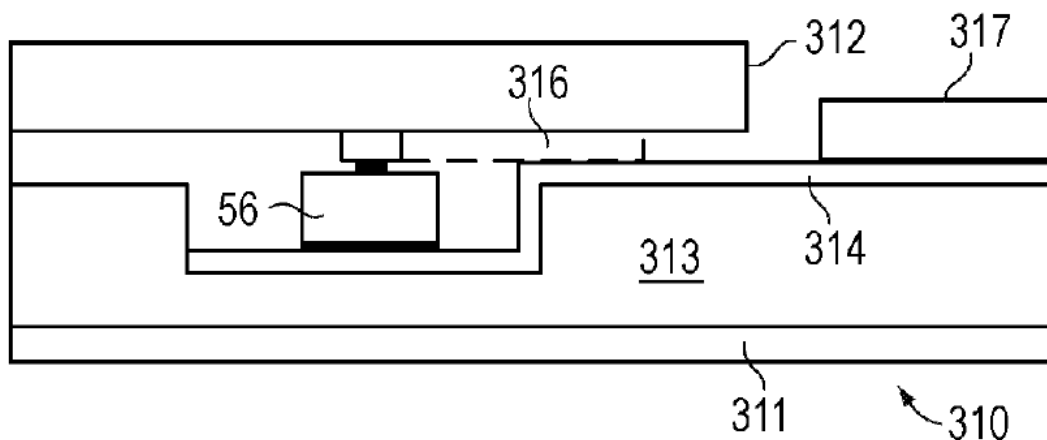


FIG. 30A

VI. THE '125 PATENT

A. Overview of the '125 Patent

46. The '125 Patent is entitled “LED Tube Lamp” and directed to an LED tube lamp, i.e., LED bulb. '125 Patent at Abstract. The LED tube lamp includes “a

lamp tube, two end caps attached at two ends of the lamp tube respectively, a power supply disposed in one of the two end caps or separately in both of the end caps, an LED light strip disposed inside the lamp tube and a protective layer disposed on the LED light strip.” *Id.* The LED light strip comprises a mounting region and a connecting region, where the mounting region “is for mounting a plurality of LED light sources” to the LED light strip and the connecting region is a region of the LED light strip “hav[ing] at least two soldering pads.” *Id.*; *see also id.* at 3:32-34. The mounting region and the connecting region are electrically connected to the plurality of LED light sources with the power supply. *Id.* at Abstract. An exploded view of the LED tube lamp described is shown in FIG. 2 of the ’125 Patent, reproduced below. In other words, the ’125 patent discloses and claims aspects of an LED tube lamp that can be used to replace a fluorescent tube lamp. *See id.* at 2:25-38.

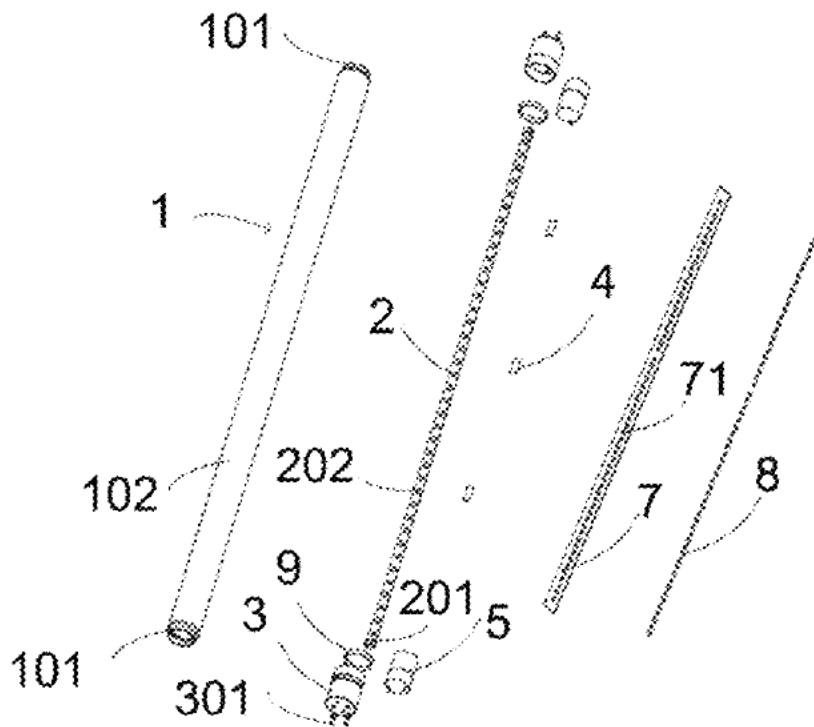


Fig. 2

'125 Patent at FIG. 2.

1. LED Tube Lamp Replacements

47. The '125 Patent teaches that replacement of incandescent and fluorescent lighting with LED tube lamps has become increasingly common due to the benefits offered by LED tube lamps relative to incandescent and fluorescent lighting. EX1001 at 2:25-26. For example, "LED tube lamps are mercury-free in comparison with fluorescent tube lamps that need to be filled with inert gas and mercury." *Id.* at 2:26-27. LED tube lamps also have improved durability and

longevity compared to traditional incandescent and fluorescent lightings. *Id.* at 2:34-35. And LED tube lamps typically consume less energy to output the same brightness. *Id.* at 2:34-36. These factors mean that LED tube lamps are typically considered a cost effective lighting option. *Id.* at 2:36-38.

48. The '125 Patent admits that LED tube lights were well known and being used to replace traditional incandescent and fluorescent lighting. '125 Patent, 2:25-44. Specifically, the '125 Patent admits that “[t]ypical LED tube lights have a lamp tube, light sources in the lamp tube, two caps connected to two ends of the lamp tube, and one power supply or two at the ends of the lamp tube.” *Id.* at 2:39-42. The '125 Patent’s purported invention is to include a protective layer formed from an ink that functions to resist soldering and increase reflectivity. See '125 Patent at 26:60-67, 29:45-48.

2. *Issues with LED Tube Lamps*

49. According to the '125 Patent, a drawback to LED tube lamps is that “the wires may be easily damaged and even broken due to any movement during manufacturing, transportation, and usage of the LED tube lamp and therefore may disable the LED tube lamp.” '125 Patent, 2:45-49.

3. Summary of Alleged Invention of the '125 Patent

50. The '125 Patent purports to solve the wire-damage problem described above by “provid[ing] an LED lamp tube” that includes “a lamp tube, two end caps each of which coupled to a respective end of the lamp tube, a power supply disposed in one or two of the end caps, an LED light strip disposed on an inner circumferential surface of the lamp tube, and *a protective layer disposed on the LED light strip.*” *Id.* at 3:25-31 (emphasis added). According to the '125 Patent the protective layer is “made of an ink with the function of resisting soldering and increasing reflectivity.” *Id.* at 29:45-48. “The protective layer have [sic] a plurality of first openings to accommodate the plurality of LED light sources and at least two second openings to accommodate the at least two soldering pads.” *Id.* at 3:36-40.

B. Interpretation of Certain Terms Used in the '125 Patent

1. “electrically connected/coupled”

51. Petitioner does not believe this term needs explicit construction, but notes that the specification expressly indicates that the term is broad enough to cover both direct connections and indirect connections (via intervening components).
EX1001,

2. “disposed on an inner circumferential surface of the lamp tube”

52. Petitioner does not believe this term needs explicit construction, but notes that the specification expressly indicates that the term “on” is broad enough to cover both direct contact or through “intervening elements.” EX1001, 12:5-17.

3. Prior Constructions

53. The following terms of the '125 Patent were previously construed in prior litigation not involving Current, the *CH Lighting* Action¹:

Term/Claim	Construction
“a power supply disposed in one or more end caps” (claims 1, 29)	Plain and ordinary meaning
“the power supply comprises a circuit board disposed inside one of the end caps” (claim 14)	Plain and ordinary meaning
“recognizing mark” (claim 29)	Plain and ordinary meaning wherein the plain and ordinary meaning is a “reference point”

CH Lighting Action Claim Constructions (EX1017), 2-3/7. The Grounds herein establish the invalidity of the challenged claims under these constructions.

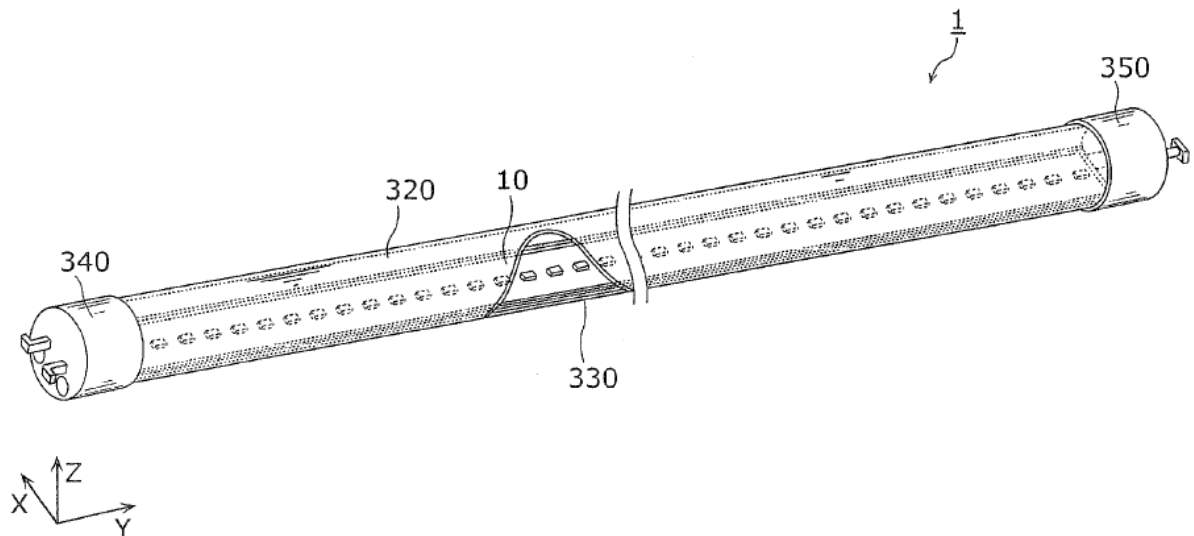
¹ *Jiaxing Super Lighting Electric Appliance Co., Ltd. et al. v. CH Lighting Technology Co., Ltd. et al*, Case No. 6:20-cv-00018 (W.D. Tex.).

VII. ANALYSIS OF PRIOR ART TO THE '125 PATENT

A. Takahashi

54. Takahashi is titled “Lighting Source and Lighting Apparatus.” (EX1005). Takahashi notes that “[i]n recent years, . . . semiconductor light-emitting elements such as LEDs [have] gained in popularity as a substitute for an incandescent light bulb.” Takahashi, 1:20-24. Takahashi describes a “straight tube LED lamp” that “substitutes for a conventional straight tube fluorescent lamp.” Takahashi, 6:28-31.

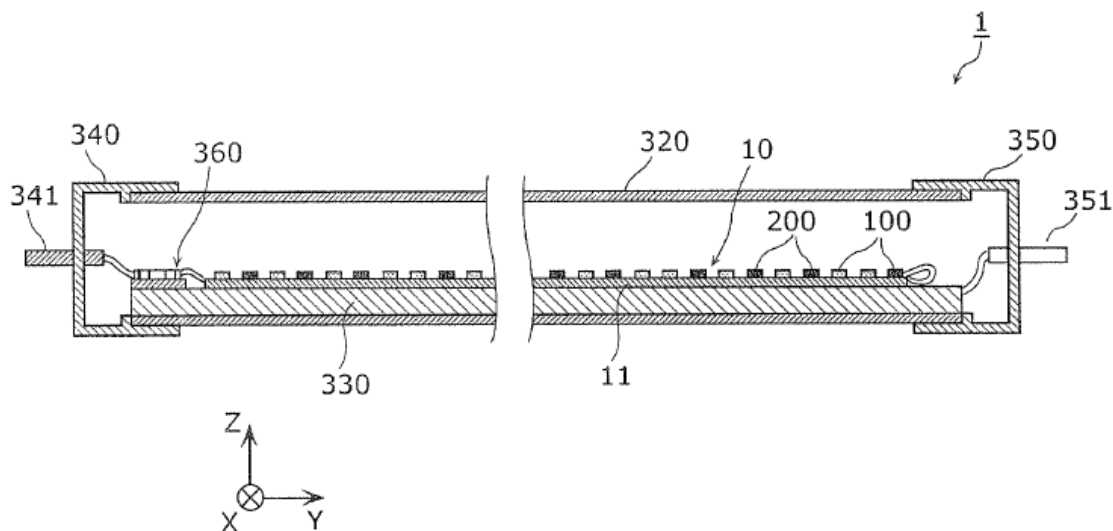
FIG. 1



Takahashi, FIG. 1.

55. Takahashi discloses the structural elements of claim 1 of the '125 Patent. As shown in FIG. 1 above, Takahashi discloses that “the straight tube LED lamp 1 is a lighting source including: an LED module 10; “an elongated case 320” (a lamp tube), “feeding base 340” and “non-feeding base 350” (end caps coupled to the ends of the lamp tube), and “an LED module 10” (LED light strip) housed in the lamp tube, and supported by a “base platform 330.” Takahashi, 6:40-48; 7:44-63; FIG. 1. Takahashi also discloses “a feeding pin 341 and a non-feeding pin 351” for connecting the LED tube lamp to an external socket and electrical power. Takahashi. 6:50-54. The pins 341 and 351 are illustrated in FIG. 2 below.

FIG. 2



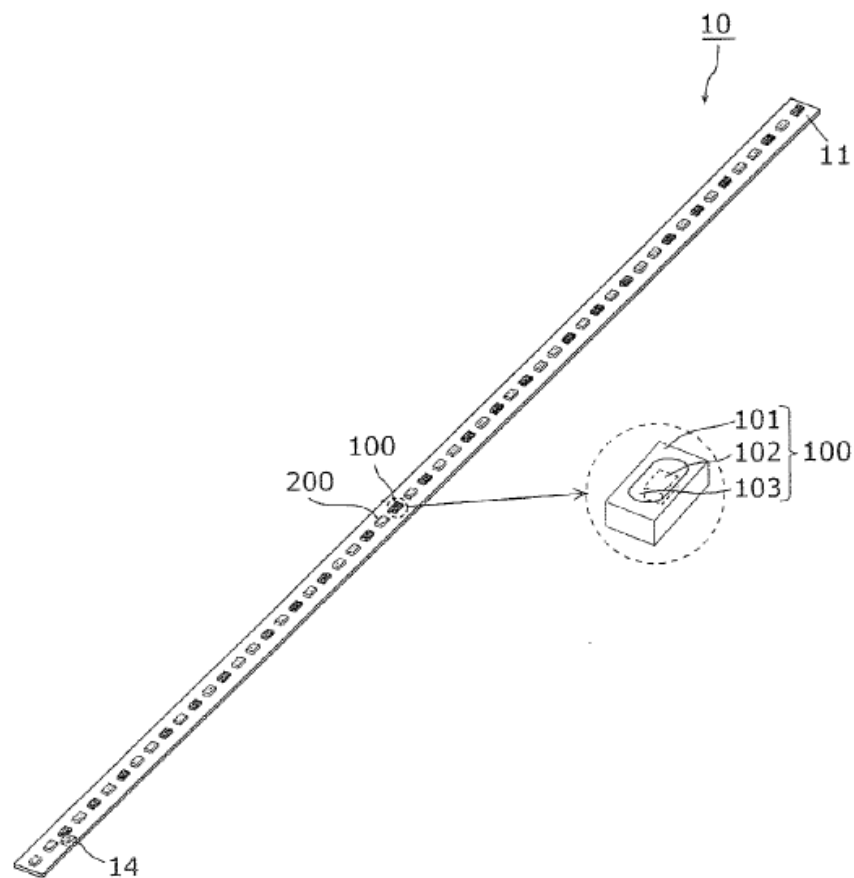
Takahashi, FIG. 2.

56. Takahashi discloses a lamp tube with diffusion elements: “The case 320 is an elongated translucent cover covering the LED module 10 and having translucency.” Takahashi, 7:7-8. “The case 320 can be made of a transparent resin material or glass.” Takahashi, 7:11-12. Takahashi notes that “the case 320 may include a light diffusion unit having a light diffusion function to diffuse light from the LED module 10.” Takahashi, 7:23-25. “Examples of the light diffusion unit include a light diffusion sheet or a light diffusion film provided to at least one of the inner surface and the outer surface of the case 320.” Takahashi, 7:27-29.

57. Takahashi discloses that “the base platform 330 holds (supports) the LED module 10 and the drive circuit 360” and “is firmly fixed to the inner surface of the case 320.” Takahashi, 7:47-51. Takahashi contemplates fixing (or attaching) its LED module 10 onto base platform 330 “with an adhesive.” Takahashi at 7:65-8:4. Takahashi discloses that “the LED module 10 is elongated in a tube axis direction of the case 320, and LED elements 100 and LED elements 200 that are surface mount devices (SMDs) are mounted on a board 11.” Takahashi, 8:5-8. As illustrated in FIG. 2, Takahashi also discloses a “drive circuit 360 [which] may be disposed inside the feeding base 340 via a lead wire connected to a connection terminal on the board 11” Takahashi, 8:17-19. “The board 11 is an LED mounting

board which has at least a surface including an insulating material and on which LED elements are mounted. Takahashi, 9:9-11. The board 11 and its wiring layers are illustrated in FIGs. 3 and 4, reproduced below.

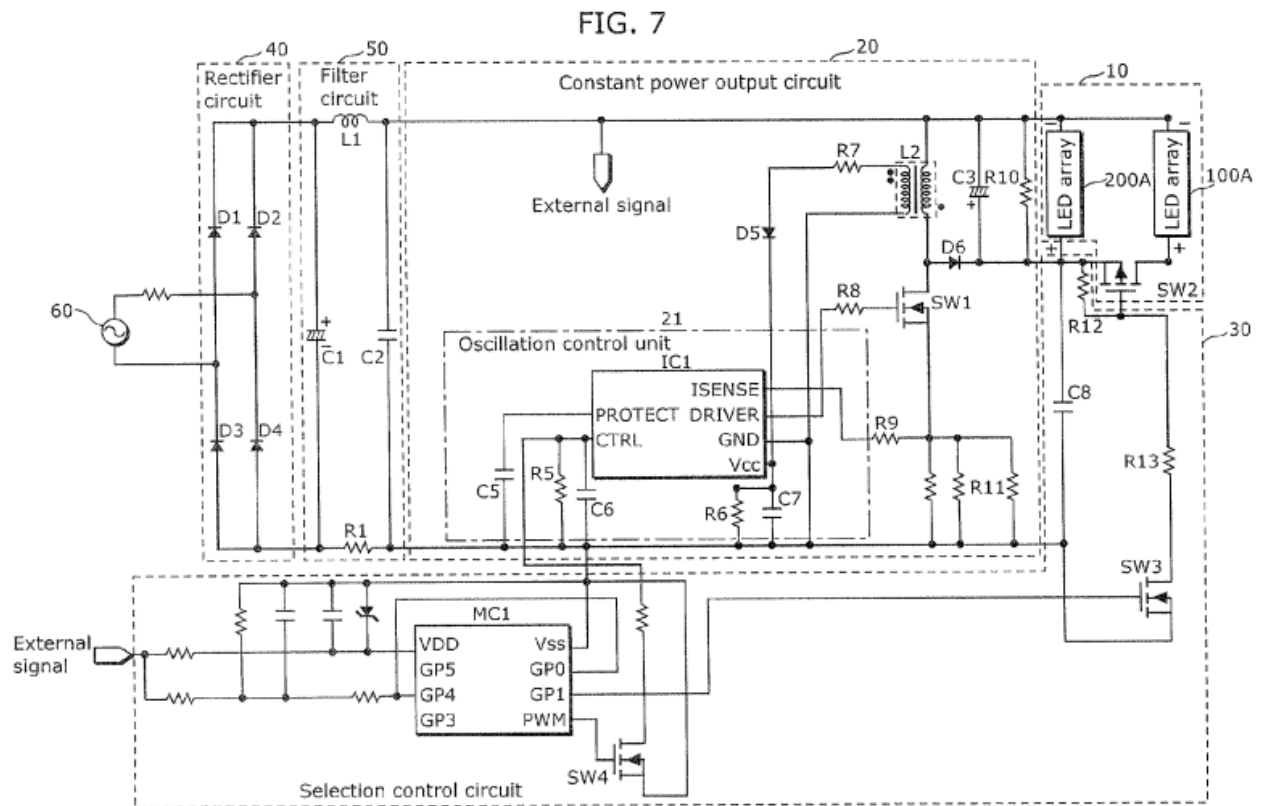
FIG. 3



Takahashi, FIG. 3.

58. Additionally, Takahashi discloses in FIG.7, below, a “circuit configuration diagram including an LED lamp.” Takahashi, 4:33-34. “FIG. 7 illustrates the LED module 10, the constant power output circuit 20, the selection control circuit 30, a rectifier circuit 40, a filter circuit 50, and an alternating-current (AC) source 60.” *Id.*, 13:49-52. The constant power output circuit 20 and the selection control circuit 30 are included in drive circuit 360. *Id.*, 6:55-65. A POSITA would have understood that these components make up a power supply for Takahashi’s LED tube lamp for the reasons discussed above at paragraphs 38-41. A POSITA would also have recognized that a circuit, such as the drive circuit 360 of

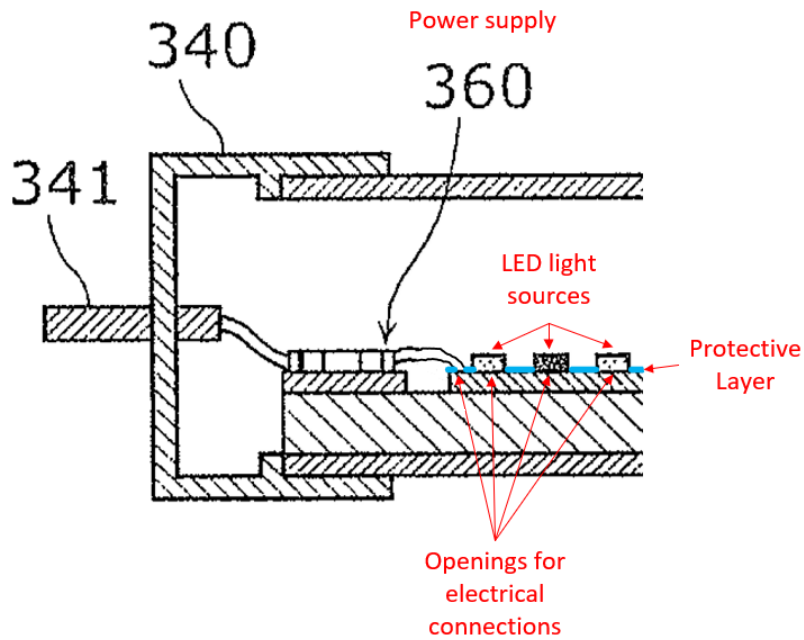
Takahashi, would include a circuit board because circuit boards have been used as substrates for electronics for decades.



Takahashi, FIG.7. A POSITA would have understood from these teachings and FIG. 4 that Takahashi's drive circuit 360 is connected to the board 11 via three different connections using a soldered lead wire in the connection terminal (connecting region) in FIG.3 above. Thus, Takahashi's connecting region has at least two soldering pads. Takahashi's mounting region and connecting region are likewise electrically connected to the LED light sources and the power supply.

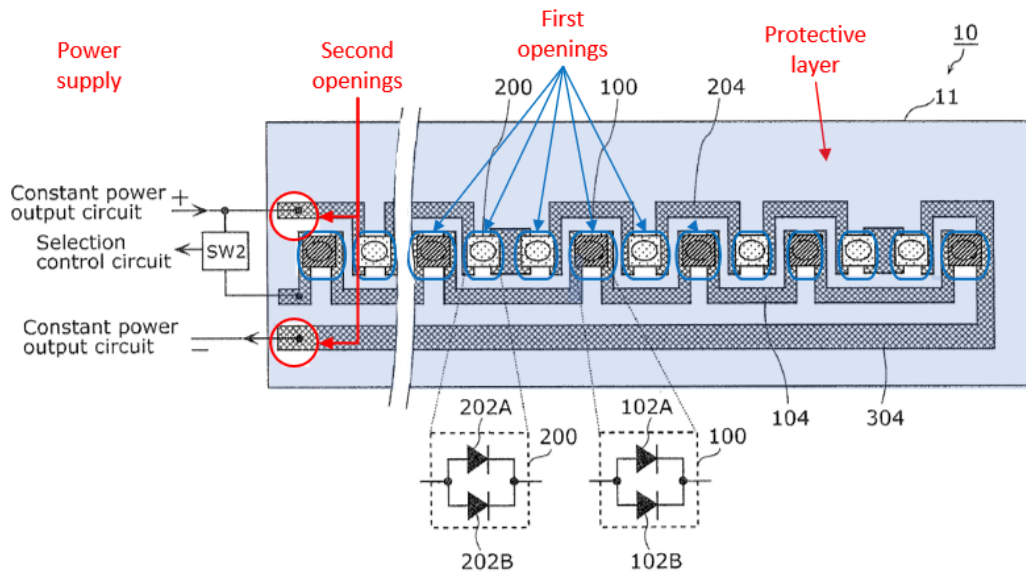
59. Takahashi teaches a protective layer disposed on a surface of the LED light strip. Takahashi teaches that “to enhance reflectivity and protect wiring, a white resist may be applied to the front surface of the board 11.” Takahashi, 9:20-22. From this teaching, a POSITA would have understood that the white resist in Takahashi is a protective layer—that is, it serves a protective function for the wiring it is applied to. A POSITA would have also understood that the white color of the resist would serve to enhance the reflectivity of the board 11, improving the light output of the LED module, as discussed above at paragraph 42. Takahashi does not specifically disclose the details of the white resist layer, e.g., openings to accommodate the LED light sources or solder pads for connection to the power circuits discussed in FIG.7. But a POSITA would have understood that openings in the protective layer for solder pads and LED light sources would be necessary for proper connection between the components. For example, Takahashi teaches connecting the LED light sources to wiring lines on the board and connecting the lines to a connection terminal (soldering pads) and to the drive circuit (power supply). *See* Takahashi, 9:27-42, FIG.4. A POSITA would have understood that such electrical connections would be more difficult if not impossible to make if the protective layer did not have openings to accommodate those elements. Therefore,

a POSITA would be motivated to include openings in Takahashi's protective layer as shown in modified FIGs.2 and 4 below.



Takahashi, FIG. 2.

FIG. 4



Takahashi, FIG. 4.

B. Shimasaki

60. Shimasaki is titled “Light-Emitting Circuit, Luminaire, and Manufacturing Method for the Light-Emitting Circuit.” (EX1006) Shimasaki notes that “[i]n recent years, according to an increase in output and improvement of efficiency of an LED (light-emitting diode), a luminaire including the LED as a light Source and used indoor or outdoor is developed.” Shimasaki, 1:26-29. Shimasaki discloses a “direct tube type LED lamp 2 [that] has dimensions and an external shape substantially the same as those of an existing direct tube type fluorescent lamp.” Shimasaki, 4:1-4. Shimasaki specifies that “for example, the direct tube type LED lamp 2 has dimensions and an external shape substantially the same as those of 20

W and 40 W direct tube type fluorescent lamps.” Shimasaki, 4:5-9. The direct tube type LED lamp of Shimasaki is illustrated below.

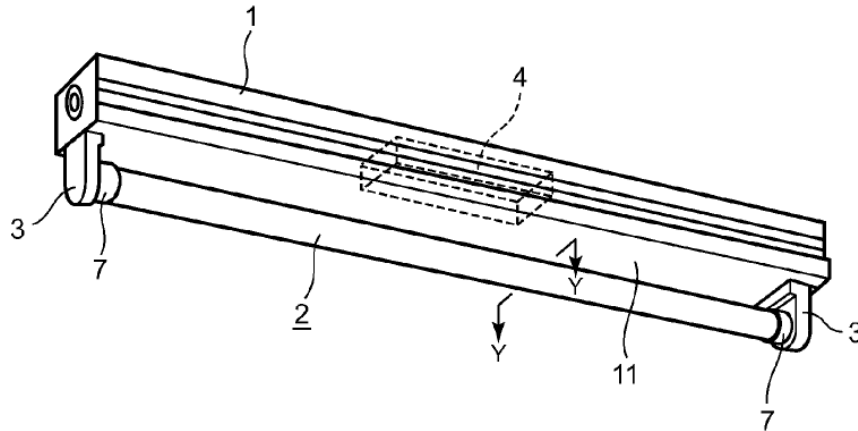


FIG. 1

Shimasaki, FIG.1.

61. Shimasaki discloses that the structure of its direct tube type LED lamp “includes an elongated main body 5 having a substantially cylindrical shape in external appearance, a light source section 6, and cap sections 7.” Shimasaki, 4:12-14. “As shown in FIG. 2 [below], the main body 5 has an internal space.” Shimasaki, 4:15. “The main body 5 is formed in a substantially cylindrical shape and manufactured by extrusion molding from a synthetic resin material such as translucent polycarbonate resin having diffusibility.” Shimasaki, 4:16-19. “On the inner wall of the main body 5, a pair of 20 supporting rails 51 opposed to each other and projecting to the inner side is formed.” Shimasaki, 4:19-21. “An elongated

attachment member 52 is supported by the supporting rails 51 and disposed along the longitudinal direction of the main body 5.” Shimasaki, 4:21-23. Shimasaki describes connecting pins, as “Power supply terminals 71 and an earth terminal 72 projecting from both ends of the direct tube type LED lamp 2 shown in FIG. 16 [which] are connected to the socket sections 3.” Shimasaki, 3:48-50.

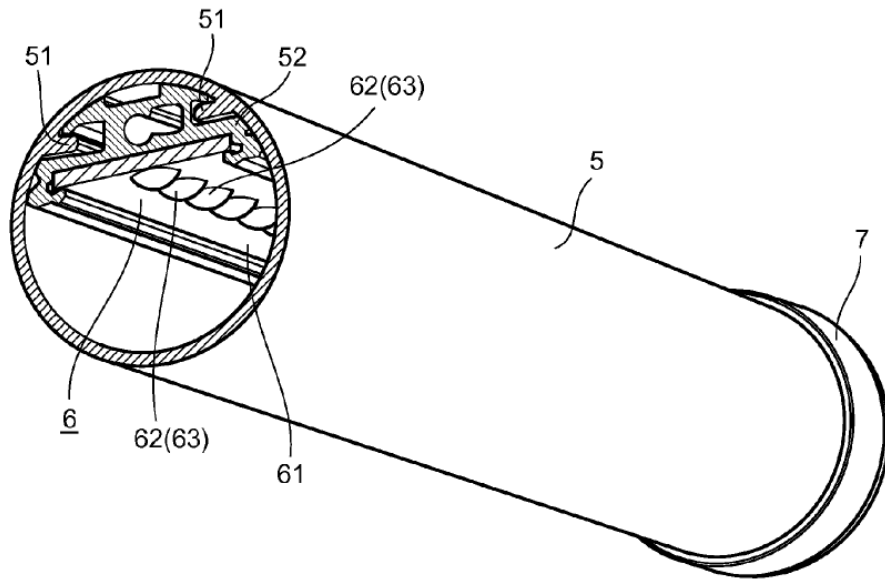


FIG. 2

Shimasaki, FIG. 2.

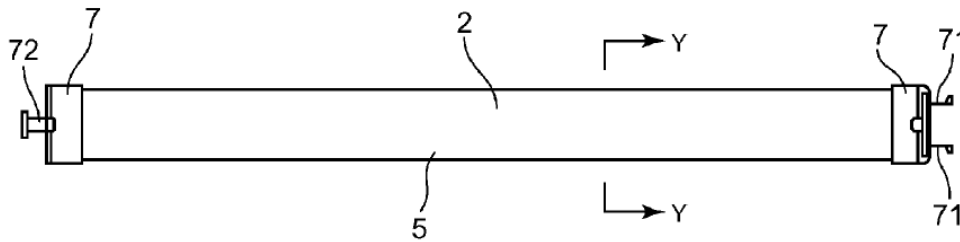


FIG. 16

Shimasaki, FIG. 16.

62. Shimasaki discloses a power supply circuit, “lighting circuit 4 housed in the luminaire main body 1” outside of the lamp tube, which connects a commercial alternating power supply to the LED tube lamp. *Id.* at 3:44-61. “The lighting circuit 4 includes a diode bridge circuit that receives electric power of the alternating-current power supply AC and generates a direct-current output.” *Id.* “The lighting circuit 4 is configured by, for example, connecting a smoothing capacitor between output terminals of the diode bridge circuit and connecting a direct-current voltage converting circuit and a current detecting section to the smoothing capacitor.” *Id.* A POSITA would have understood that the lighting circuit 4, with its diode bridge circuit, direct-current voltage converting circuit, and current detecting section, is a power supply for the reasons set out in paragraphs 38-41 above.

63. Shimasaki's "light source section 6 includes a substrate 61, a plurality of light-emitting elements 62 linearly arranged and mounted on the substrate 61, and a phosphor layer 63 that covers the light-emitting elements 62." Shimasaki, 4:33-39. "A plurality of the substrates 61 are arranged and disposed in the longitudinal direction of the light source section 6." *Id.* "A wiring pattern layer 61a formed of a copper foil is formed on the front surface side of the substrate 61." Shimasaki, 4:44-52. "A resist layer 61b is laminated on the wiring pattern layer 61a as appropriate." *Id.* "The resist layer 61b is a white resist layer having high reflectance." *Id.* "The resist layer 61b is laminated over substantially the entire surface of the front layer of the substrate 61 excluding a mounting region of the light-emitting elements 62 and solder land sections 61c" *Id.* "The solder land sections 61c are a part of the wiring pattern layer 61a and are portions where the wiring pattern layer 61a, on which the resist layer 61b is not laminated, is exposed to the surface and formed in a corner-rounded rectangular shape." Shimasaki, 6:24-30. From these teachings, and the discussion above at paragraphs 42-43, a POSITA would have understood this resist layer to be a protective layer because it covers the wiring layers. A POSITA would also have understood that the protective layer of Shimasaki explicitly included openings to accommodate the LED light sources (light emitting elements) and at least two soldering pads (solder land sections). This

structure, including the openings in the resist layer for a mounting region and solder land sections, is illustrated below.

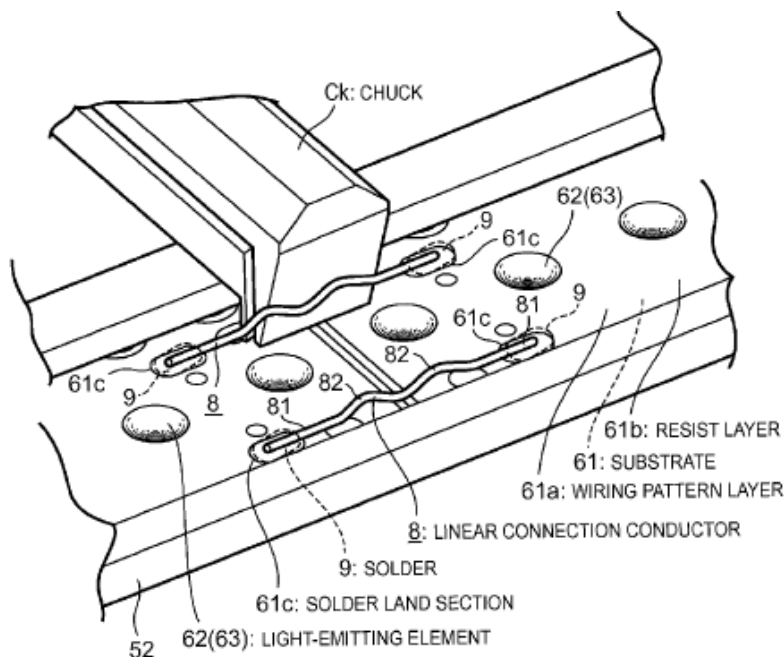


FIG. 5

Shimasaki at FIG. 5.

1. ***It Would Have Been Obvious to Modify Takahashi's LED Tube Light to Utilize Shimasaki's Resist Layer with Openings for LED Light Sources and Solder Pads***

64. The LED tube lamp taught by Takahashi includes structural elements recited in Claim 1 of the '125 Patent. Specifically, and as explained above at paragraphs 54-59, Takahashi teaches an LED tube lamp with a lamp tube; two end caps, each of the two end caps coupled to a respective end of the lamp tube; a power

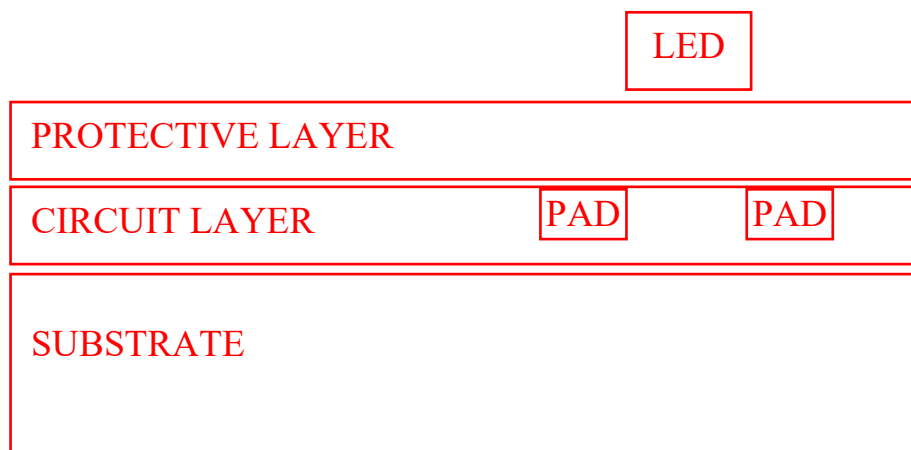
supply disposed in one of the end caps; an LED light strip disposed on an inner circumferential surface of the lamp tube, the LED light strip having a mounting region on which LED light sources are mounted and a connecting region with at least two soldering pads; and a protective layer disposed on a surface of the LED light strip. This is summarized here in the following table:

Claim 1 Limitation	Teaching of Takahashi
1[p] An LED tube lamp, comprising:	“straight tube LED lamp 1” (Takahashi, 6:33-54)
1[a] a lamp tube;	“elongated case 320”(id.)
1[b] two end caps, each of the two end caps coupled to a respective end of the lamp tube;	“feeding base 340” and “non-feeding base 350” (id.)
1[c] a power supply disposed in one or two end caps;	“drive circuit 360 provided inside the feeding base 340.” (id.) (Takahashi, 9:39-40.)
1[d]an LED light strip disposed on an inner circumferential surface of the lamp tube, the LED light strip comprising a mounting region . . . for mounting a plurality of LED light sources, a connecting region . . . having at least two soldering pads, and the mounting region and the connecting region being electrically connected to the plurality of LED light sources and the power supply; and	LED module 10 held by base platform 330 “is firmly fixed to the inner surface of the case 320” (Takahashi, 7:47-58) “LED elements 100 ... are surface mount devices ... mounted on a board 11.” (Takahashi, 8:24-27) “connection terminal 14” “The LED elements 100 aligned on the board 11 are connected in series by a line 104 to form the LED array 100A” “The line[] 104 ... connected to the connection terminal 14 and to the drive circuit 360” (Takahashi, 9:26-40.)

Claim 1 Limitation	Teaching of Takahashi
1[e] a protective layer disposed on a surface of the LED light strip, the protective layer having a plurality of first openings to accommodate the plurality of LED light sources and at least two second openings to accommodate the at least two soldering pads.	“to enhance reflectivity and <i>protect wiring</i> , a white resist may be applied to the front surface of board 11” (Takahashi, 9:20-22, (emphasis added))

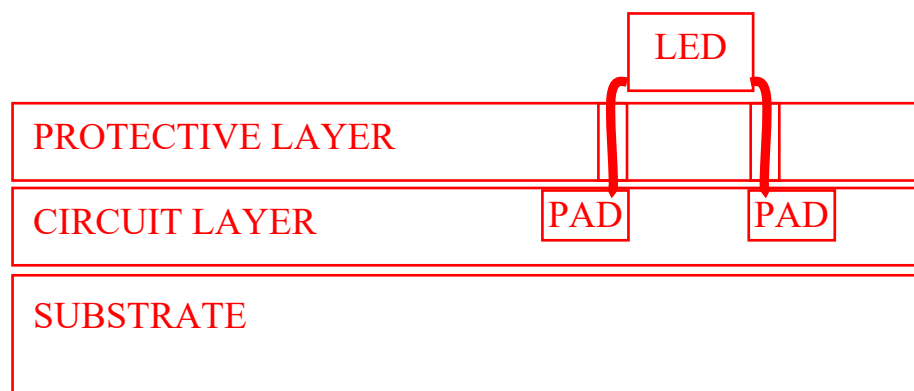
65. Takahashi does not teach explicitly that the protective layer has openings to accommodate the LED light sources or its connection terminal to which “lead wire is soldered” “to be fixed to the board 11.” Takahashi, 9:40-42). . But Takahashi implicitly teaches openings in the protective layer for the connection terminal and LED light sources. And, because a POSITA would have viewed such connections—between the LEDs and the board, and between the drive circuit 360 and the connection terminal 14 of the board—to be necessary for the operation of Takahashi’s LED lamp, a POSITA would have been motivated to include such openings through Takahashi’s “white resist” layer on “the front surface of the board 11.” *Id.* More particularly, Takahashi teaches connecting the LED light sources to wiring lines on the board and connecting the lines to a connection terminal (connecting region with soldering pads) and to the drive circuit. *See* Takahashi at 9:27-42 and FIG. 4. A POSITA would have understood that—“to ... protect wiring”—the protective layer must necessarily be above the wiring. And—“to

enhance reflectivity”—the protective layer must necessarily be below the LEDs (and not over the LEDs). As illustrated conceptually below, a POSITA would have also understood that such circuit boards are typically manufactured layer-by-layer, such that the circuits would be added as a layer over a substrate, and the protective layer would be added as an additional layer over the circuits.



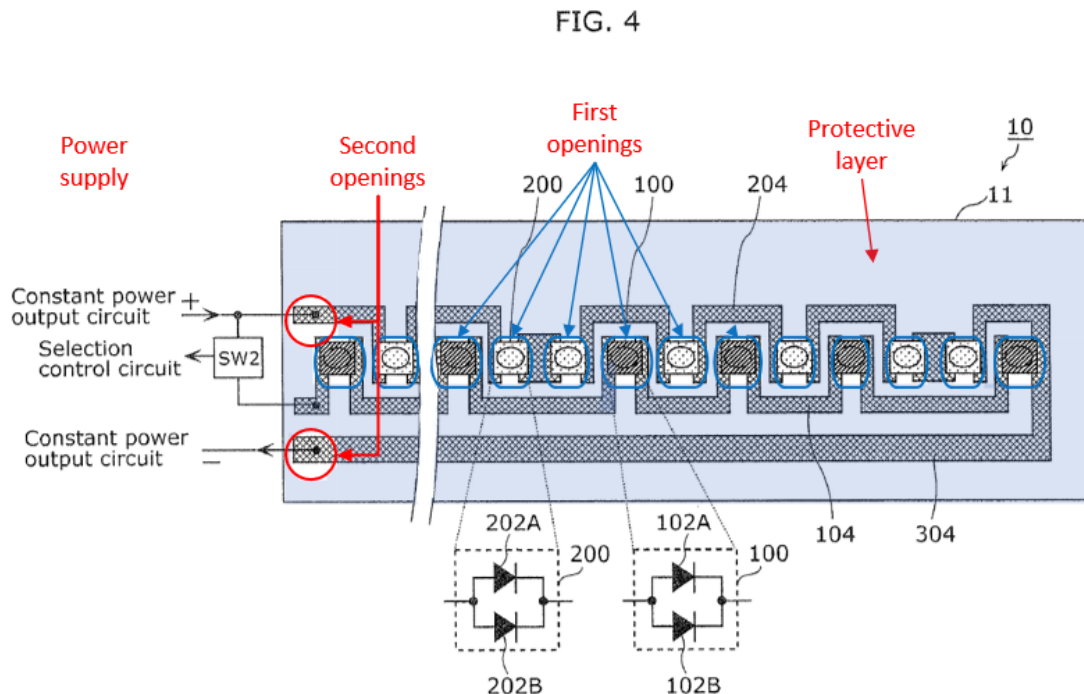
66. In this illustrated example, the circuit layer includes two solder pads for connecting the LED to receive power. Similar solder pads could be formed adjacent to an end of the LED light strip to make connections to the power supply. A POSITA would have understood that such electrical connections would be more difficult, and likely impossible, without creating openings in the protective layer through which to make the connections. To that end, in such layered circuit manufacturing, a POSITA would have expected such a protective layer to be applied over the entire area and then “etched” to remove portions of the coating where a connection is needed between layers. Alternatively, a POSITA would have understood that a mask

could be applied to the circuit layer before the protective layer is applied, such that when the mask is removed, it would remove portions of the protective layer applied to the mask and similarly expose openings through which connections to the LEDs or the power supply could be made. Such masking would occur before the placement of the LEDs at least because the effectiveness of masking depends on the mask being placed directly on the underlying layer. Otherwise, during deposition of the protective layer, material could seep under the mask, resulting in ill-defined boundaries that frustrate the purpose of masking, such that placing the mask over LEDs would be ineffective. In either option, the protective layer would be between the circuit layer and the LED, such that openings would necessarily be included for electrical connections, as indicated below.



Therefore, a POSITA would have been motivated to include openings in Takahashi's protective layer would include openings, shown conceptually below in annotated

FIG. 4. In the absence of explicit disclosure within Takahaski, a POSITA would have also been motivated to look elsewhere for details of such openings.



67. Shimasaki explicitly discloses such openings through a protective resist layer to allow for LED connections and Board-level connections. *See* Shimasaki at 4:44-52. “A resist layer 61b is laminated on the wiring pattern layer 61a as appropriate.” *Id.* “The resist layer 61b is a white resist layer having high reflectance.” *Id.* “The resist layer 61b is laminated over substantially the entire surface of the front layer of the substrate 61 excluding a mounting region of the light-emitting elements 62 and solder land sections 61c.” *Id.* As discussed in the introduction to Shimasaki at paragraphs 60-63, a POSITA would have understood

this resist layer to be a protective layer explicitly including openings exposing LED light sources and soldering pads. Furthermore, Shimasaki explicitly teaches making these openings for mounting LED light sources to the LED light strip (Shimasaki at 4:34-36, 47-50) and for soldering pads formed so connections between circuit elements, including the wiring layers and the power supply, can be made (Shimasaki at 4:47-51, 5:40-42, and 10:4-7). A POSITA would have been motivated to incorporate openings into the protective layer of Takahashi, as explicitly taught by Shimasaki, at least because such openings would enable efficient connection of the LED light sources to the wiring used to provide power to the LED light sources while providing the advantages offered by the protective layer, such as improved light output efficiency and protection against corrosion and damage as explained above at paragraph 42.

68. Moreover, a POSITA would have been motivated to include such openings in Takahashi's "white resist" layer (EX1005, 9:20-22) to enable the soldered connections contemplated by Takahashi (*id.*, 9:40-42) because soldered connections through such openings represented a desirable one of a limited number of options. First, Takahashi's soldered connections could theoretically have been enabled by omitting the resist layer, but doing so would sacrifice the benefits—enhanced reflectivity and protection for wiring—taught by Takahashi (*id.*, 9:20-22).

Alternatively, Takahashi's connection terminal could have theoretically been replaced by a mechanical plug connector, but a POSITA would have viewed a soldered connection as a more-reliable connection. For example, soldering typically secures and strengthens the direct contact between a wire and the solder pads, and eliminates an intermediate connection that would otherwise be present between the wire and the connector. Additionally, a POSITA would have expected soldered connections to be less susceptible to oxidation that could impede the connection between plug connectors, at least because the solder fills and surrounds the interface between the wire and the solder pad, whereas a connector—even when tight—permits air (and entrained moisture) to intrude into the interface between the pin and socket. Thus, a POSITA would have preferred openings in Takahashi's resist layer for solder pads as preferred among a small set of known options.

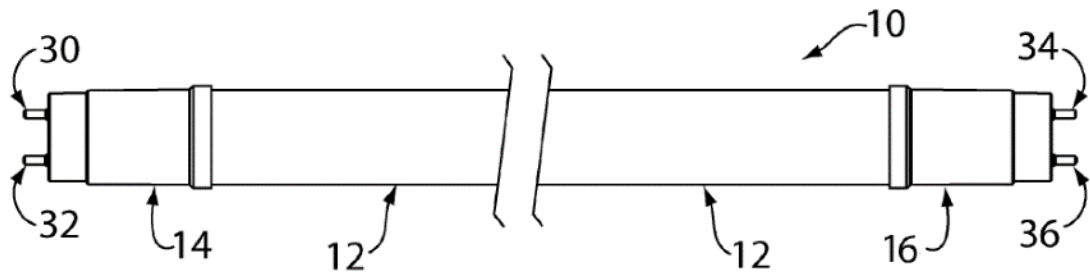
69. Finally, a POSITA would have reasonably expected to successfully incorporate such openings into Takahashi's resist layer to allow connections through that layer, at least because such openings and connections were known in the art, and because Shimasaki successfully uses them in the same field—i.e., connection between a power circuit and PCB board for an LED lamp.

C. Guang

70. Guang is titled “LED Tube Driver Circuitry for Ballast and Non-Ballast Fluorescent Tube Replacement.” (EX1007) Guang discloses “[a]n LED lamp tube and driver circuit that is direct replacement for fluorescent tubes with or without ballasts, that works with standard AC high voltage current input, with high frequency pulse current input, or with lower voltage input.” Guang, Abstract. Guang notes that “there has been over the past decade an enormous commercial move toward replacing both incandescent and fluorescent light fixtures with light-emitting diode (LED) lighting.” Guang, 4:13-16 “Arrays of LEDs can be fitted in tubes that are physically compatible replacement for fluorescent tubes, using the same sockets for their electrodes to fit into.” Guang, 4:16-19.

71. Guang describes the external structure of the LED tube lamp as illustrated in FIG. 4 below. “FIG. 4 shows a side view of an assembled fluorescent compatible LED tube lamp 10 (containing an LED array and the LED driver circuitry of the present invention) comprising of a cylindrical translucent or transparent tube 12, enclosed at the left end by a left PCB housing 14 with a first pair of electrode pin 30 and 32 and on the right end by a right PCB housing 16 with a second pair of electrode pins 34 and 36.” Guang, 15:52-58. “The PCB housings function as end caps for the tube 12.” Guang, 15:58-59.

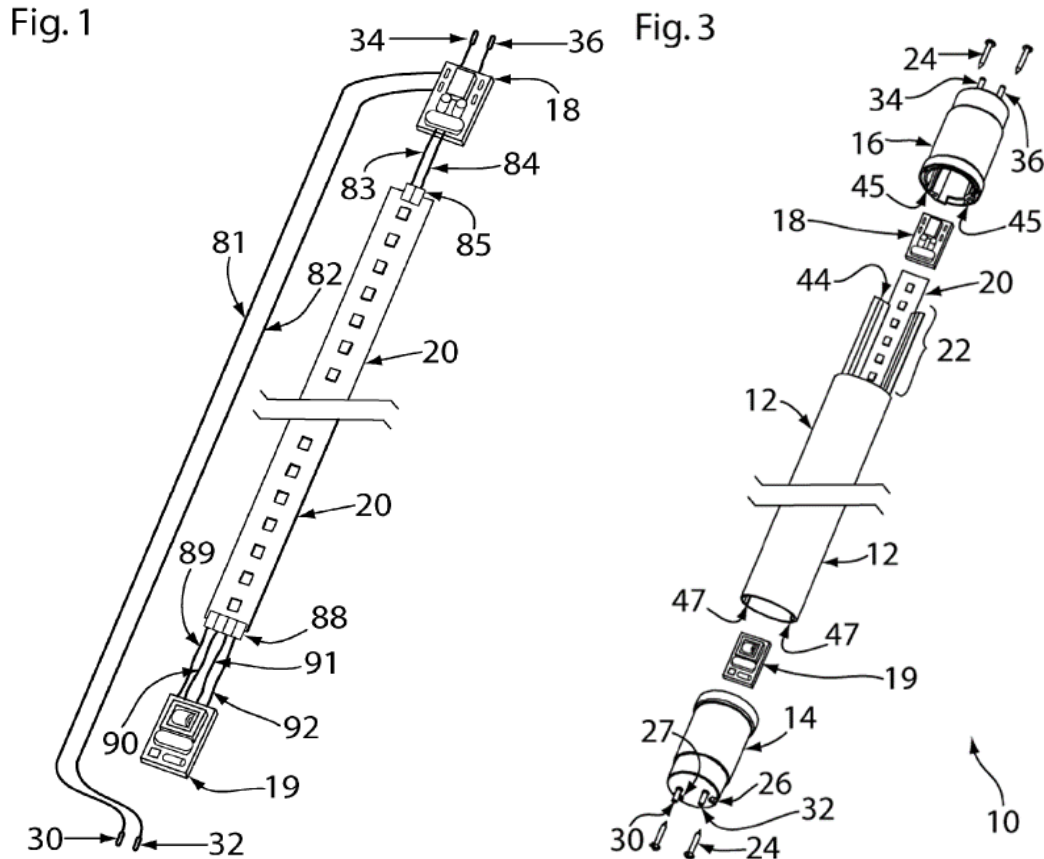
Fig. 4



Guang, FIG. 4.

72. Guang discloses an LED light strip disposed on the inner surface of the lamp tube. Guang teaches an “LED array 20 . . . supported inside the tube 12 by means of the LED holder 22 with ridges 44 for longitudinal strength. The LED holder can be made of plastic or alternatively of metal in which case the ridges 44 function as cooling fins to help dissipate heat away from individual LEDs in the LED array 20.” Guang, at 15:44-49. “The channels 45 inside tube end 16 (and like channels in the other tube end) receive and hold flanged LED array holder 22 with its ridges 44.” Guang, 15:49-51. A POSITA would have understood, based on the arrangement of channels 45 on one lower portion of PCB housings 14 and 16, that LED array 20 supported by LED holder 22 is disposed on a circumferential surface of tube 12. Guang does not explicitly describe the wiring layer of LED array 20, but a POSITA would have understood that the LED light sources of Guang are disposed on a first side of and electrically connected to a wiring layer based on Guang’s use

of a known structure. For example, FIGs. 1, and 3 of Guang show a plurality of LED light sources on a same surface of the LED array, and Guang discloses connections between power supply elements made through “long conductors” “*layered* within [the LED array] PCB.” Guang, 8:45-49 (emphasis added).



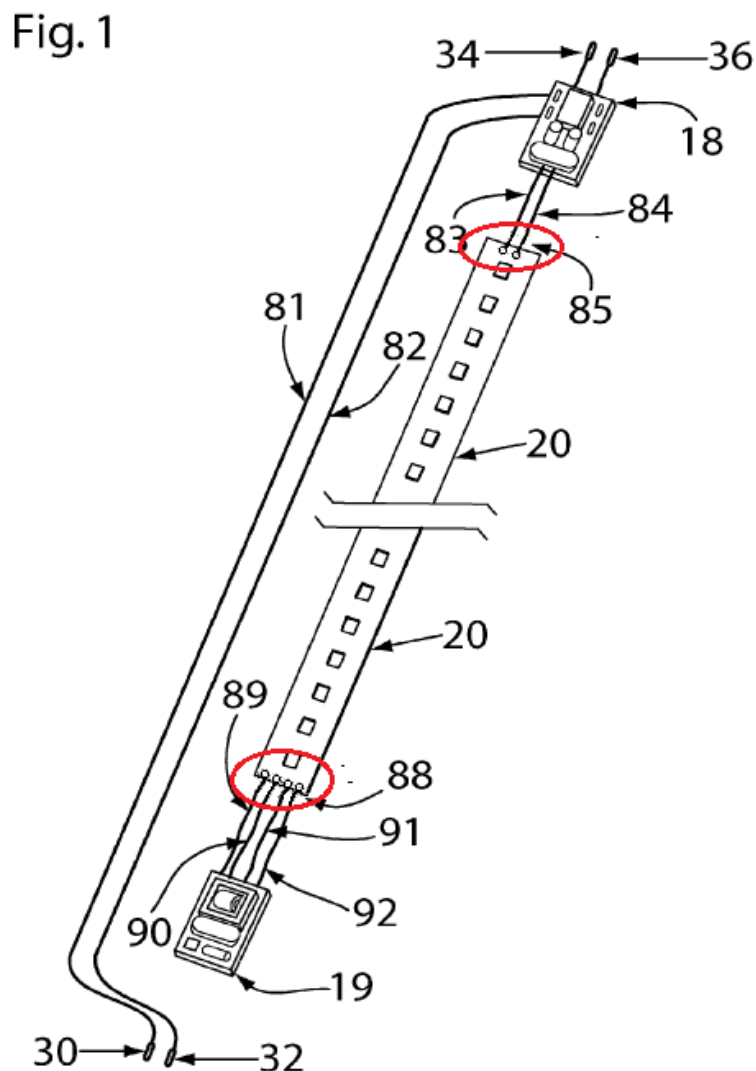
73. Guang teaches a power supply configured as one or both of “rectifier and filter printed circuit board (PCB) 18” and “step-down constant current PCB 19 [which] are each to be enclosed by a PCB housing (14 or 16).” EX1007, 15:6-9. Guang discloses that the PCBs rectify and filter external AC current to DC power,

such that the PCB output leads are electrically connected to an LED array 20. Guang, 15:21-36. “The filtered DC power is modified by the step-down constant current circuit of the driver circuitry to supply DC power at a voltage and current level that will drive the LED array 20 to illuminate in accordance with its capabilities.” Guang, 15:36-40. A POSITA would understand these PCBs to be a power supply for the reasons discussed above at paragraphs 38-41. Guang teaches that connections between these power supply PCBs and the LED light strip could be made with pin connectors. EX1007, FIG.1, 8:45-49 (“The filtered DC output from PCB 18 is conducted via wires 83 and 84 through their 2-pin connector 85 on the LED array PCB on long conductors (not shown) layered within that PCB that terminate at two of the four pins at 4-pin connector 88.”). A POSITA would also have understood that other methods of making electrical connections, such as through soldering pads, were known in the art. See paragraphs 44-45 above.

1. It Would Have Been Obvious to Incorporate Solder Pads on the LED Array of Guang in View of Shimasaki

74. It would have been obvious to construct Guang’s LED tube lamp using an LED array that included solder pads for connecting the LED array to the rectifier and filter PCB 18 and constant current PCB 19 (e.g., power supplies) supplying power to the LED array, as illustrated below in a modified version of FIG. 1 of Guang. Guang itself contemplates use of alternative construction techniques, noting

that “[o]ther forming techniques and other materials may be employed” to create LED lamp tubes for the same ends (i.e., LED lamp tubes as fluorescent light replacements) as those explicitly described by Guang. *See* Guang at 16:41-48.



would have recognized the LED array of Guang's LED tube lamp could be connected to power supply components using solder pads, as shown in the red circles in the modified version of FIG. 1 of Guang above, rather than pin connectors, as both pin connectors and soldering techniques were well known techniques for making electrical connections. *See* paragraph 45 above; *see also* Shimasaki at 4:47-52, 6:20-40, 7:31-41, and 10:4-7. A POSITA would have also understood that such a modification is merely substitution of one known technique for making electrical connections for LED lighting devices for another known technique and the results of both techniques are predictable (*e.g.*, working electrical connections suitable for receiving and distributing power from a power supply to LED light sources). Second, a POSITA would have been motivated to utilize solder pads instead of pin connectors to enable automation of manufacturing processes, as taught by Shimasaki, which describes using automated supply machines and techniques to manufacture LED light devices. *See* Shimasaki at 5:40-7:64; *see also* Shimasaki at 9:29-31 (describing use of automatic joining processes to produce LED lighting arrays with electrical connections formed using solder pads). To that end, Shimasaki explains that the use of connectors (instead of solder pads) makes it “difficult to efficiently perform work for connecting the substrates” and “is not advantageous in terms of costs.” EX1006, 1:35-38. Thus, a POSITA would have recognized that the

use of solder pads would improve manufacturability and reduce costs for such an LED.

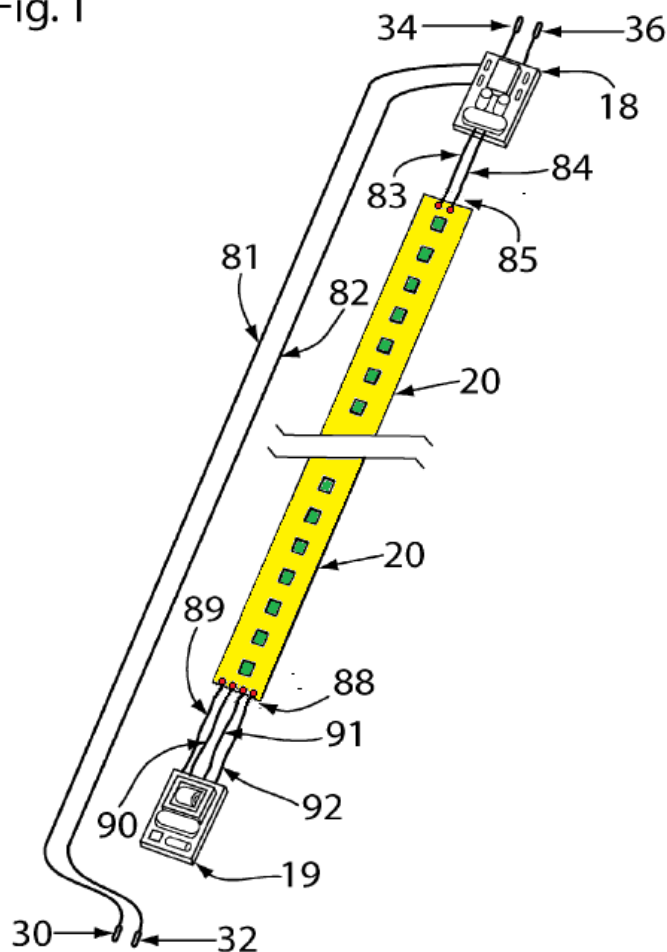
76. A POSITA would have expected the use of solder pads instead of connectors to result in a more reliable connection between the power supply and the LED light strip. For example, soldering typically secures and strengthens the direct contact between a wire and the solder pads, and eliminates an intermediate connection that would otherwise be present between the wire and the connector. Additionally, a POSITA would have expected soldered connections to be less susceptible to oxidation that could impede the connection between the pins and sockets in Guang's pin connectors, at least because the solder fills and surrounds the interface between the wire and the solder pad, whereas a connector—even when tight—permits air (and entrained moisture) to intrude into the interface between the pin and socket.

2. *It Would Have Been Obvious to Incorporate a Resist Layer into the LED Tube Lamp of Guang in View of Shimasaki*

77. A POSITA would have been motivated to incorporate a resist layer on the surface of the modified LED array of Guang's LED tube lamp discussed above in paragraphs 74-76, as illustrated below in a modified version of FIG. 1 of Guang, which shows the resist layer is shown in yellow, the LED light sources are shown in green, and the solder pads are shown in red, based on the teachings of Shimasaki.

The Guang-Shimasaki LED light strip would use solder pads to form connections between the LED light strip and the power supply PCBs in lieu of each of the pins of Guang's pin connectors.

Fig. 1



Guang itself contemplates such a construction, noting that “[o]ther forming techniques and other materials may be employed” to create LED lamp tubes for the same ends (i.e., LED lamp tubes as fluorescent light replacements) as those explicitly described by Guang. *See* Guang at 16:41-48. Moreover, Shimasaki also

explains that the resist layer, when applied to an LED array, should cover “the entire surface of the front layer of the [LED array] substrate [] **excluding** a mounting region of the light-emitting elements [] and solder land sections”. Shimasaki at 4:40-52. Shimasaki also teaches that the resist layer is formed of a material having high reflectance. *Id.* From these teachings of Shimasaki a POSITA would have understood that a high reflectivity resist layer could be applied on the surface of the LED array of Guang, at least because both Shimasaki and Guang teach similar structures for LED arrays and LED tube lamps. Indeed, use of high reflectance resist layers in LED lighting applications and devices was a well-known technique used by a POSITA to form LED lighting devices even prior to Shimasaki, as explained above at paragraph 42, which demonstrates that incorporation of a resist layer was known by a POSITA to provide several benefits to LED lighting devices, such as improved light output efficiency and preventing light absorption through the substrate on which the LED light sources (i.e., LED chips) are disposed. Such teachings would have motivated a POSITA to incorporate a reflective resist layer on the surface of an LED array of Guang, as taught by Shimasaki and generally known to a POSITA, in order to prevent light absorption and improve the light output efficiency of the LED lamp tube of Guang.

78. Moreover, A POSITA would have understood that Shimasaki's resist layer 61b would benefit Guang's LED array 20 because it would protect the wiring on LED array 20 from corrosion and damage, as taught above in paragraph 42. The openings in Shimasaki's protective layer would allow for this protection while facilitating electrical connections between the LED tube lamp's electrical components, such as connecting LED light sources to wiring of the LED tube lamp and connecting soldering pads to a power supply. *See* Shimasaki, 4:40-52, 5:7-13; 6:35-40. A POSITA would have understood that the openings in the resist layer of Shimasaki would provide locations for a reliable connection for electrical components and wiring to the LED light strip. Thus, a POSITA would have been motivated to incorporate a resist layer onto Guang's LED array 20 to protect the wiring and improve connection reliability.

79. Openings in the protective layer enable efficient and secure electrical connections to be made. As was discussed above at paragraph 76, soldering is a technique that produces more reliable circuit connections. Providing openings in the protective layer for each solder pad furthers the goal of developing reliable connections. For example, substituting each pin of Guang's 2-pin connector 85 and 4-pin connector 88 with a soldering pad in the Guang-Shimasaki lamp would result in two solder pads at one end of the LED array and four solder pads at the other end

of the array, each of which would need an opening in the protective layer. Having separate openings for each of the solder pads is beneficial because the protective layer acts as a solder resist. *See* paragraph 43 above. A POSITA would have understood that Shimasaki implies a solder resist because Shimasaki's protective layer is designated as a "resist layer 61b." EX1006, 4:40-52. Thus, a POSITA would have understood that having openings in the protective layer of the modified Guang-Shimasaki lamp for each solder pad would help prevent undesired solder bridges from short-circuiting the solder pads.

80. The modification of Guang described above merely involves use of a well-known LED lighting device manufacturing technique—namely, application of a reflective solder resist layer on the surface of a substrate upon which LED light sources are disposed—in which the technique is being applied for the purpose that the technique was known to be used for, such as to improve the light output efficiency of the LED lighting device. *See* paragraph 42 above. Additionally, the modification represented by the combination of Guang and Shimasaki outlined above would yield a predictable result—improving the light output efficiency and the electrical connections of the LED lamp tube of Guang—which were well-known benefits obtained by application of a reflective solder resist layer to a surface of a substrate on which LED light sources are disposed.

3. ***It Would Have Been Obvious to Incorporate a Wiring Layer into the LED Tube Lamp of Guang in View of Shimasaki***

81. As discussed above in paragraph 72, Guang does not explicitly describe the wiring of LED array 20 in any particular configuration, but a POSITA would have understood that the LED light sources of Guang are disposed on a first side of and electrically connected to a wiring layer based on Guang's use of a known structure. For example, FIGs. 1, and 3 of Guang show a plurality of LED light sources on a same surface of the LED array, and Guang discloses connections between power supply elements made through "long conductors" "***layered*** within [the LED array] PCB." Guang, 8:45-49 (emphasis added). Additionally, the use of layered constructions, including wiring layers, in LED and other semiconductor manufacturing was well known, as discussed above at paragraphs 66-67.

82. In the absence of explicit disclosure of a wiring layer within Guang, a POSITA would have also been motivated to look elsewhere for details of the wiring of an LED light strip. For example, A POSITA would have found details confirming the use of a wiring layer in Shimasaki's "wiring pattern layer 61a," onto which LEDs are disposed and electrically connected. *See* Shimasaki at 4:40-52, 5:7-13. As Shimasaki teaches, having a wiring pattern layer for making electrical connections promotes efficient manufacturing and light functionality (*see* Shimasaki at 1:35-38,

5:7-13). As Guang's LED tube lamp required similar connections, A POSITA would have been motivated to incorporate the wiring pattern layer of Shimasaki into Guang's LED array 20.

4. *It Would Have Been Obvious to Include a Diffusion Film into the Combined Guang-Shimasaki LED Tube Lamp in View of Takahashi*

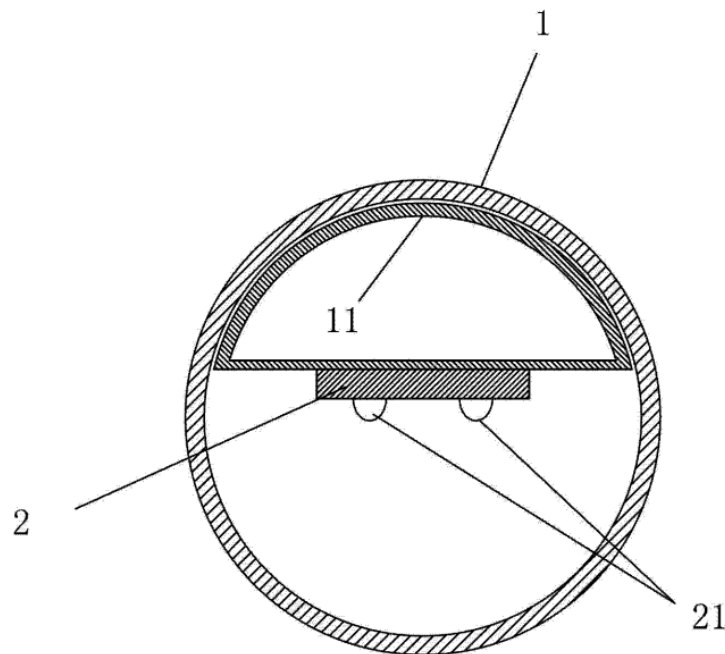
83. A POSITA would have understood that diffusion films, as taught by Takahashi, could be applied to a surface of a lamp tube of an LED tube lamp, such as the LED tube lamps of Guang and Shimasaki. Takahashi's diffusion techniques discussed above at paragraphs 31 and 56 include "a light diffusion sheet or ***a light diffusion film provided to at least one of the inner surface and the outer surface of the case 320***. Takahashi at 7:27-29 (emphasis added). Guang and Shimasaki also explicitly teach LED tube lamps having diffusion. Guang teaches that LED tube lights are available with "frosted [diffusing] lens styles" (Guang at 4:29-31) and specifically contemplates that its lamp tube can be a "cylindrical translucent or transparent tube 12". Guang at 15:55. Shimasaki teaches that "main body 5 is formed . . . from a synthetic resin material such as translucent polycarbonate resin having diffusibility." Shimasaki at 4:16-19; *see also* 8:41-44 (contemplating light transmitting through the translucent tube).

84. A POSITA would have understood that incorporating the diffusion layer of Takahashi would enable diffusion of light from the Guang-Shimasaki LED tube lamp. *See* Takahashi, 7:18-45. A POSITA would have been motivated to incorporate the diffusion film of Takahashi in order to create a uniform or smooth light output from the LED tube lamp of Guang-Shimasaki, a benefit discussed above at paragraph 31. Takahashi's teaching of several effective methods for diffusing light from an LED lamp tube demonstrates that such elements would have been known to a POSITA before the '125 Patent, and that using any of the various diffusing elements would be merely substituting one known element for another. This substitution would yield the predictable result of an LED tube lamp diffusing light over its area of illumination. A POSITA would have been particularly motivated to use Takahashi's diffusion film as the diffusing element in the Guang-Shimaskai-Takahashi tube lamp as opposed to Guang's frosted lens or Shimasaki's translucent polycarbonate for the advantages discussed above at paragraph 32, including greater precision control over diffusion film thickness and the corresponding level of diffusion, and increased ease of manufacturing, and safety.

D. Jing

85. Jing is titled "LED Fluorescent Lamp" (EX1015) and was published July 3, 2013. In "Background Technology," Jing describes an "LED fluorescent

lamp in the prior art is composed of a glass lamp tube 1 [and] a light emitting component arranged in the lamp tube 1 . . . The light emitting component includes a bracket 11 made of aluminum profiles extending from one end of the lamp tube to the other end, and a circuit board 2 fixed on the bracket, which extends along the axis of the lamp tube and is equipped with LED lamp beads 21.” Jing at ¶ [0002].



Jing, FIG. 1.

86. “This structure has the following shortcomings: . . . Due to the barrier of the bracket, when the LED light source in the enclosed space inside the lamp tube works, the heat generated is transferred to the bracket through the circuit board, and then transferred from the bracket to the external space through the glass wall of the

lamp tube. In this way, the heat resistance will be larger through two heat conduction exchange layers.” Jing, ¶¶ [0003]-[0005].

87. In “Invention Content,” Jing states that “[t]he technical problem to be solved is to reduce the manufacturing cost.” Jing, ¶ [0006]. “This Utility Model sets reflective film layers on the inner and outer walls of the lamp tube, so that the light emitted from the LED light source to the back of the lamp tube can be fully utilized due to reflection, thereby correspondingly enhancing the luminance of the LED fluorescent lamp.” *Id.*, ¶ [0018]. “The further improvement of the Utility Model is that the inner wall of the lamp tube 1 corresponding to the back of the circuit board 2 is coated with a film that can reflect light by electroplating, spraying or vacuum coating.” *Id.*, ¶ [0032].

88. Jing teaches that the LED fluorescent lamp “is composed of a lamp tube 1 with a circular section and glass material, a circuit board 2 arranged in the lamp tube 1 extending along the axis, and a plug with a driver arranged on both ends of the lamp tube 1 and electrically connecting the circuit board 2 with the external power supply.” Jing, ¶ [0027].

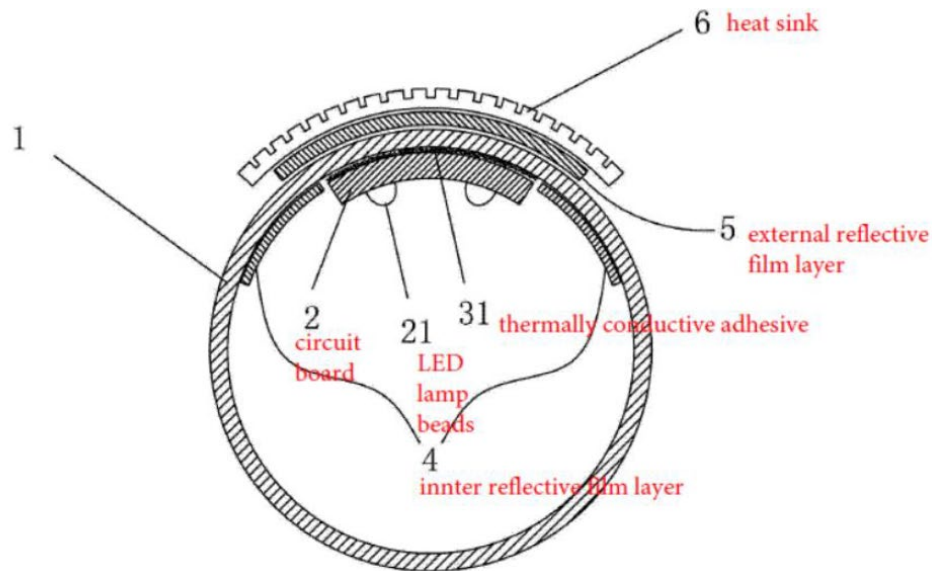
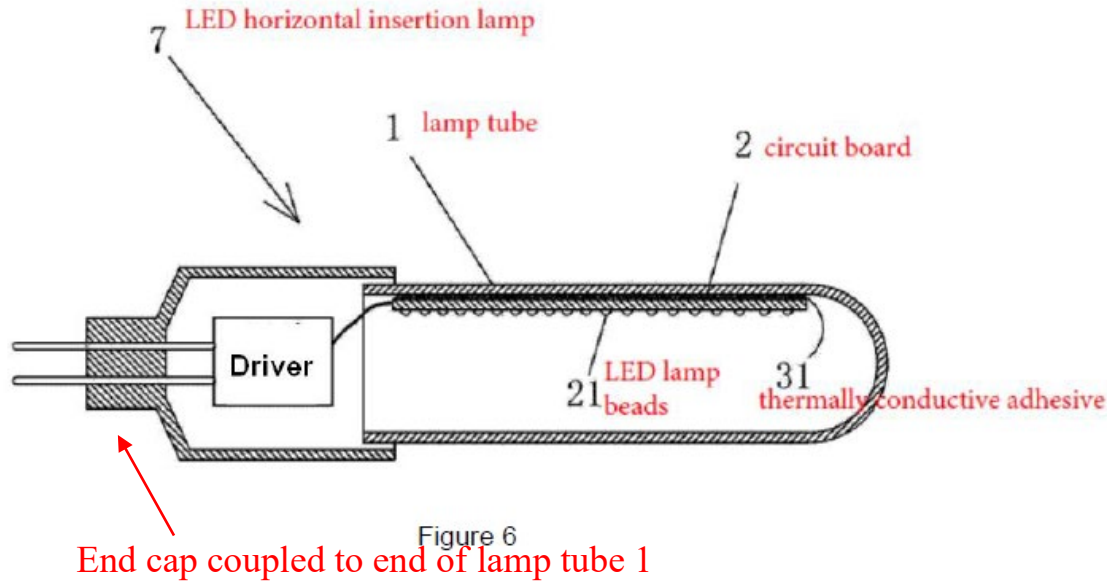


Figure 2

EX1015, FIG. 2.

89. Jing teaches an embodiment in which the LED fluorescent lamp “is composed of . . . a plug with a driver arranged on both ends of the lamp tube 1 and electrically connecting the circuit board 2 with the external power supply.” Jing, ¶ [0027]. In another embodiment, “one end is an open end, [and] the other end is a closed LED horizontal insertion lamp 7, that is, the circuit board is installed into the lamp tube through the open end of the horizontal insertion lamp tube, and then the plug with the driver electrically connected to the external power supply is blocked on the open end, as shown in Figure 6.” *Id.*



EX1015, FIG. 6.

1. *It Would Have Been Obvious to Attach the LED Light Strip of Takahashi-Shimasaki to an Inner Circumferential Surface of the Lamp Tube with an Adhesive as Taught by Jing*

90. As noted previously, consumer interest in LED lamps in the mid-2010s was high due to the increased energy efficiency, long lifespan, and reduced use of toxic materials in LED lamps, as discussed at paragraphs 29 and 33 above. A POSITA would also have understood the need for increased reliability and lower manufacturing costs of LED tube lamp designs.

91. A POSITA would have been motivated to look for examples of LED lamps using structures that could reduce manufacturing cost for the reasons described above in paragraphs 29, 33, 36, and 37. Jing describes one such approach. Jing describes an LED lamp that results in reduced manufacturing cost for the LED

tube, higher luminance, and better heat performance. Jing at ¶¶ [0006], [0018], [0032]. Specifically, Jing describes that a “structure that directly fixes the circuit board onto the inner wall of the lamp tube through the fixing layer *omits the metal bracket used to fix the circuit board in the LED fluorescent lamp tube in the prior art, and greatly reduces the manufacturing cost* of the LED fluorescent lamp.” Jing, ¶ [Summary]; *see also* ¶ [0018].

92. Importantly, Jing shows that a POSITA would have been aware of benefits from having an intervening structure for disposing LEDs within a lamp tube (e.g., heat dissipation, supporting the LED light strip) and would have still recognized that in some instances reducing costs is more important than utilizing these benefits.

93. A POSITA would have understood that Takahashi contemplates fixing (or attaching) its LED module 10 onto base platform 330 “with an adhesive.” Takahashi at 7:65-8:4. A POSITA would have also understood that adhesive could be used to ensure “base platform 330 is fixed to the inner surface of the case 320.” *See* Takahashi at 7:50-51. Accordingly, a POSITA would have been motivated to modify Takahashi-Shimasaki’s LED tube lamp to use Jing’s adhesive to securely attach the LED light strip to the inner surface of the LED tube with the predictable result of to reduced manufacturing costs and increased luminance. It would have

been obvious to a POSITA to try attaching the LED light strip with Jing's adhesive to Takahashi-Shimasaki's LED tube lamp because a POSITA would have expected this implementation to be successful in stably attaching the LED light strip to the light tube while reducing manufacturing costs.

2. ***It Would Have Been Obvious to Attach the LED Light Strip of Guang-Shimasaki to an Inner Circumferential Surface of the Lamp Tube with an Adhesive as Taught by Jing***

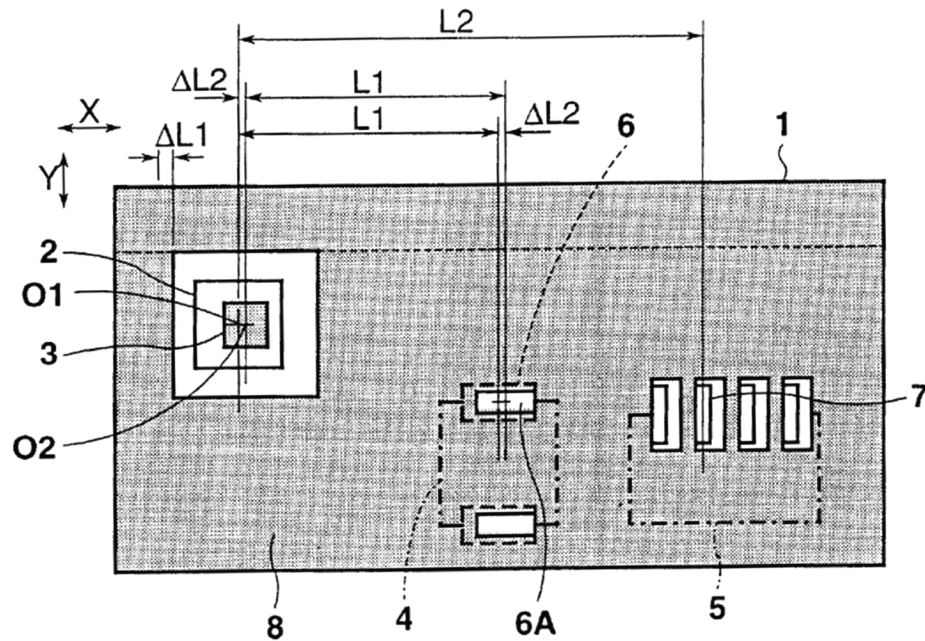
94. As discussed above regarding the combination of Takahashi and Shimasaki, A POSITA implementing the combination of Guang and Shimasaki would have been motivated to look for examples of LED lamps using structures that could reduce manufacturing cost for the reasons described above in paragraphs 29, 33, 36, and 37. Jing describes one such approach. Jing describes an LED lamp that results in reduced manufacturing cost for the LED tube, higher luminance, and better heat performance. Jing at ¶¶ [0006], [0018], [0032]. Specifically, Jing describes that a “structure that directly fixes the circuit board onto the inner wall of the lamp tube through the fixing layer **omits the metal bracket used to fix the circuit board in the LED fluorescent lamp tube in the prior art, and greatly reduces the manufacturing cost** of the LED fluorescent lamp.” Jing, ¶ [Summary]; see also ¶ [0018]. Accordingly, a POSITA would have been motivated to modify Guang-Shimasaki's LED tube lamp to use Jing's adhesive to securely attach the LED light

strip to the inner surface of the LED tube with the predictable result of to reduced manufacturing costs and increased luminance. It would have been obvious to a POSITA to try attaching the LED light strip with Jing's adhesive to Guang-Shimasaki's LED tube lamp because a POSITA would have expected this implementation to be successful in stably attaching the LED light strip to the light tube while reducing manufacturing costs.

E. Takigami

95. Takigami is titled “Printed Circuit Board with Resist Coating Defining Reference Marks.” (EX1008) Takigami teaches “[a] printed circuit board includes a first mark 2 formed by a thin conductor, a second mark 3 formed by a resist 8, a land 6 which is partially coated by the resist 8 and a land 7 which is not coated by the resist 8.” Takigami, Abstract. “The second mark 3 is formed when the land 6 is partially coated by the resist 8.” *Id.* “A device 4, which corresponds to the land 6, is mounted at a position apart from a center O2 of the second mark 3 by a predetermined distance L1.” *Id.* “A device 5, which corresponds to the land 7, is mounted at a position apart from a center O1 of the first mark 2 by a predetermined distance L2.” *Id.* “Therefor [sic], the devices 4, 5 can be properly mounted on the printed circuit board 1 in spite of a positional error of the resist 8.” *Id.*

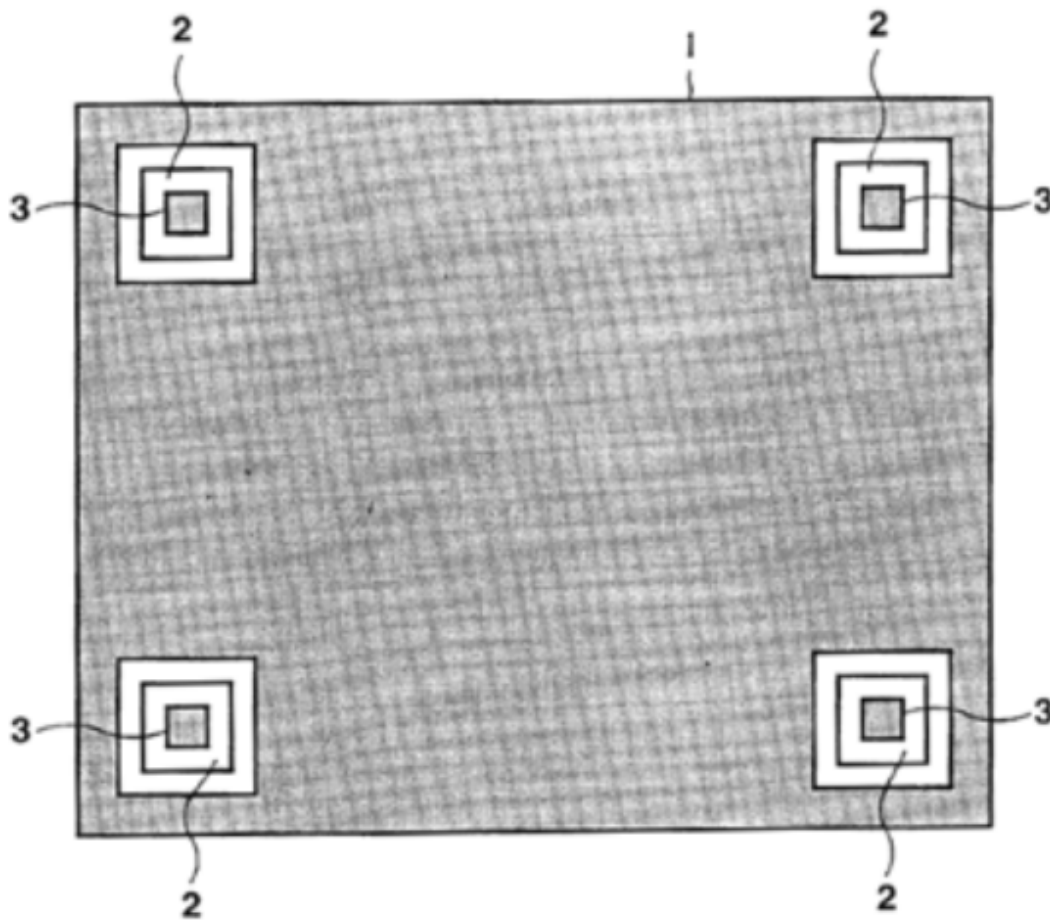
FIG. 1



96. In other words, as shown above in FIG. 1, Takigami discloses a solder resist layer on a printed circuit board that is masked to form openings or gaps to expose solder pads, or lands for mounting electric components. *See* Takigami, 3:29-44. Solder resists with openings were thus known in the art to persons of ordinary skill in the art. The solder resist layer includes an opening for mark 2 that can be used to position a mounter. *See* Takigami, 3:45-59. FIG. 4 below demonstrates that multiple openings exposing multiple marks 2 was also possible. *See* Takigami, 4:63-67 (“Generally, in a case that the resist 8 is rotated against the printed circuit board

1, it is very valid to form, at every corner of two or three or four corners of the printed circuit board 1, one set of the first mark 2 and the second mark 3.”). A POSITA would have understood that the use of two such marks would enable alignment in two dimensions (*e.g.*, X and Y) and the use of three marks would enable alignment in three dimensions (*e.g.*, X, Y, and rotational angle θ).

FIG. 4

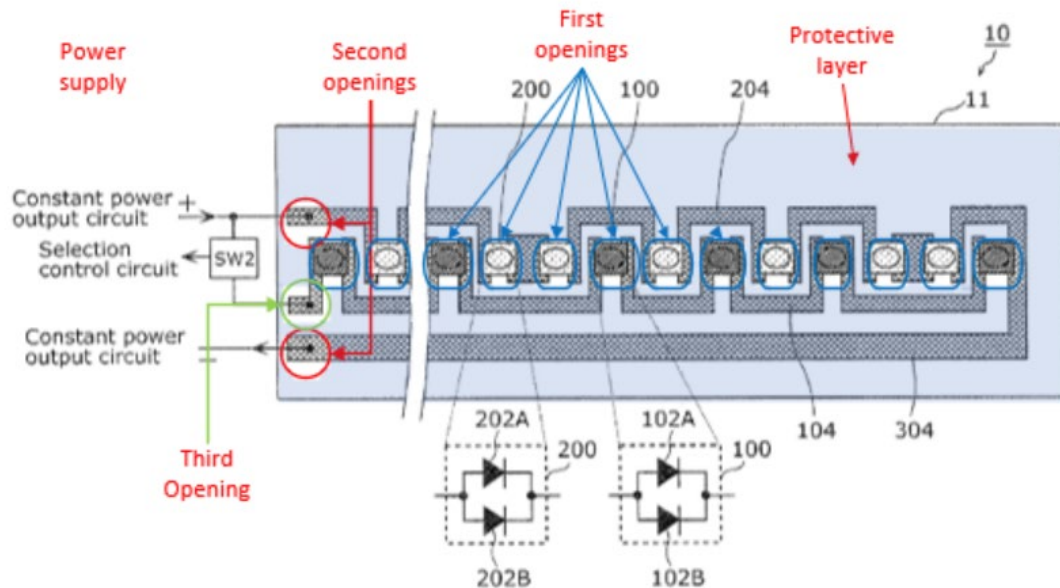


97. Takigami discloses that the use of openings or other recognizing marks to position mounters was known in the art prior to its invention: “When a mounter mounts devices 4, 5 such as electric parts on the printed circuit board 10, the mark 2 is recognized and used as an origin for mounting by the mounter. The mounter is a machine which is used for mounting devices on the printed circuit board.” Takigami, 1:18-21 (describing the prior art solution being improved upon).

1. It Would Have Been Obvious to Use a Third Opening in a Resist Layer Like in Takigami in the Modified Takahashi Tube Lamp

98. As explained above, the combinations of Takahashi-Shimasaki and Takahashi-Shimasaki- Jing rendered obvious the features of Claim 1 of the '125 Patent and its dependent claims, including Claim 2. There is nothing in the language of Claim 2 that prevents the “third opening” in the protective layer from being an opening for a third solder pad, as shown in green in Annotated FIG. 4 of Takahashi below, and as described in the '125 Patent. FIG.4 of Takahashi below shows three adjacent solder land sections, one for each of lines 104, 204, 304, and Shimasaki teaches that a protective layer should not be applied to the solder land sections. Takahashi, FIGs.4, 7; Shimasaki, 4:40-52, 6:26-34 See '125 Patent at 33:33-37 (describing LED light strips having more than 2 solder pads).

FIG. 4

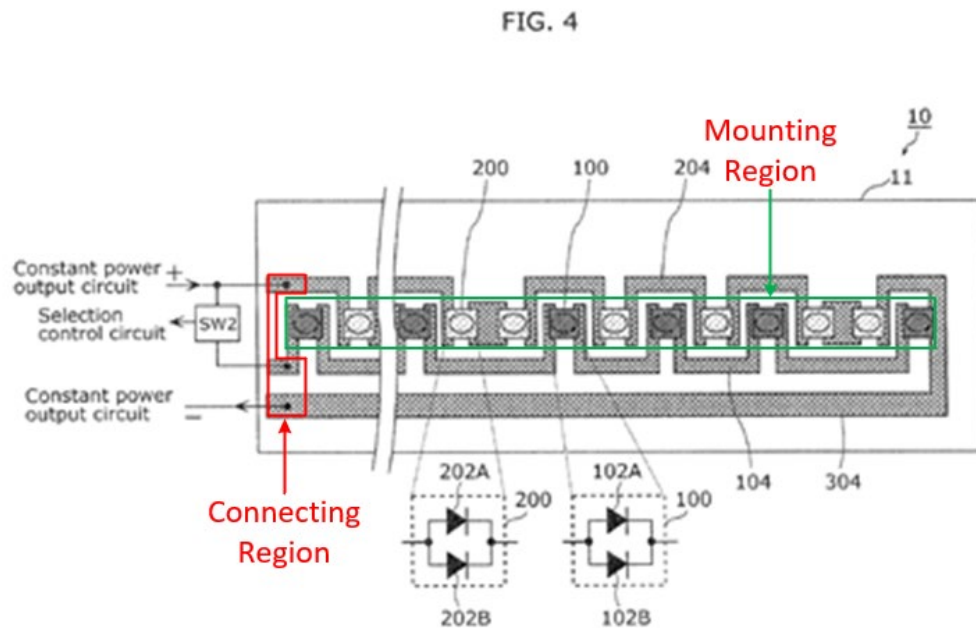


99. The '125 Patent also describes providing openings in the protective layer for elements other than soldering pads. *See* '125 Patent at 3:44-48 (exposing a through hole on the LED light strip), 4:60-62 (exposing a recognizing mark on the LED light strip). To the extent it could be argued that Claim 2 requires the “third opening” to be related to something other than a solder pad, Takahashi in view of Shimasaki and in further view of Takigami renders obvious “a third opening [in a protective layer] adjacent to two second openings”, as in Claim 2 of the '125 Patent. Takigami discloses coating a printed circuit board with a solder resist (i.e., a protective layer) and leaving openings in the resist. Takigami at 3:11-59. Takigami explicitly discloses providing openings in the resist layer for exposing a recognizing

mark (*e.g.*, a mark recognized by a mounter machine as a reference or origin) and for other purposes (*e.g.*, mounting electrical components to lands on the printed circuit board). *See* Takigami at FIGs. 1-4, 1:14-2:34.

100. A POSITA would have understood that a recognizing mark could be utilized with the LED strips of Takahashi and Shimasaki, which describe LED light strips having LED light sources (*i.e.*, electrical devices) mounted to and electrically connected to a wiring layer. A POSITA would have been motivated to incorporate a recognizing mark to enable a mounter, such as the mounter of Takigami, to be used to mount the LED light sources to their respective lands, as taught by Takigami, and explained in paragraph 37. A POSITA would further recognize that the protective layers taught by Takahashi and Shimasaki could include an opening for the recognizing mark, and would have been motivated to provide an opening in the protective layer for the recognizing mark to enable the mounter to accurately locate the recognizing mark and adjust for position errors, as taught by Takigami. Incorporating Takigami's openings in a resist (protective layer) to expose a recognizing mark into the LED tube lamp of Takahashi-Shimasaki would have thus been a known use of existing technology to improve manufacture of LED lamps. Takigami teaches that when the mounter locates the recognizing mark, it moves a programmed distance in one or more dimensions from the detected position of the

recognizing mark to mount an electrical device. *Id.* As explained above, at paragraphs 54-58, Takahashi teaches an LED light strip having a mounting region and a connecting region, where a plurality of LED light sources are mounted on the mounting region and at least two solder pads are arranged on the connecting region, as shown in annotated FIG. 4 of Takahashi below.



101. A POSITA would have understood that a recognizing mark could be arranged on the connecting region shown in annotated FIG. 4 of Takahashi above, and would have been motivated to position the recognizing mark in the connecting region to simplify programming of the mounter with respect to mounting each of the LED light sources to the LED light strip. This would enable the LED light strip to be manufactured in an automated or semi-automated manner in which a mounter

device is used to mount the LED light sources to their respective lands along the length of the LED light strip. For example, FIG. 4 of Takahashi illustrates that each of the LED light sources are arranged in a row and are approximately evenly spaced. A recognizing mark arranged on the connecting region would have enabled a POSITA to program the mounter to move incremental distances in a single direction or dimension (*e.g.*, left to right in FIG. 4) to mount each of the LED light sources (*e.g.*, mount LED1 at location (X_{1n}, Y) , mount LED2 at location (X_{2n}, Y) , and so on, where n represents the incremental distance to move the mounter between mounting each LED light source). This would simplify the manufacturing process and reduce costs.

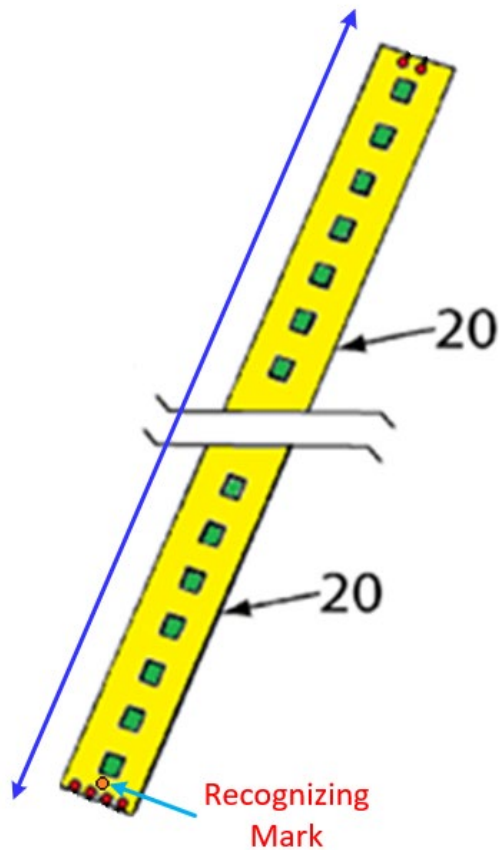
102. A POSITA would have further understood that using a mounter device and recognizing mark, as in the combination of Takahashi and Shimasaki above, provides additional benefits, such as reducing the cost of manufacturing the LED light strip, enabling smaller LED light sources to be utilized, providing a more energy-efficient LED tube lamp, as explained above in paragraphs 33, 36, and 37. These additional benefits realized by incorporating a recognizing mark exposed through an opening in a protective layer (*e.g.*, for recognition by a mounter device) would have further motivated a POSITA to incorporate recognizing marks and openings in the protective layer (*e.g.*, openings other than those pertaining to the

solder pads and LED light source mounting areas). Thus, when a POSITA would have designed an LED light strip, it would have been obvious to try including recognizing marks free from resist to enable an automated mounting process for the LED light sources to the strip, and the POSITA would have had a reasonable expectation that such an implementation would be successful.

2. *It Would Have Been Obvious to Use Openings in a Resist Layer Like in Takigami in the Modified Guang Tube Lamp*

103. As explained above in paragraphs 95-97, Takigami teaches that “a mark 2 . . . is formed on a . . . [substrate] . . . [and] is recognized and used as an origin for mounting by [a] mounter” device, where the mounter device “is a machine . . . used for mounting devices on the [substrate]”. Takigami at 1:14-21. The mounter device of Takigami is programmable such that once the mark is recognized, the mounter device can mount devices at different locations, referred to in Takigami as lands. *See* Takigami at 1:14-51, 3:11-25, and 4:22-5:15. Takigami also explains that “a resist material (a solder resist) . . . is generally coated on the [substrate] . . . except for the mark 2” and the lands. Takigami at 1:24-30. A POSITA would have understood that Takigami teaches providing openings in the resist layer (i.e., a protective layer) to expose elements other than soldering pads and LED mounting locations—namely, openings to expose recognizing marks, such as mark 2 of Takigami.

104. As discussed above in paragraphs 74-80, the combinations of Guang and Shimasaki, and Guang-Shimasaki-Jing result in an LED light strip having solder pads for connecting the LED light strip to a power supply and a resist layer having openings to expose areas for mounting LED light sources and solder pads. A POSITA would have understood that the resist layer (or protective layer) of the LED light strip produced by the combination of Guang and Shimasaki could incorporate a third opening, such as the openings exposing one or more recognizing marks, as taught by Takigami and discussed above at paragraphs 96-97. A POSITA would have been motivated to include a third opening in the resist layer of the Guang/Shimasaki LED light strip, as taught by Takigami, in order to enable a mounter device to mount devices on the LED light strip, such as the LED light sources. An example of the LED light strip produced by the combination of Guang, Shimasaki, and Takigami is shown below in the modified version of FIG. 1 of Guang.



105. It is noted that while the modified FIG. 1 of Guang shows the recognizing mark (and corresponding opening in the protective layer (yellow)) being located next to the soldering pads (red) and aligned with the LED light sources (green), a POSITA would have recognized that the recognizing mark could be located elsewhere on the LED light strip. A POSITA would have understood that providing a recognizing mark, as taught by Takigami, would enable the LED light strip to be manufactured in an automated or semi-automated manner in which a mounter device is used to mount the LED light sources (green) to their respective

lands along the length of the LED light strip. Furthermore, a POSITA would have understood that positioning the recognizing mark in alignment with the LED light source lands and adjacent to solder pads on an end of the LED light strip would provide additional benefits, such as enabling the recognizing mark to be recognized used as an origin by the mounter device in a manner that allows the mounter device to move in a single dimension or direction, shown by blue arrow to the left of the annotated image above, to place or mount each of the LED light sources (e.g., by shifting over). For example, FIG. 1 of Guang illustrates that each of the LED light sources are arranged in a row and are approximately evenly spaced. A recognizing mark arranged on the connecting region would have enabled a POSITA to program the mounter to move incremental distances in a single direction or dimension (e.g., left to right in FIG. 4) to mount each of the LED light sources (e.g., mount LED1 at location (X_{1n}, Y) , mount LED2 at location (X_{2n}, Y) , and so on, where n represents the incremental distance to move the mounter between mounting each LED light source). This would simplify the manufacturing process and reduce costs. This would simplify the manufacturing process and reduce costs. A POSITA would further recognize that the protective layer of Guang-Shimasaki or Guang-Shimasaki-Jing could include an opening for the recognizing mark, and would have been motivated to provide an opening in the protective layer for the recognizing mark to

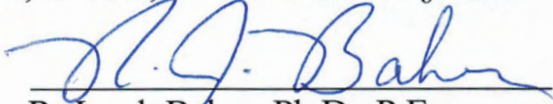
enable the mounter to accurately locate the recognizing mark and adjust for position errors, as taught by Takigami. *Id.* Incorporating Takigami's openings in a resist (protective layer) to expose a recognizing mark into the LED tube lamp of Guang-Shimasaki or Guang-Shimasaki-Jing would have thus been a known use of existing technology to improve manufacture of LED lamps. Takigami teaches that when the mounter locates the recognizing mark, it moves a programmed distance in one or more dimensions from the detected position of the recognizing mark to mount an electrical device.

106. A POSITA would have further recognized that using a mounter device and recognizing mark, as in the proposed combination of Guang, Shimasaki, and Takahashi above, provides additional benefits, such as reducing the cost of manufacturing the LED light strip, enabling smaller LED light sources to be utilized, providing a more energy-efficient LED tube lamp, as explained above in paragraphs 33, 36, and 37. The additional benefits realized by incorporating a recognizing mark exposed through an opening in a protective layer (e.g., for recognition by a mounter device) would further have motivated a POSITA to incorporate recognizing marks and openings in the protective layer (e.g., openings other than those pertaining to the solder pads and LED light source mounting areas).

XVII. CONCLUSION

107. All statements made herein of my own knowledge are true, all statements made herein on information and belief are believed to be true, and these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001.

Dated: December 14, 2022



R. Jacob Baker, Ph.D., P.E.