

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CURRENT LIGHTING SOLUTIONS, LLC d/b/a GE CURRENT

Petitioner

v.

JIAXING SUPER LIGHTING ELECTRIC APPLIANCE CO., LTD.

Patent Owner

Patent 9,945,520

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

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PETITIONER'S EXHIBIT LIST

Exhibit	Shorthand	Description
1001	'520 Patent	U.S. Patent No. 9,945,520
1002	'520 File History	Excerpts of Prosecution History of U.S. Patent No. 9,945,520
1003	Baker	Declaration of R. Jacob Baker, Ph.D.
1004	Baker CV	CV of R. Jacob Baker, Ph.D.
1005	Shimizu	Japanese Patent Publication JP 2014-154479A to Shimizu Certified Translation
1006	Ono	Japanese Patent Publication JP 2014-103000A to Ono Certified Translation
1007	Foo	PCT Publication No. WO2013/152485 A1 to Foo
1008	Wilcox	U.S. Patent No. 9,726,330 to Wilcox
1009	Holec	U.S. Patent No. 7,980,863 to Holec
1010	Leong	U.S. Patent No. 6,762,562 to Leong
1011	Levante	U.S. Patent No. 9,057,504 to Levante
1012	Li	U.S. Patent No. 8,262,250 to Li
1013	Kawabata	U.S. Patent No. 8,591,057 to Kawabata
1014	Sato	Japanese Patent Publication JP 2010-153579A to Sato Certified Translation
1015	Deng	Chinese Patent No. CN203797412U to Deng Certified Translation
1016	Liu	LED Packaging for Lighting Applications – Design, Manufacturing and Testing, Sheng Liu et al., Chemical Industry Press (2011)
1017	Guang	U.S. Patent No. 9,338,853 to Guang
1018	Draft Stipulation	Draft Stipulation of Invalidity Contentions
1019	Scheduling Order	Litigation Scheduling Order

Exhibit	Shorthand	Description
1020		Chinese Patent Publication 103899939A to Li Certified Translation
1021		U.S. Patent No. 9,271,354 to Takahashi

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. 9,945,520 (the “520 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:

- 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;
- merely substituting one known element for another known element in the field, and the substitution yields no more than a predictable result;

- 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;
- whether design incentives or other market forces in a field prompted variations in a work that were predictable to a POSITA;
- 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 '520 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 November 6, 2014, it is my opinion that a POSITA as to the '520 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 POSITA 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 '520 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 November 6, 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 '520 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 November 6, 2014.

V. OVERVIEW OF THE TECHNICAL FIELD AND PRIOR ART

29. The '520 Patent is directed to “an LED tube lamp and its components including the light sources, a tube, electronic components, and end caps.” EX1001, Abstract, 1:17-20. The '520 Patent describes an LED tube lamp including a tube

100 with two ends and a heat shrink sleeve 190 that covers the outer surface of the tube 100. *Id.*, 9:30-32. 5:5-9, 5:12-15.

A. Fluorescent lamps

30. At the time of the '520 Patent, fluorescent lamps were in common use. EX1001, 1:24-27. "A fluorescent lamp consists of a glass tube filled with an inert gas (usually argon) at low pressure. On each side of the glass tube is an electrode. Electricity is passed through the gas, causing an arc of illumination." EX1017, 1:22-25. "Historically, fluorescent lamps use AC power, effectively meaning that the electrode that functions as the cathode switches back and forth." *Id.*, 2:1-3.

31. "As electrical current forms an arc through the lamp, it ionizes a higher percentage of the tube's contained gas molecules. The more molecules that are ionized, the lower the resistance of the gas. If too many gas molecules are ionized, the resistance will drop to the point that an electrical short would occur." *Id.*, 2:13-18. "Therefore, the ballast [included in the fluorescent lamp] also contains electronic components that control the current, preventing the current through the lamp from rising to the point that the lamp would burn out." *Id.*, 2:18-21. "An electrical ballast is a device that intended to limit the amount of current in an electric circuit." *Id.*, 1:45-47. "The ballast is typically physically located in a box mounted near its lamp or lamps." *Id.*, 1:63-65. The electrical ballast "contains electronic components that control the current, preventing the current through the lamp from rising to the point

that the lamp would burn out. Electronic ballasts use semiconductors to limit power to a fluorescent lamp.” *Id.*, 2:18-22. “The ballast is typically physically located in a box mounted near its lamp or lamps.” *Id.*, 1:63-65. The electrical ballast “contains electronic components that control the current, preventing the current through the lamp from rising to the point that the lamp would burn out. Electronic ballasts use semiconductors to limit power to a fluorescent lamp.” *Id.*, 2:18-22.

B. The Rise of LED Lamps

32. “[T]here has been over the past decade an enormous commercial move toward replacing both incandescent and fluorescent light fixtures with light-emitting diode (LED) lighting.” EX1017, 4:13-16. “LEDs have advantages over those prior light sources: lower energy consumption, longer life, improved robustness, smaller size, and the ability to be switched on and off faster.” *Id.*, 4:20-22.

C. Bendable LED Light Strips and Direct Connections

33. LEDs for use in tube lamps were typically mounted in arrays on LED light strips made of various materials, including traditional printed circuit boards (PCBs) and flexible circuit boards or strips with a freely extending end that connects to a power supply. Flexible or bendable circuit boards were common as discussed, for example, in Wilcox that teaches “[t]he substrate 20 [with LEDs 10] may comprise a flex circuit 20a where the flex circuit 20a may comprise 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.” EX1008, 7:46-51. Levante also teaches that “flexible LED light strips, have become increasingly popular in various applications.” EX1011, 1:38-40. Other references disclose that “[t]he lighting strip devices can be made of flexible material to allow for applying the lighting devices along flat as well as contoured surfaces” (EX1012, 1:22-24), and “[t]he present invention relates to a flexible LED substrate that is well-suited for making a long display” (EX1014, [0001]). Holec also teaches that “the present invention is directed towards flexible lighting circuit boards and more directly towards flexible LED circuit boards.” EX1009, 6:43-47, 1:19-26, 7:1-6, 11:23-65, Cl. 2. And Kawabata teaches that “LED bare chips 11” are mounted on a “flexible wiring substrate 34.” EX1013, 22:13-50.

34. Connecting freely extending ends of flexible LED light strips to other devices directly using solder pads was also well-known as taught by Holec. EX1009, 8:52-9:8, 12:52-59, FIGS. 8, 11a, 11b, 12, 13a, 13b. Other references teach soldering directly to other devices, for example, “[t]he end of the flexible LED light strip may be attached by soldering the LED light strip to the connector.” EX1011, 1:54-55. Kawabata also teaches directly soldering via leads: “[t]he leads 51 are provided at ends of the power supply substrate 5 spaced in the longitudinal direction, with one end of each lead fixed to the power supply substrate 5 with solder while the other end of the lead soldered to a pad (not shown) provided on the mount surface

2a of the substrate 2.” EX1013, 11:41-50; *see also* EX1014, [0012] (“FIG. 3 is a plan view where a plurality of LEDs 31 are mounted with substantially equal spacing on the flexible LED substrate. Lead wires of a power supply may be soldered to the power supply interconnection exposing portion 32 in order to connect the power supply for the LED lighting, or power supply cables may be connected to a connector 33.”). As such, in my opinion, a POSITA would have been familiar with manufacturing flexible or bendable LED light strips and connection methods for LED light strips and other devices, such as power supplies.

D. Heat Dissipation

35. LED lighting devices generate heat that, if not dissipated, can reduce performance and damage components of an LED lighting device. EX1016, 167/367, 201/367, 203/367. “Therefore, it is crucial to rapidly remove the heat and keep the junction temperature below a certain limit for the maintenance of performance.” *Id.*, 167/367. As such, a POSITA would have understood the importance of heat management in an LED lighting device.

36. A POSITA also would have known about the use of vents to provide air flow through an LED lamp to dissipate heat. Deng, for example, teaches that “[a]ir vents 12 in an appropriate quantity and size can be opened on the end faces of the end covers 10 according to the power and heat output of the LEDs 32.” EX1015, [0037], cl. 10.

E. Heat Shrink Sleeves for LED Tubes

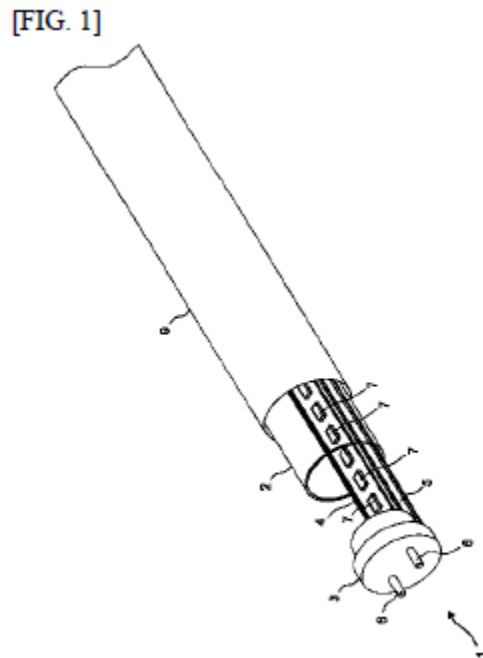
37. A POSITA would have been familiar with the use of heat shrink sleeves. LED tube lamps often included an exterior heat shrink sleeve to prevent shattering the glass tube in the event the tube is damaged. EX1005, [0010]. For example, Shimizu teaches that “[t]he outer periphery of the glass tube 2 is covered with a translucent milky white heat-shrinkable tube 9.” EX1005, [0017]. Shimizu’s heat shrink sleeve aids in the “dispersion of heat” and also “prevents scattering of broken shards when the glass tube 2 is damaged.” *Id.*, [0010], [0017], [0022]-[0024]. Wilcox also teaches that the outside surface of a tube 2 has a diffusing layer 14 made from a cylindrical PET film tube. EX1008, 6:43-44, 6:57-60. The PET tube is heat shrunk to the exterior of the tube 2 and provides “a shatterproof coating in addition to providing additional diffusion.” *Id.*, 6:59-66.

F. Shimizu (EX1005)

38. Shimizu is titled “LED lamp.” Shimizu was published on August 25, 2014. I understand that Shimizu qualifies as prior art to the ’520 Patent.

39. Shimizu teaches that and LED lamp “has a glass tube 2 that forms a cylinder.” EX1005, [0012]. “Both ends of the glass tube 2 are closed by caps 3.” *Id.*, [0013]. “The cap 3 has a power supply terminal 6.” *Id.*, [0014]. “The substrate 4 is structured through laying out a large number of LED elements 7 on a wiring board, for example, and mounting a driving circuit (omitted from the drawings) for

driving the LED elements 7 so as to emit light.” *Id.*, [0016]. “The outer periphery of the glass tube 2 is covered with a translucent milky white heat-shrinkable tube 9.” *Id.*, [0017].



Id., FIG. 1.

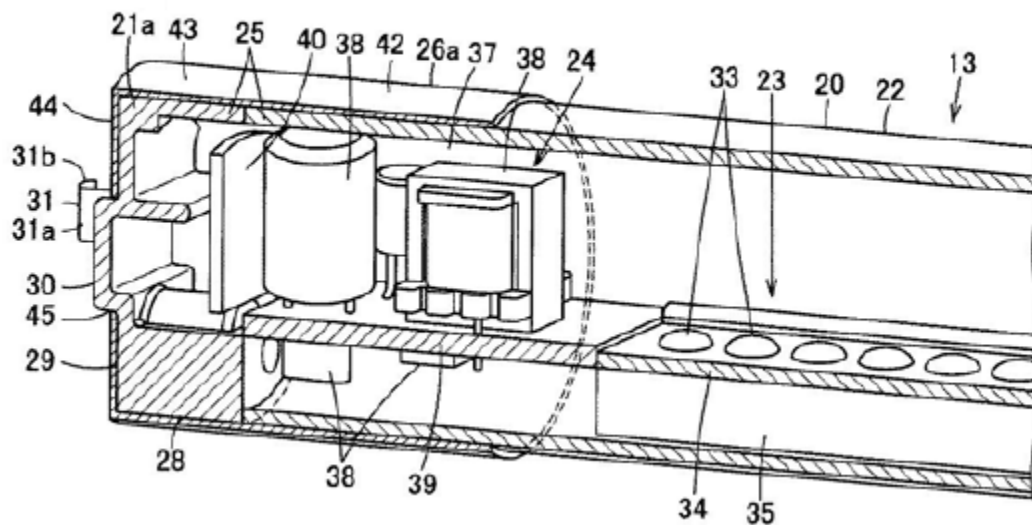
G. Ono (EX1006)

40. Ono is titled “Straight Tube Lamp and Lighting Device.” Ono was published on June 5, 2014. I understand that Ono qualifies as prior art to the ’520 Patent.

41. “The straight tube lamp 13 includes a light source unit 23 having light emitting elements 33, a lighting circuit 24 for lighting the light emitting elements 33, and a lamp unit 22 housing the light source unit 23 and the lighting circuit 24.

The lamp unit 22 includes a straight tube 20 that is at least partially translucent, and a cap 21a disposed on one end of the tube 20. The lighting circuit 24 is covered with an insulator 25, and the lighting circuit 24 is covered with a non-combustible cover 26a via the insulator 25.” EX1006, [Solution].

[Fig. 1]



Id., FIG. 1.

42. “The lighting circuit 24 receives commercial alternating current power from the cap 21a on one end, converts the alternating current power into direct current power for lighting the light emitting elements 33, and supplies the direct current power to the light emitting elements 33.” *Id.*, [0017]. “The lighting circuit 24 is housed inside the tube 20 on one end in a lighting circuit housing portion 37 between the light source unit 23 housed inside the tube 20 and the cap 21a attached to one end of the tube 20. The lighting circuit 24 has a circuit board 39 on which a plurality of electronic components 38 have been mounted. Lead components such

as capacitors and inductors are mounted on the mounting surface of the circuit board 39, and surface mounted components such as resistors and switching elements are mounted on the wiring pattern surface.” *Id.*

H. Foo (EX1007)

43. Foo is titled “LED Light Tube For Use In Fluorescent Light Fixture.” Foo was published on October 17, 2013. I understand that Foo qualifies as prior art to the ’520 Patent.

44. Foo describes “a need for a LED light tube that increases luminous efficiency and has reduced loss of light energy.” EX1007, 2:23-26. “The present invention has been developed to fulfill the needs noted above and therefore has a principle object of the provision of a LED light tube which produces evenly-distributed high lumens output along the length of the tube and covers an illumination angle of 270 degrees or above.” *Id.*, 2:29-32.

45. Foo discloses an “LED light tube 100 comprises a casing 10, a heat sink 20, a circuit board 30, a plurality of LED light sources 40, and two end caps 50.” *Id.*, 6:11-14. “The inner surface of the casing 10 may be constructed to have a surface roughness of smaller than 0.8μm to enhance the reflectance and reflux of the light.” *Id.*, 10:18-20, FIG. 2. Foo discloses that “the casing has an inner surface with a surface roughness smaller than 0.8μm.” *Id.*, cl. 8. “By selecting a material having an appropriate combination of light diffusion, transmission and reflection

characteristics, the casing can produce an evenly-distributed illumination along the length of the tube with high luminous efficiency [A]dvantageously the material is constructed to have a surface roughness smaller than $0.8\mu\text{m}$, e.g. $6\mu\text{m}$ or $7\mu\text{m}$ ” (*sic*).
Id., 3:17-22.

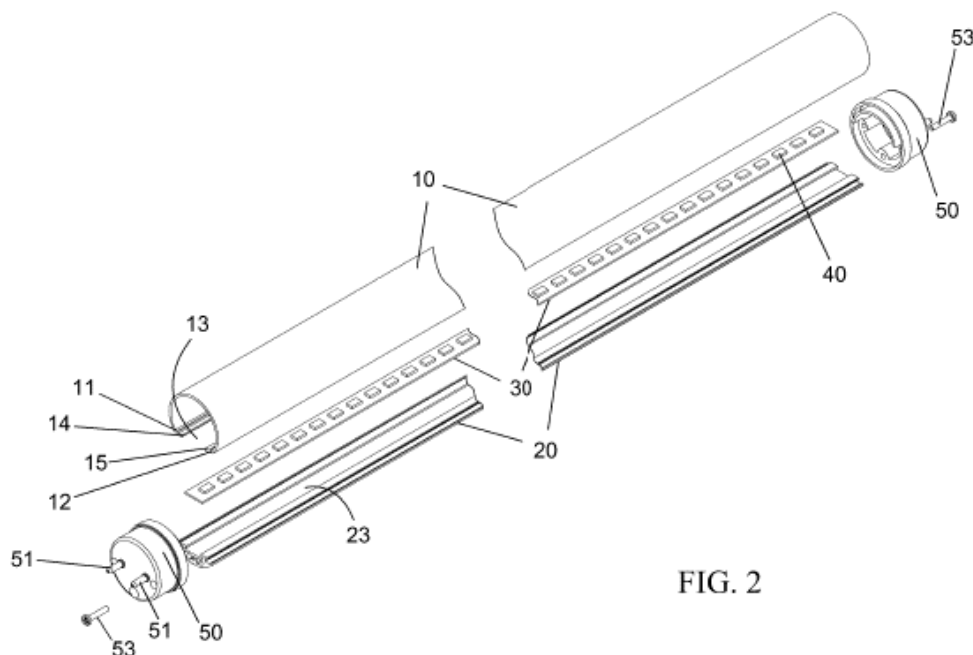


FIG. 2

Id., FIG. 2.

I. Holec (EX1009)

46. Holec is titled “Printed Circuit Boards Flexible Interconnect Design.” Holec issued on July 19, 2011. I understand that Holec qualifies as prior art to the ’520 Patent.

47. Holec notes that for some LED applications, “it is advantageous to have interconnections between circuit boards which are highly reliable, carry significant levels of current or voltage without loss, are protected from mechanical damage and

shorting, allow various shapes and geometries of connection and are easy and efficient to apply.” EX1009, 2:28-35. Holec further teaches that “the present invention is directed towards flexible lighting circuit boards and more directly towards *flexible [e.g., bendable] LED circuit boards.*” *Id.*, 6:43-47, 1:19-26, 7:1-6, 11:23-65, Cl. 2.

48. Holec discloses a method for interconnecting printed circuit boards in LED applications where at least one board is a flexible LED circuit board. *Id.*, 1:19-26. Holec describes overlapping circuit boards to provide an interconnection. EX1009, 8:50-52. This allows a direct connection between two circuit boards. *Id.*, 8:52-9:8.

49. As shown in FIG. 8, a top board 6 or 13 includes conductive pads and a bottom board 5 or 39 includes conductive pads. *Id.*, 8:50-9:8, 12:52-59, FIGS. 8, 11a, 11b, 12, 13a, 13b.

50. The conductive pads are soldered directly to one another with overlapping joints 26 with one board having a vertical step offset 41 at its freely extending end. *Id.*, 9:26-28, 12:52-59. This electrically connects the two boards. *Id.*, 8:52-9:8, 12:52-59, cl. 1, 2.

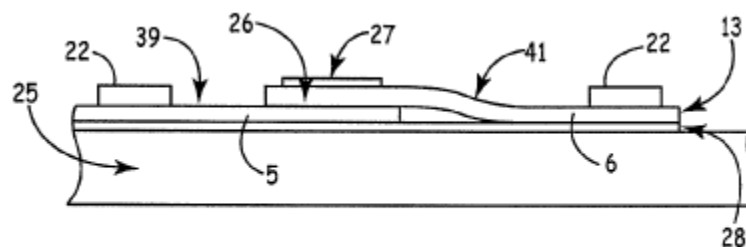


FIG. 8

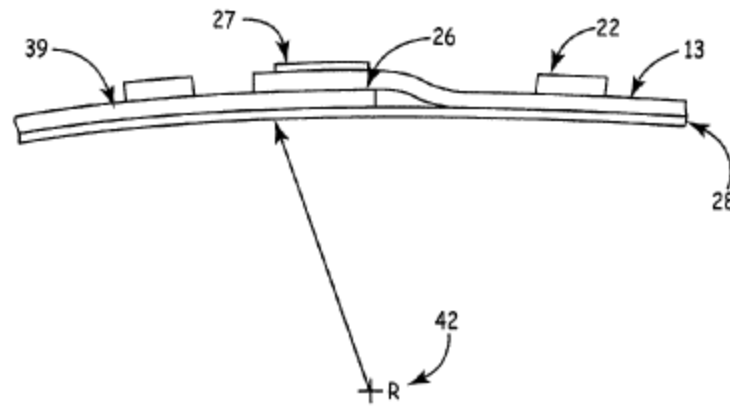


FIG. 14

Id., FIGS. 8 and 14.

51. FIGS. 11a, 11b, 12, 13a, and 13b illustrate LEDs 22, integrated circuits 36, and conductive pads 30, 31, 33, and 38 that include through holes 1 on boards 13 and 5. *Id.*, 8:40-9:17, 9:26-28, 9:38-41, 10:48-54, 11:13-22, 11:60-63, FIGS. 11a, 11b, 12, 13a, and 13b.

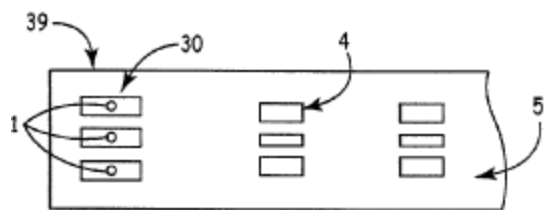


FIG. 11a

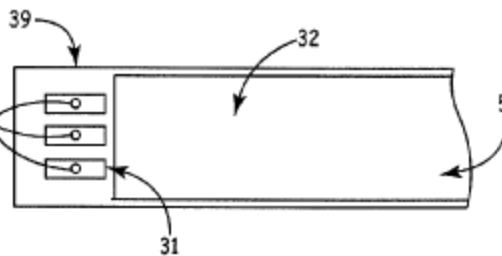


FIG. 11b

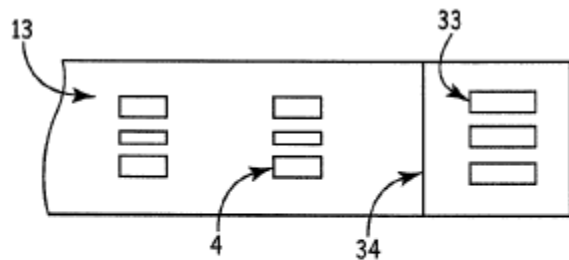


FIG. 12

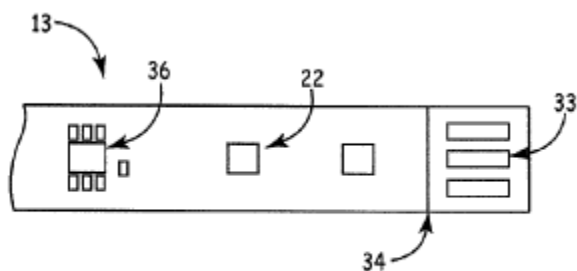


FIG. 13a

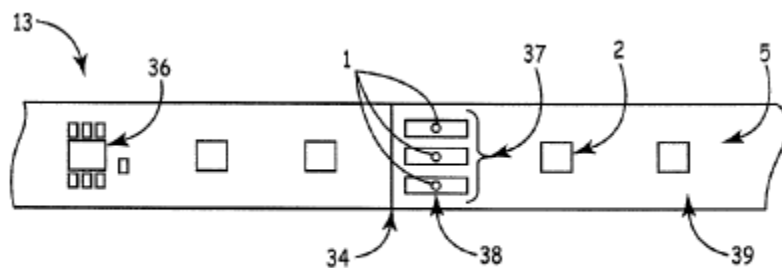


FIG. 13b

J. Leong (EX1010)

52. Leong is titled “Tubular Housing with Light Emitting Diodes.” Leong issued on July 13, 2004. I understand that Leong qualifies as prior art to the ’520 Patent.

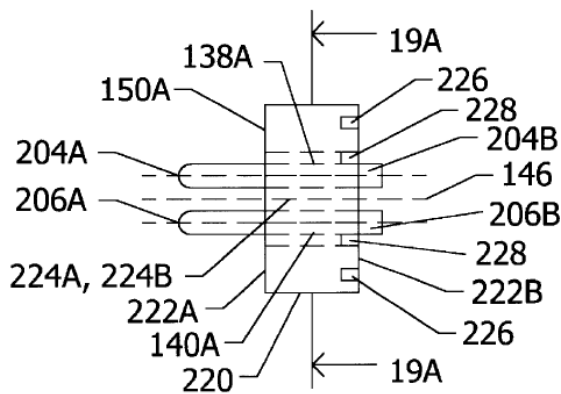


FIG. 19

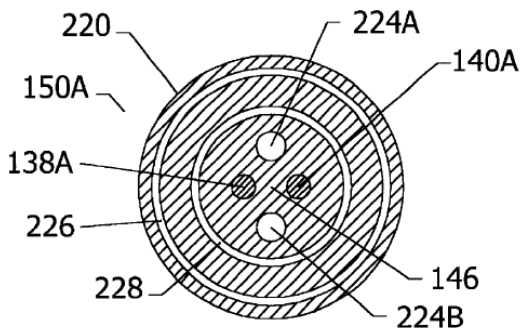


FIG. 19A

Id., FIGS. 19, 19A.

VI. THE '520 PATENT

55. The '520 Patent is directed to "an LED tube lamp and its components including the light sources, a tube, electronic components, and end caps." EX1001, Abstract, 1:17-20. The '520 Patent describes an LED tube lamp including a tube 100 with two ends and a heat shrink sleeve 190 that covers the outer surface of the tube 100. *Id.*, 9:30-32. 5:5-9, 5:12-15. Inside the tube is a LED light strip 200 with multiple LED lights 202 are mounted. *Id.*, 5:51-52. End cap 300 is attached to each tube end and inside at least one end cap is a power supply 400. *Id.*, 5:12-15. 5:52-53, FIG. 6. Each end cap 300 includes an end wall, conductive pins 301, and openings 304 to provide heat dissipation. *Id.*, 12:4-8, 12:16-20. Power supply 400 includes electronic components 430 and is connected to light strip 205 via soldering pads a and b. *Id.*, 9:52-57, 10:16-25, 10:38-40, FIGS. 7-8.

56. As acknowledged by the '520 Patent, prior art LED lamps include a rigid substrate for the LED light strip that can be damaged yet the tube lamp remains straight even if partially ruptured or broken, resulting in a potentially dangerous situation for users. EX1001, 1:24-59. 1:40-45. The rigid substrate is typically connected to the end caps using wire bonding that may be easily damaged or broken during manufacturing, transportation, and usage that will disable the lamp. *Id.*, 1:46-48. 1:48-51. The '520 Patent also notes that as electro-optical conversion efficiency increases, the heat generated by the LEDs increases and prior art lamps did not include ventilating holes for dissipating heat. *Id.*, 1:52-56.

A. Challenged Claims

57. I understand that Claims 1-3, 9-13, 16, 18-20, 22, 25, 28, 29, 31-39, 42, 44, 45, 47, 49, 50, 54, 58-60, 64, and 68 of the '520 Patent are Challenged Claims. Claims 1, 10, 19, and 29 are independent. Claims 2, 3, 9, 31, and 32 depend from independent Claim 1, Claims 11-13, 16, 18, 33, and 34 depend from independent Claim 10, Claims 20, 22, 25, 28, 33, 35, 36, 39, 42, 49, 50, 54, and 58 depend from independent Claim 19, and Claims 37, 38, 44, 45, 47, 59, 60, 64, and 68 depend from independent Claim 29.

58. The '520 Patent, Claim 1 reads:

1[p] An LED tube lamp, comprising:

1[a] a glass tube covered by a heat shrink sleeve and having two end portions;

1[b] a plurality of LED light sources;

1[c] two end caps respectively sleeving the two end portions of the glass tube;

1[d] a power supply in one of the end caps or separately in both of the end caps; and

1[e] an LED light strip on an inner surface of the glass tube forming a freely extending end portion at one end along a longitudinal direction of the glass tube, the freely extending end portion directly soldered to the power supply, the plurality of LED light sources being on the LED light strip;

1[f] wherein each of the end caps comprises: an end wall; and

1[g] two conductive pins on the end wall.

59. The '520 Patent, Claim 2 reads:

2 The LED tube lamp according to claim 1, further comprising at least two openings on the end wall symmetric to each other with respect to a plane passing through the middle of a line connecting the two pins and perpendicular to the line connecting the two pins.

60. The '520 Patent, Claim 3 reads:

3 The LED tube lamp according to claim 2, wherein the at least two openings are on a surface of the end wall on which the two pins are disposed.

61. The '520 Patent, Claim 9 reads:

9 The LED tube lamp according to claim 1, wherein at least a part of the openings are arranged along an arc and spaced apart from each other.

62. The '520 Patent, Claim 10 reads:

10[p] An LED tube lamp, comprising:

10[a] a glass tube comprising an inner surface and an outer surface, at least part of the inner surface of the glass tube has a rough surface, the glass tube having two end portions;

10[b] a plurality of LED light sources;

10[c] two end caps respectively sleeving the two end portions of the glass tube;

10[d] a power supply in one of the end caps or separately in both of the end caps; and

10[e] an LED light strip on the inner surface of the glass tube forming a freely extending end portion at one end along a longitudinal direction of the glass tube, the freely extending end portion directly soldered to the power supply, the plurality of LED light sources being on the LED light strip.

63. The '520 Patent, Claim 11 reads:

11 The LED tube lamp according to claim 10, wherein the roughness of the rough surface is substantially from 0.1 to 40 μm .

64. The '520 Patent, Claim 12 reads:

12 The LED tube lamp according to claim 10, wherein each of the end caps comprises a plurality of openings thereon, and the two sets of the plurality of openings are symmetric to each other with respect to a virtual central axis of the end cap.

65. The '520 Patent, Claim 13 reads:

13 The LED tube lamp according to claim 12, wherein the plurality of openings dissipate heat resulted from the power supply.

66. The '520 Patent, Claim 16 reads:

16 The LED tube lamp according to claim 10, wherein the plurality of openings are separately in a shape of a circle.

67. The '520 Patent, Claim 18 reads:

18 The LED tube lamp according to claim 12, wherein at least a part of the openings are arranged along an arc and spaced apart from each other.

68. The '520 Patent, Claim 19 reads:

19[p] An LED tube lamp, comprising:

19[a] a glass tube having two end portions;

19[b] a plurality of LED light sources;

19[c] two end caps respectively sleeving the two end portions of the glass tube, each of the end caps comprising two pins and a plurality of openings, the two pins being on a surface of the end cap, the plurality of openings being on the surface of the end cap and divided into two sets, and the two sets of the openings being symmetric to each other with respect to a plane passing through the two pins;

19[d] a power supply disposed in at least one of the end caps; and

19[e] an LED light strip on an inner surface of the glass tube forming a freely extending end portion at one end along a longitudinal direction of the glass tube, the freely extending end portion directly soldered to the power supply, the plurality of LED light sources being on the LED light strip.

69. The '520 Patent, Claim 20 reads:

20 The LED tube lamp according to claim 19, wherein the power supply comprises a current-limiting element, and the plurality of openings dissipate heat resulted from the power supply.

70. The '520 Patent, Claim 22 reads:

22 The LED tube lamp according to claim 20, wherein the surface of the end cap is vertical to the length direction of the glass tube.

71. The '520 Patent, Claim 25 reads:

25 The LED tube lamp according to claim 20, wherein the plurality of openings are separately in a shape of a circle.

72. The '520 Patent, Claim 28 reads:

28 The LED tube lamp according to claim 20, wherein at least a part of the openings are arranged along an arc and spaced apart from each other.

73. The '520 Patent, Claim 29 reads:

29[p] An LED tube lamp, comprising:

29[a] a glass tube;

29[b] a plurality of LED light sources;

29[c] two end caps respectively at two opposite ends of the glass tube;

29[d] a power supply in one of the end caps or separately in both of the end caps; and

29[e] an LED light strip on an inner surface of the glass tube forming a freely extending end portion at one end along a longitudinal direction of the glass tube, the freely extending end portion directly soldered to the power supply, the plurality of LED light sources being on the LED light strip;

29[f] wherein each of the end caps comprises: an end wall;

29[g] two pins on the end wall; and

29[h] at least two openings on the end wall symmetric to each other with respect to a plane passing through the middle of a line connecting the two pins and perpendicular to the line connecting the two pins.

74. The '520 Patent, Claim 31 reads:

31 The LED tube lamp according to claim 1, wherein the LED light strip is a bendable circuit sheet.

75. The '520 Patent, Claim 32 reads:

32 The LED tube lamp according to claim 1, wherein the end cap comprises a metal part.

76. The '520 Patent, Claim 33 reads:

33 The LED tube lamp according to claim 10, wherein the LED light strip is a bendable circuit sheet.

77. The '520 Patent, Claim 34 reads:

34 The LED tube lamp according to claim 10, wherein the end cap comprises a metal part.

78. The '520 Patent, Claim 35 reads:

35 The LED tube lamp according to claim 19, wherein the LED light strip is a bendable circuit sheet.

79. The '520 Patent, Claim 36 reads:

36 The LED tube lamp according to claim 19, wherein the end cap comprises a metal part.

80. The '520 Patent, Claim 37 reads:

37 The LED tube lamp according to claim 29, wherein the LED light strip is a bendable circuit sheet.

81. The '520 Patent, Claim 38 reads:

38 The LED tube lamp according to claim 29, wherein the end cap comprises a metal part.

82. The '520 Patent, Claim 39 reads:

39 The LED tube lamp according to claim 20, wherein the current-limiting element comprises a resistor, a capacitor, an inductor, or any combination thereof.

83. The '520 Patent, Claim 42 reads:

42 The LED tube lamp according to claim 19, wherein the power supply comprises a rectifying circuit and a filtering circuit disposed in at least one of the end caps, and the plurality of openings are for dissipating heat from the power supply.

84. The '520 Patent, Claim 44 reads:

44 The LED tube lamp according to claim 29, wherein the power supply comprises a current-limiting element disposed in at least one of the end caps, and the at least two openings are for dissipating heat from the power supply.

85. The '520 Patent, Claim 45 reads:

45 The LED tube lamp according to claim 44, wherein the current-limiting element comprises a resistor, a capacitor, an inductor, or any combination thereof.

86. The '520 Patent, Claim 47 reads:

47 The LED tube lamp according to claim 29, wherein the power supply comprises a rectifying circuit and a filtering circuit disposed in at least one of the end caps, and the at least two openings are for dissipating heat from the power supply.

87. The '520 Patent, Claim 49 reads:

49 The LED tube lamp according to claim 19, wherein the power supply further comprises a circuit board with two second bond pads.

88. The '520 Patent, Claim 50 reads:

50 The LED tube lamp according to claim 49, wherein each of the second bond pads comprises a through-hole.

89. The '520 Patent, Claim 54 reads:

54 The LED tube lamp according to claim 19, wherein the light bar comprises two first bond pads at a first end.

90. The '520 Patent, Claim 58 reads:

58 The LED tube lamp according to claim 19, wherein the power supply comprises a printed circuit board and the light bar comprises a bendable circuit sheet.

91. The '520 Patent, Claim 59 reads:

59 The LED tube lamp according to claim 29, wherein the power supply further comprises a circuit board with two second bond pads.

92. The '520 Patent, Claim 60 reads:

60 The LED tube lamp according to claim 59, wherein each of the second bond pads comprises a through-hole.

93. The '520 Patent, Claim 64 reads:

64 The LED tube lamp according to claim 29, wherein the light bar comprises two first bond pads at a first end.

94. The '520 Patent, Claim 68 reads:

68 The LED tube lamp according to claim 29, wherein the power supply comprises a printed circuit board and the light bar comprises a bendable circuit sheet.

B. Prosecution History

95. I have reviewed the prosecution history of the '520 Patent. The '520 Patent issued from an application filed on April 10, 2017, U.S. Patent Application No. 15/483,368.

96. On July 7, 2017, the Examiner issued a non-final office action that rejected all pending claims. EX1002, 170/249. The Examiner rejected then pending claim 1-10 and 13-34 as rendered obvious by the combination of Guang (US 2016/0081147) in view of Wilcox (US 2015/0176770), Leong-814 (US 2008/0290814), and Chen (US 2011/0038146). *Id.*, 171/249, 177/249. The Examiner rejected claims 11-12 as rendered obvious by the combination of Guang, Wilcox, and Leong-814. *Id.*, 175/249.

97. On October 6, 2017, the applicant filed a response that included a substitute specification and new drawings. *Id.*, 62-63/249. The applicant also amended the independent claims 1, 11, 22, and 33 to recite “an LED light strip on an inner surface of the glass tube forming a freely extending end portion at one end along a longitudinal direction of the glass tube, the freely extending end portion directly soldered to the power supply, the plurality of LED light sources being on the LED light strip.” *Id.*, 64-69/249. The applicant argued that none of the asserted referenced disclosed this limitation. *Id.*, 74-78/249.

98. On November 17, 2017, the Examiner issued a notice of allowance indicating “the prior art of record fails to teach, disclose or render obvious the applicant's invention as claimed, particularly the feature describing: an LED light strip on an inner surface of the glass tube forming a freely extending end portion at one end along a longitudinal direction of the glass tube, the freely extending end portion directly soldered to the power supply, the plurality of LED sources being on the LED light strip.” *Id.*, 28-34/249.

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

99. I understand claims are to be given their ordinary and customary meaning to a POSITA in view of the claims, specification, and prosecution history. I also understand that Applicants can define their own claim terms in the specification, which will be used when interpreting the claims.

1. “an LED light strip on an inner surface of the glass tube”

100. In my opinion, “an LED light strip on an inner surface of the glass tube” means either directly on, with no intervening components, or indirectly on, with at least one intervening component. My opinion is informed by the ’520 Patent. When a claim of the ’520 Patent requires a direct interface, the term “directly” is used, as shown in limitations 1[e], 10[e], 19[e]. and 29[e]. Additionally, the ’520 Patent used the term “directly” when a direct bonding is required. EX1001, 6:35-38 (“In another alternative embodiment, the dielectric layer can be omitted, in which the wiring layer is directly bonded to the inner circumferential surface of the glass tube 100.”); *see also id.*, 8:61-9:19, FIG. 4 (reflective film 120 disposed between light sources 202 and inner surface of the lamp tube); 3:18-19, FIG. 2. Therefore, the patent describes both directly on, with no intervening components, or indirectly on, with at least one intervening component.

VII. COMPARISON OF THE PRIOR ART TO THE CHALLENGED CLAIMS

A. Ground 1 - Claims 19, 20, 22, 25, 28, 29, 35-39, 42, 44, 45, 47, 49, 50, 54, 58-60, 64, and 68 Are Obvious Over Ono in view of Holec and Leong

1. Motivation to Combine Ono and Holec, and Ono-Holec and Leong

101. Ono discloses an LED lamp including a glass tube, light sources on a light strip, end caps, and a power supply as lighting circuit 24. EX1006, [Solution]. Ono’s lighting circuit 24 provides an example of installing capacitors, resistors, and other

electronic components on a PCB at the end of a LED lamp tube. *Id.*, [0017] (“The lighting circuit 24 has a circuit board 39 on which a plurality of electronic components 38 have been mounted. Lead components such as capacitors and inductors are mounted on the mounting surface of the circuit board 39, and surface mounted components such as resistors and switching elements are mounted on the wiring pattern surface.”). Lighting circuit 24 is on a circuit board 39 with electronic components such as capacitors and inductors mounted on one surface, and resistors and switches mounted on another surface. *Id.* Ono teaches that circuit board 39 with lighting circuit 24 is mounted flush with board 34 with light emitting element 33. *Id.*, [0017] (“The mounting surface of the circuit board 39 is arranged so as to be substantially flush with the mounting surface of the board 34 on which the light emitting elements 33 have been mounted.”), [0016] (“The light source unit 23 includes a plurality of light emitting elements 33 such as LED elements or EL elements, a board 34 with a mounting surface on which the plurality of light emitting elements 33 have been mounted”), FIG. 1. A cap 21a is disposed at the end of the tube 20 and a non-combustible cover 26a is disposed over cap 21a and an end portion of tube 20. *Id.*, [0019] (“The non-combustible covers 26a, 26b are made of a metal material such as aluminum or a steel plate, have the same shape and structure, and cover both ends of the tube 20 and the outer surfaces of the caps 21a, 21b on both ends.”), FIG. 1.

102. Ono however omits details regarding connecting lighting circuit 24 and light source unit 23. In my opinion, a POSITA would have been motivated to look elsewhere for the details Ono omits regarding connecting the lighting circuit 24 to the light source unit 23 within the LED tube. Holec provides this detail in disclosing how to manufacture flexible circuit boards for an LED lamp and connect circuit boards directly together. EX1009, Abstract, 1:19-26 (“Embodiments of the present invention relate to the design and method of interconnecting printed circuit boards. Particularly, embodiments of the present invention disclose a method for making long or continuous circuit strips and using the same. More particularly, embodiments of the present invention disclose the construction of layered, semi-flexible circuit strips for use with high powered LEDs in Solid State Lighting (SSL) applications.”). Further, a POSITA would have been motivated to implement Holec’s flexible circuit boards and direct connection to a power supply circuit board, to improve mechanical strength and integrity of electrical connections therebetween. Holec describes that using flexible circuit boards allows the board to “conform to normal variations of board thickness, solder height, and mechanical mounting height differences” and improves assembly and “mechanical strength and integrity of the electrical connection.” EX1009, 11:52-60; 2:28-43 (“Embodiments of the present invention include aspects addressing the strength, reliability and usability of interconnects

between the semiflexible substrates in order to produce long strips or continuous reels for ease in fixture assembly.”).

103. Further, Holec describes that two boards, including a flexible circuit board, can be directly joined together in an “overlapping fashion.” *Id.*, 3:15-24 (“a second circuit board having a metal pad able to couple to the first circuit board in an overlapping fashion when solder is passed through the plated through hole”), 6:30-41 (“While connector board 2 is shown coupling the top surfaces of circuit boards 5 and 6 it is fully contemplated connector board 2 could be coupled between circuit boards 5 and 6 in most any fashion including on the bottom surface of circuit boards 5 and 6 and overlapping between a top surface and a bottom surface.”), 7:54-61, 8:50-9:28 (“With reference to FIG. 8, a top profile view of an overlapping joint between boards in an alternate embodiment of the present invention is shown.”), 11:1-22, 12:52-59, Cl. 1. In my opinion, a POSITA would have looked to Holec’s flexible circuit board and connecting method when connecting the lighting circuit and light source unit of Ono.

104. Ono also teaches the use of a heat dissipator with the light source unit 23 to mitigate heat related damage. EX1006, [0016]. Ono also recognizes that the lighting circuit 24 disposed at the end of the lamp tube can “experience excessive heat” that results in “heat damage.” *Id.*, [0027] (“As a result, covering the lighting circuit 24, the end portion of the tube 20, and the cap 21a with the non-combustible

cover 26a can prevent external heat damage when the electronic components 38 in the lighting circuit 24 experience excessive heat due to aging, etc., and the end of the tube body 20 and the cap 21a have been damaged by the heat.”), [0031], [0042]. Ono recognizes the negative effects of heating in an LED lamp and discloses methods of dispersing the heat throughout the glass tube and mitigating heat damage on the exterior of the glass tube. *Id.*, [0016], [0027], [0031], [0042].

105. In my opinion, a POSITA would have recognized that while dispersing heat within the glass tube and mitigating exterior damage are useful, there are advantages to dissipating heat out of the lamp. *See* §V.D. Therefore, in my opinion, a POSITA would have investigated and looked for a solution for dissipating heat out of the LED lamp. Leong provides a solution for cooling the interior of an LED lamp by dissipating heat to the outside environment using vent holes in end caps. EX1010, 7:67-8:4 (“There may be cooling holes or air holes on either lamp base end caps of the LED retrofit lamp, ... to allow for proper cooling and airflow.”), 8:54-58 (same), 9:58-62 (same). A POSITA would have been motivated to include Leong’s holes in Ono’s end caps to improve cooling and airflow as disclosed by Leong itself. EX1010, 7:67-8:4, 8:54-58, 9:58-62. Doing so would have directly benefited Ono’s recognized concerns with dispersing heat to mitigate damage to the tube. *See, e.g.*, EX1006, [0016], [0027], [0031], [0042].

106. In my opinion, it would have been obvious to a POSITA to try and would have reasonably expected success in implementing Holec's flexible circuit board and circuit board joining techniques to join Ono's lighting circuit and light source unit. For example, Ono teaches that "[t]he lighting circuit 24 has a circuit board 39 on which a plurality of electronic components 38 have been mounted." EX1006, [0017]. And separately "[t]he light source unit 23 includes... board 34 with a mounting surface on which the plurality of light emitting elements 33 have been mounted." *Id.*, [0016]. Holec discloses a soldering method for joining two circuit boards. EX1009, Abstract. Specifically, Holec successfully implements its joining technique in an identical application, *i.e.*, "flexible lighting circuit boards and more directly towards *flexible [e.g., bendable] LED circuit boards.*" EX1009, 6:43-47. A POSITA would have understood that Holec's joining technique readily be incorporated into Ono's LED lamp. EX1003, ¶@@; *see also* §V.C. The technology for circuit board joining techniques was well developed, and such an installation would have been a straight-forward implementation of known technology. EX1003, ¶@@. As such, a POSITA would have reasonably expected to be successful in making the combination. EX1003, ¶@@; *see also* §V.C. Further, A POSITA would have recognized a design need for attaching Ono's lighting circuit to the light source unit—that was not described in Ono—and would have looked to Holec's joining method that also taught joining circuit boards, including flexible circuit boards, in

an LED lamp. In doing so, a POSITA would have expected this implementation to be successful and yield predictable results based on the stability of the technology and straight-forward implementation of the technology in Holec. *See also* §V.C.

107. In my opinion, a POSITA would have been motivated to implement Holec's manufacturing techniques to understand how to join the Ono lighting circuit board to the light source unit board to ensure that electricity from the lighting circuit was supplied to the LEDs on the light source unit in a reliable and predictable manner. Ono describes a lighting circuit at the end of a light source unit, but does not describe how the lighting circuit and light source unit are connected to one another. Therefore, a POSITA would have been motivated to look to other references that teach how to connect circuits. Holec describes joining two circuit boards together by soldering together conductive pads on each board. EX1009, Abstract, 8:50-9:14, 9:47-55 ("After it is melted, solder tends to wet to the metal pads 30 and exposed conductors of printed circuit boards 5 and 6. It moves by capillary action to actively fill small gaps and spaces between pads 31 and 33, particularly pads in flat surface-to surface contact."). Holec describes that using the disclosed manufacturing techniques that "reduce manufacturing, installation, and assembly costs." EX1009, 2:48-50. Thus, in my opinion, a POSITA would have used Holec's manufacturing process to improve manufacturing efficiency and reliability, a goal of Ono. EX1006, [0030-0031], [0046]; EX1009. 1:42-44

(“Further, the type and number of interconnections has a strong effect on reliability.”), 1:62-64, 2:28-50 (“Embodiments of the present invention include aspects addressing the strength, reliability and usability of interconnects between the semiflexible substrates in order to produce long strips or continuous reels for ease in fixture assembly.”), 11:55-65, 12:20-30.

108. In my opinion, a POSITA would also have found it obvious to try implementing Leong’s end cap openings with Ono’s LED lamp because there were a finite number of identified, predictable solutions a POSITA would have pursued. *See* §V.D. For example, Ono teaches the use of a heat dissipator interposed between the light source unit 23 and the inner surface of the glass tube to mitigate heat related damage. EX1006, [0016]. Leong likewise describes “[o]ptional support member 164, which may be made of a heat conducting material, can operate as a heat sink to draw heat away from LED circuit board 152 to the center of elongated housing 142 and thereby dissipating the heat at the two ends 148A and 148B of tubular wall 144.” EX1010, 31:26-36. The heat is then vented through the “[t]wo cylindrical parallel vent holes 224A and 224B” in the end walls of Leong’s end caps. *Id.*, 40:41-43. In my opinion, a POSITA would have recognized a design need for implementing Ono’s heat dissipator to channel heat away from the LEDs and would have looked to Leong’s end cap openings to dissipate the heat out of the lamp. A POSITA would have expected this implementation to be successful and yield predictable results

based on the stability of the technology and straight-forward implementation of the technology in Leong. *See* §V.D.

109. In my opinion, a POSITA would further have been motivated to use Leong's openings in the end caps to implement Ono's teaching of improved safety and minimized damage through heat dissipation. EX1006, [0031], [0042]; EX1010, 7:61-8:4, 8:50-58, 9:58-62.

110. Additionally, in my opinion a POSITA would have been recognized that implementing Leong's openings in the end caps in Ono's lamp would not increase the cost while improving heat dissipation properties of Ono's lamp. Ono describes that an objective of its invention is to reduce heat damage. EX1006, [0016], [0027], [0031], [0042]. A POSITA would have understood that adding openings to the Ono end caps, as taught in Leong, would have not had any material impact on the cost of the Ono LED lamp. Therefore, a POSITA would have been motivated to implement Leong's known end cap openings to improve air flow and heat dissipation in the LED lamp without increasing the cost of the lamp. EX1010, 7:67-8:4, 8:54-58, 9:58-62.

111. In my opinion, the substitution of Leong's known end caps with openings to provide heat dissipation and air flow for Ono's end caps would have predictable results as would be understood by a POSITA. As discussed above, Ono describes end caps at each end of a glass tube of an LED tube lamp and Leong also describes

that end caps 150A/150B at each end of a tubular wall. EX1010, 30:36-39 (“Tubular wall 144 is mounted to opposed base end caps 150A and 150B at tubular wall circular ends 148A and 148B, respectively, ...”), FIG. 12. Because both Ono’s end caps and Leong’s end caps serve the same function of providing conductive pins to allow the LED lamps to be installed in a light fixture, a POSITA would have understood that Leong’s teachings of openings in an end cap could be used to facilitate Ono’s heat dissipation mechanism.

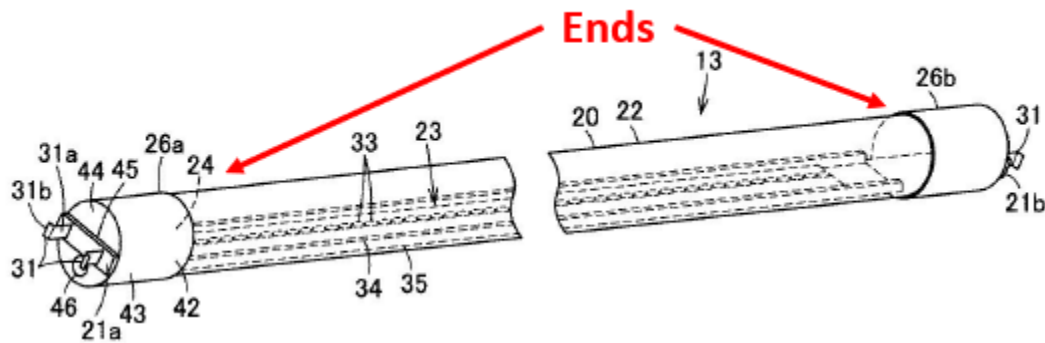
112. Additionally, a POSITA, in my opinion, would have reasonably expected success in implementing Leong’s end cap openings in the end caps of Ono’s LED lamp. Leong successfully implements its own end cap configuration in an identical application, *i.e.*, an LED lamp bulb for replacement of a conventional fluorescent bulb. EX1010, FIGS. 11, 12, 19, 19A. A POSITA would have understood that Leong’s end cap openings could readily be incorporated into Ono’s LED lamp. The technology for end caps on a tubular LED lamp was well developed, and such an installation would have been a straight-forward implementation of known technology. *See* §V.D. As such, a POSITA would have reasonably expected to be successful in making the combination.

2. *Modification of Ono with Holec and Leong*

113. A POSITA would have been motivated to modify the Ono LED lamp that includes lighting circuit 34 connected with light source unit 23 to use the flexible

on one end of the tube 20.” EX1006, [Solution]. The straight tube 20 may be made of “glass or a ceramic.” *Id.*, [0032].

[Fig. 2]

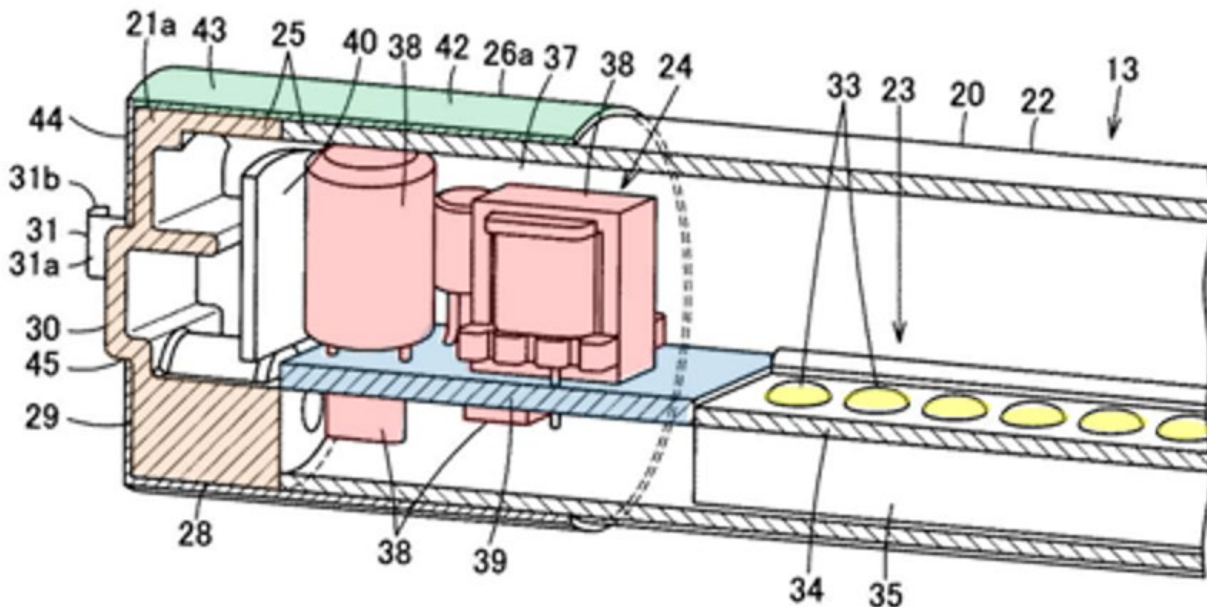


Id., FIG. 2.

(c) *Limitation 19[b] a plurality of LED light sources;*

116. It is my opinion that the combination of Ono, Holec, and Leong renders obvious a plurality of LED light sources. Ono discloses a “light source unit 23 includes a plurality of [yellow] light emitting elements 33 such as LED elements or EL elements, a board 34 with a mounting surface on which the plurality of light emitting elements 33 have been mounted.” EX1006, [0016].

[Fig. 1]



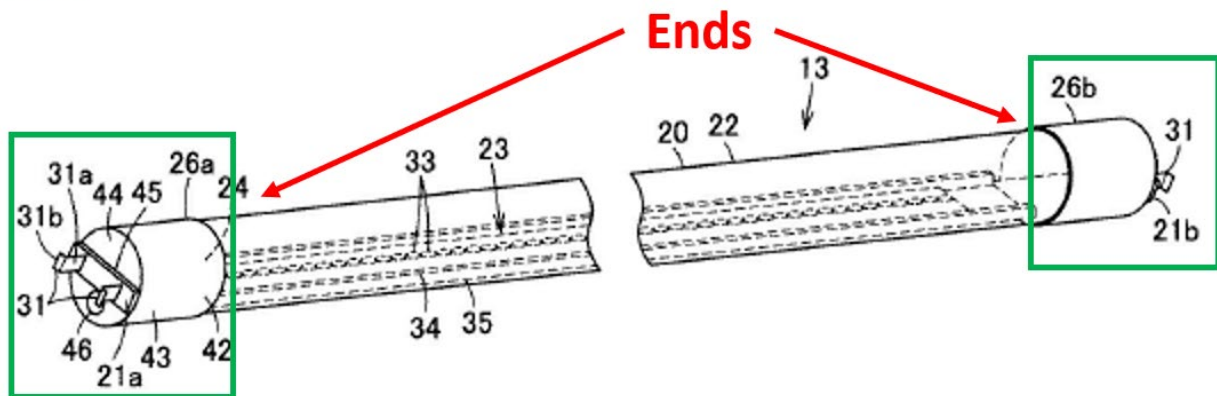
Id., FIG. 1.

- (d) *Limitation 19[c] two end caps respectively sleeving the two end portions of the glass tube, each of the end caps comprising two pins and a plurality of openings, the two pins being on a surface of the end cap, the plurality of openings being on the surface of the end cap and divided into two sets, and the two sets of the openings being symmetric to each other with respect to a plane passing through the two pins;*

117. It is my opinion that the combination of Ono, Holec, and Leong renders obvious two end caps respectively sleeving the two end portions of the glass tube, each of the end caps comprising two pins and a plurality of openings, the two pins being on a surface of the end cap, the plurality of openings being on the surface of the end cap and divided into two sets, and the two sets of the openings being symmetric to each other with respect to a plane passing through the two pins.

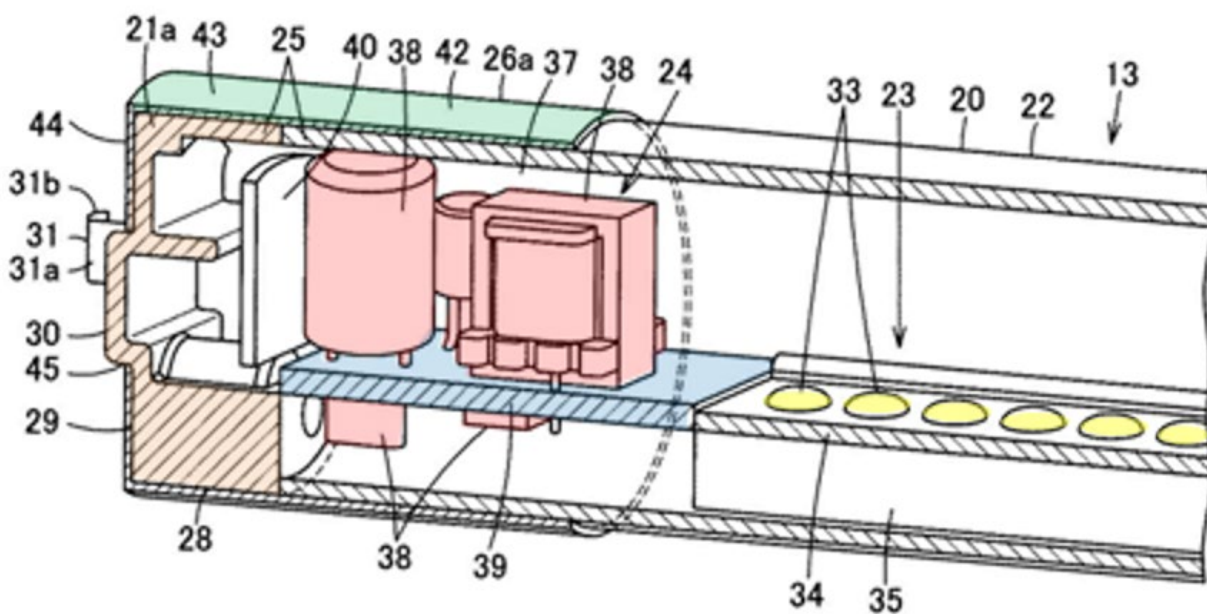
118. First, Ono teaches two end caps ([green] non-combustible covers/caps 26a, 26b with caps 21a/21b) sleeving the ends of the glass tube (straight tube 20).

[Fig. 2]



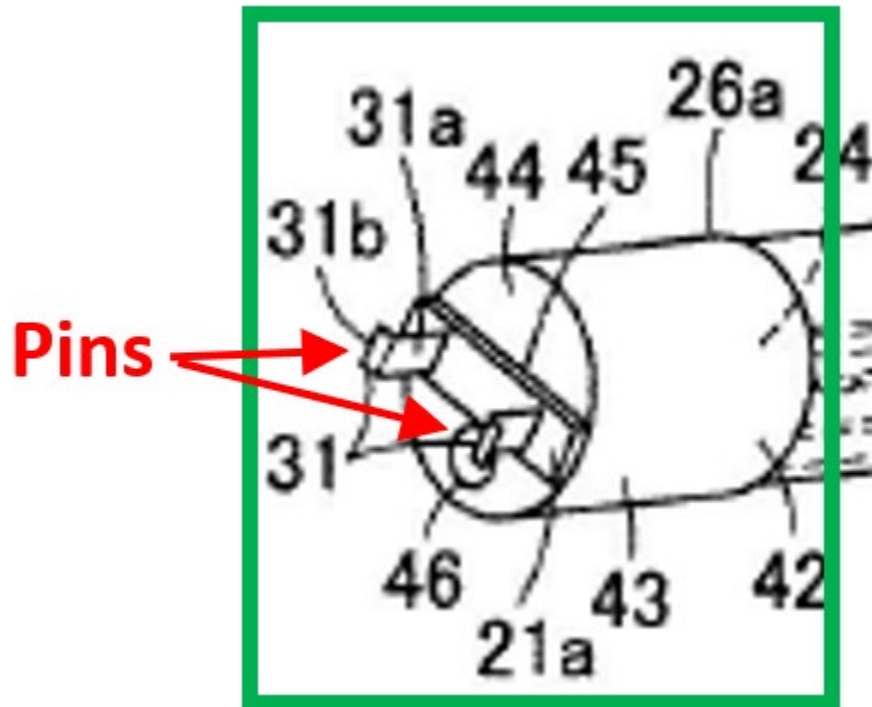
EX1006, FIG. 2. Ono's "lighting circuit 24 is covered with an insulator 25, and the lighting circuit 24 is covered with a [green] non-combustible cover 26a via the insulator 25." *Id.*, [Solution].

[Fig. 1]



Id., FIG. 1.

119. Ono further teaches that “a pair of terminals 31 protrude in parallel from the caps 21a, 21b at both ends,” and are thus on the surface of the end wall of the end cap as shown in excerpted FIG. 2 below. EX1006, [0020].



EX1006, FIG. 2. Alternatively, Leong discloses bi-pin electrical contacts 138A and 140A on the surface of the end wall of the end cap as shown in FIGS. 19 and 19A below. EX1010, 40:30-41:25, FIGS. 19, 19A.

120. Leong discloses that its end caps 150A, 150B include at least two vent holes 224A, 224B (two sets) that are symmetric to each other with respect with the center line 146 of the end caps. EX1010, 40:41-43. As explained above, Leong’s vent holes 224A, 224B are incorporated into the Ono’s end cap. §VII.A.2. As

shown in the figure below, the vent holes 224A, 224B are symmetric to each other with respect to the plane passing through the middle of a line connecting the two pins. A set does not itself require multiple openings, *e.g.*, a unitary set.

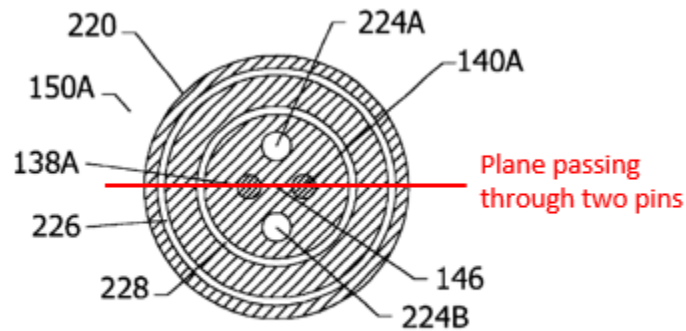


FIG. 19A

EX1010, FIG. 19A.

121. The vent holes 224A, 224B are also on the surface of the end caps. The vent holes 224A, 224B “are defined between end walls 222A and 222B.” EX1010, 40:41-43. As shown in FIG. 19A above and FIG. 19 below, end walls 222A and 222B are the surfaces of the end wall of the end cap. Therefore, the vent holes 224A, 224B are on the surface of the end wall. This is the same end wall that includes the conductive pins.

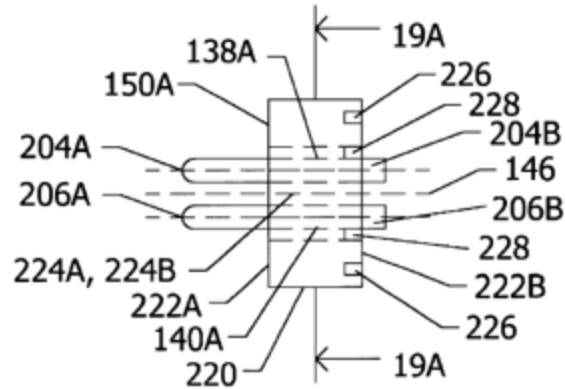


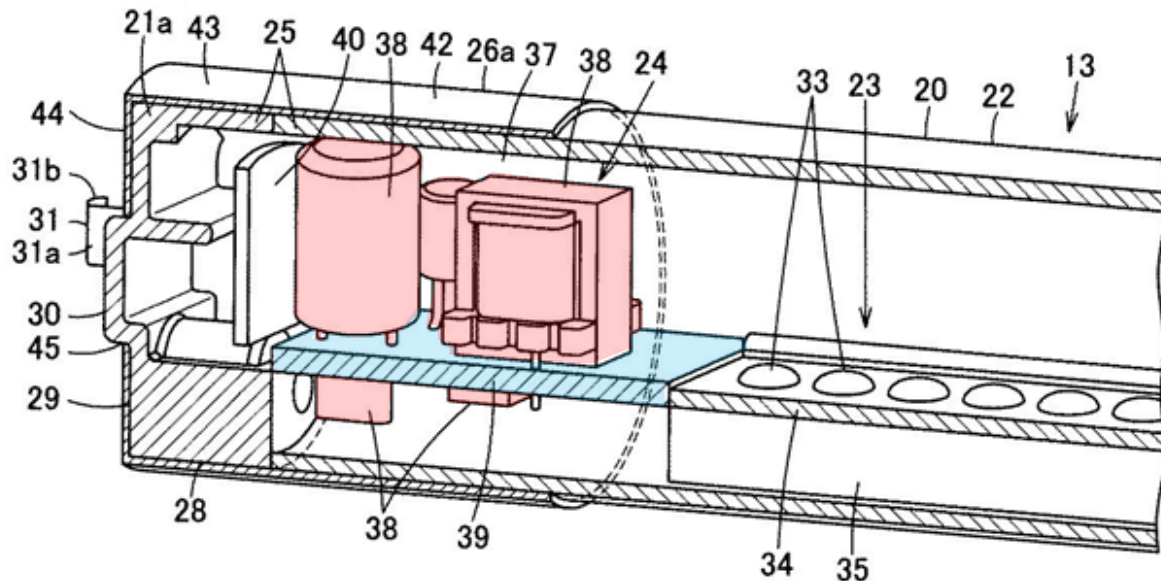
FIG. 19

EX1010, FIG. 19. Moreover, as discussed in §V.D, heat dissipation methods using vent holes in end caps was well-known.

(e) *Limitation 19[d] a power supply disposed in at least one of the end caps; and*

122. It is my opinion that the combination of Ono, Holec, and Leong renders obvious a power supply disposed in at least one of the end caps. Ono describes “a lighting circuit 24 for lighting the light emitting elements 33.” EX1006, [Solution].

[Fig. 1]



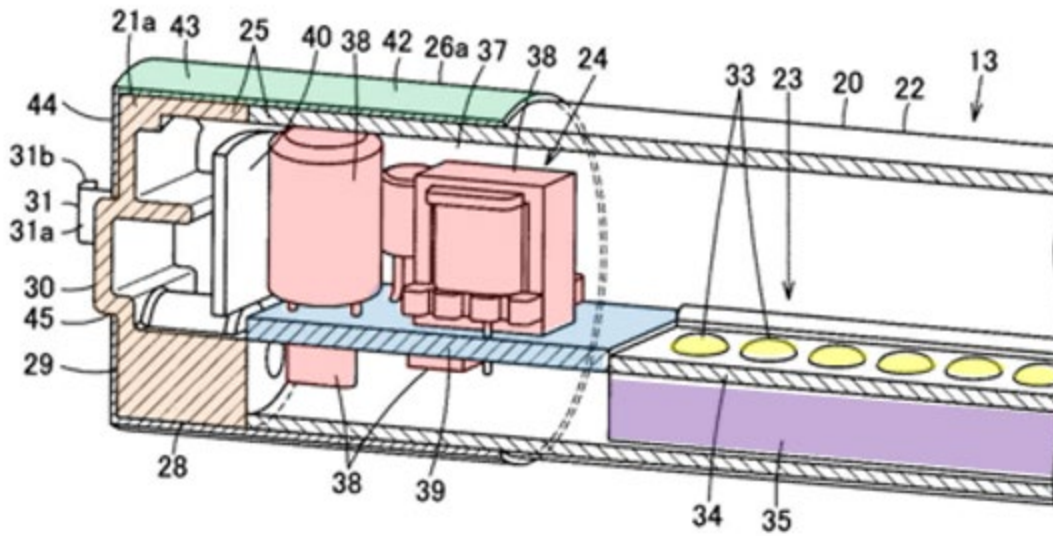
EX1006, FIG. 1.

123. Ono's lighting circuit "is housed inside the tube 20 on one end in a lighting circuit housing portion 37 between the light source unit 23 housed inside the tube 20 and the cap 21a attached to one end of the tube 20." EX1006, [0017]. "The lighting circuit 24 has a [blue] circuit board 39 on which a plurality of [red] electronic components 38 have been mounted." *Id.* Specifically, "[l]ead components such as capacitors and inductors are mounted on the mounting surface of the circuit board 39, and surface mounted components such as resistors and switching elements are mounted on the wiring pattern surface." *Id.*

- (f) ***Limitation 19[e] an LED light strip on an inner surface of the glass tube forming a freely extending end portion at one end along a longitudinal direction of the glass tube, the freely extending end portion directly soldered to the power supply, the plurality of LED light sources being on the LED light strip.***

124. It is my opinion that the combination of Ono, Holec, and Leong renders obvious an LED light strip on an inner surface of the glass tube forming a freely extending end portion at one end along a longitudinal direction of the glass tube, the freely extending end portion directly soldered to the power supply, the plurality of LED light sources being on the LED light strip. Inside Ono's glass tube 20 is a "light source unit 23 includes a plurality of [yellow] light emitting elements 33 such as LED elements or EL elements, a board 34 with a mounting surface on which the plurality of [yellow] light emitting elements 33 have been mounted." EX1006, [0016]. The light source unit 23 on an inner surface of glass tube 20 via "[purple] heat dissipator 35 bonded to the opposite side of the board 34 from the mounting surface." *Id.*; see also §VI.C.1.

[Fig. 1]



Id., FIG. 1.

125. The light source unit 23 and lighting circuit 24 are connected using Holec's circuit board connection method. Holec describes overlapping circuit boards to provide an interconnection. EX1009, 8:52-9:8. This allows a direct connection between two circuit boards. *Id.* In Holec, a [red] top board 6 or 13 includes conductive pads and a [green] bottom board 5 or 39 includes conductive pads. *Id.*, 8:50-9:8, 12:52-59, FIGS. 8, 11a, 11b, 12, 13a, 13b. The conductive pads are soldered directly to one another with overlapping joints 26 with one board having a vertical step offset 41 at its freely extending end. *Id.*, 9:26-28, 12:52-59. In this way, the top board and bottom board are electrically connected. EX1009, 8:52-9:8, 12:52-59, cl. 1, 2.

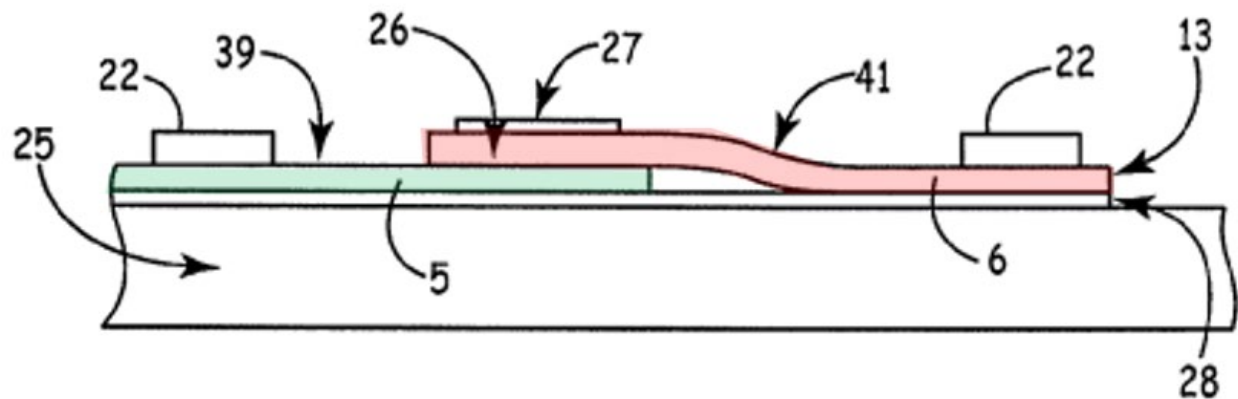


FIG. 8

Id., FIG. 8.

126. Holec further teaches the use of flexible circuit boards, such as “flexible LED circuit boards,” that include a freely extending end portion, shown in the purple box below, that would connect in an overlapping joint to Ono’s lighting circuit 24. EX1009, 6:43-47, 1:19-26, 7:1-6, 11:23-65, Cl. 2.

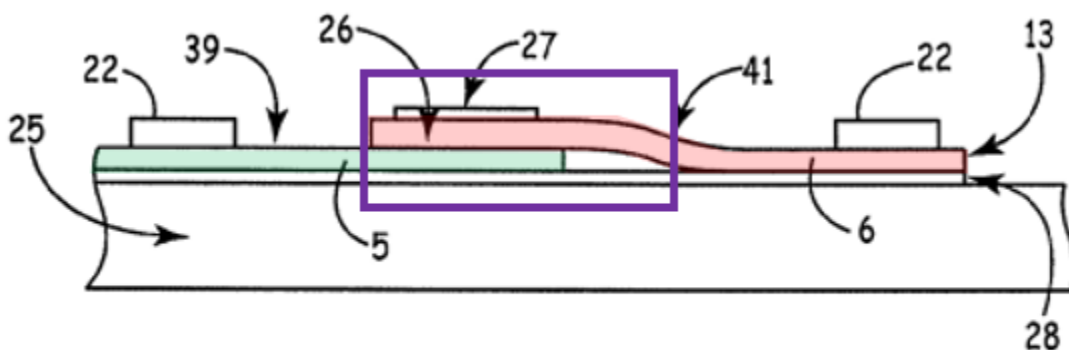


FIG. 8

Id., FIG. 8.

127. In the Ono-Holec-Leong combination, both the board 34 of the light source unit 23 and board 39 of the lighting circuit 24 include at least two conductive pads, as described in Holec and shown in FIGS. 11a, 11b, 12, 13a, and 13b below in green.

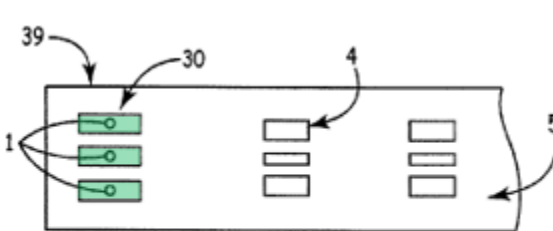


FIG. 11a

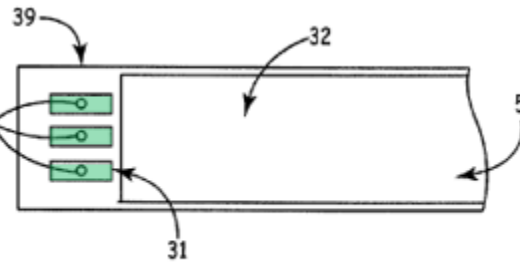


FIG. 11b

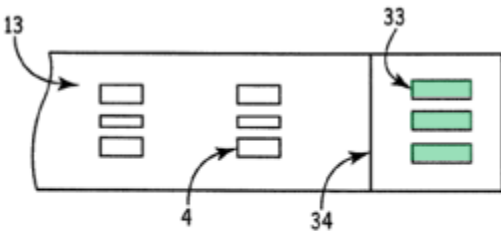


FIG. 12

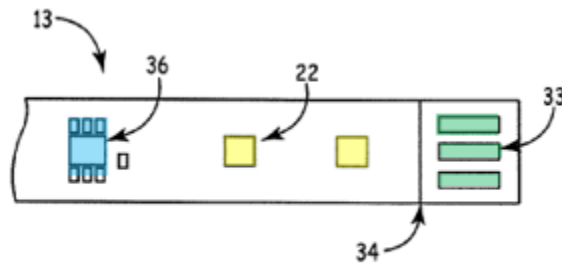


FIG. 13a

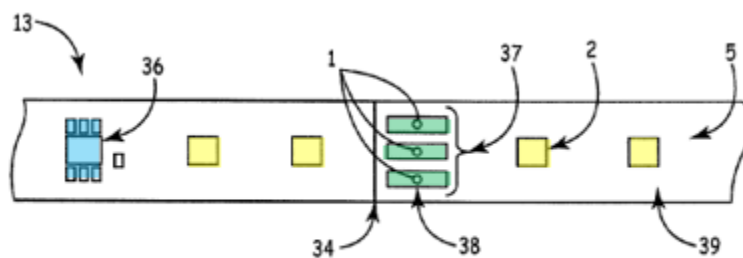


FIG. 13b

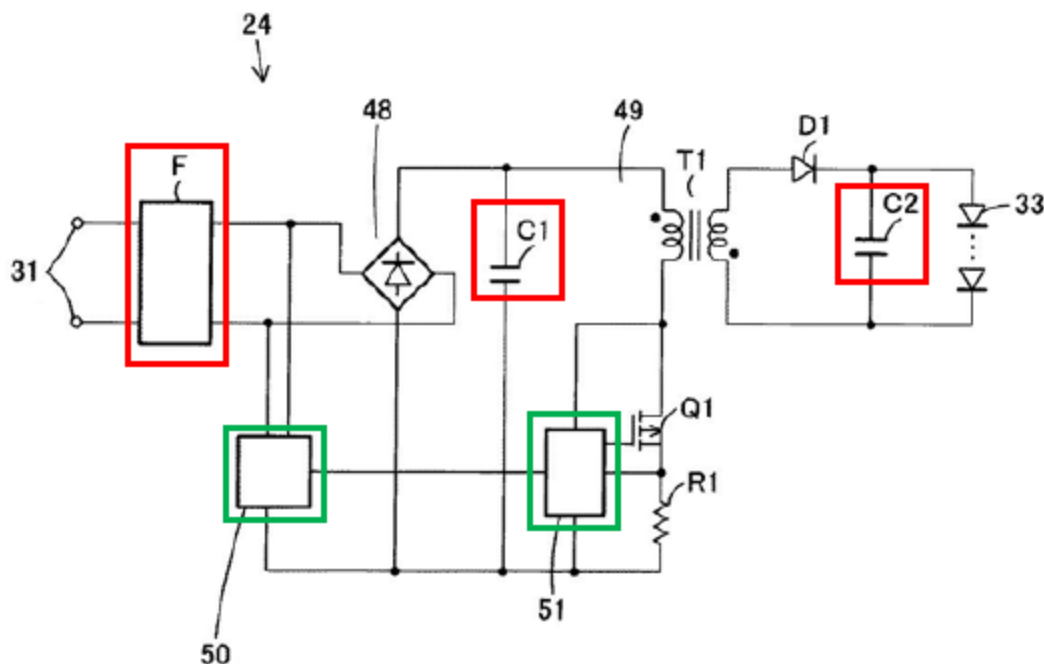
EX1009, 1a, 11b, 12, 13a, and 13b. Solder is used to couple the conductive pads on each board such that the LED light strip and power supply PCB are electrically connected. *Id.*, 8:50-9:14, 9:47-55 (“After it is melted, solder tends to wet to the metal pads 30 and exposed conductors of printed circuit boards 5 and 6. It moves by

capillary action to actively fill small gaps and spaces between pads 31 and 33, particularly pads in flat surface-to surface contact.”). Moreover, as discussed in §V.C, bendable circuit sheets (that would have a freely extending end) used for mounting LEDs and directly soldered to other devices, such as a power supply board, was well-known.

(g) *Claim 20 The LED tube lamp according to claim 19, wherein the power supply comprises a current-limiting element, and the plurality of openings dissipate heat resulted from the power supply.*

128. It is my opinion that the combination of Ono, Holec, and Leong renders obvious a power supply that includes a current limiting elements and the openings dissipate heat from the power supply. As shown in FIG. 3 below, Ono teaches its lighting circuit 24 includes a [red] noise filter F, [red] smoothing capacitor C1, and/or [red] electrolytic capacitor C2 that limit current. EX1006, [0021]. Further, [green] detecting means 50 and control means 51 detect the type of current provided and does not operate the lighting means 49 if the power is direct current power or “if the frequency is not that of the commercial alternating current power supply” and thus, also limit current. EX1006, [0022], [0023].

[Fig. 3]



48: Rectifying means

49: Lighting means

50: Power supply type detecting means or frequency detecting means

51: Control means

129. Additionally, Leong discloses that its end caps 150A, 150B include two vent holes 224A, 224B that operate to “dissipate[e] the heat at the two lamp ends.” EX1010, 7:61-8:4, 8:50-58, 9:58-62, 7:16-19, 20:19-24, 26:25-30. Heat is drawn away “from LED circuit board 152 *including the circuitry for LED array 158* to the center of elongated housing 142 and thereby dissipating the heat at the two ends 148A and 148B of tubular wall 144.” EX1010, 31:26-36, *see also id.*, 7:16-19 (“Desirably, the two base end caps of the retrofitting LED lamp have apertures therein to allow air to pass through into and out from the interior of the main outer tubular housing and integral electronic circuitry.”), 46:26-27, 46:42-44, 50:14-16,

52:32-35, 52:49-51. A POSITA would understand that Leong's "circuitry for LED array 158" would include a power supply such as Ono's lighting circuit 24 disposed in the end cap near the vent holes 224a/224b of Leong.

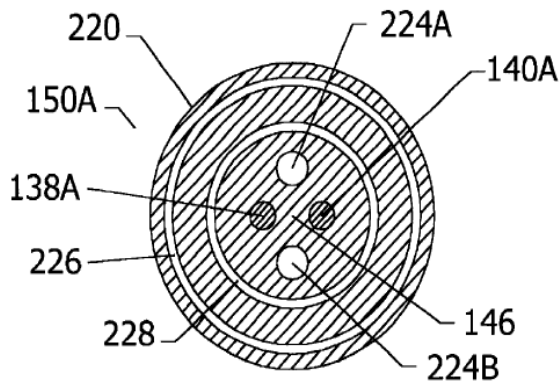


FIG. 19A

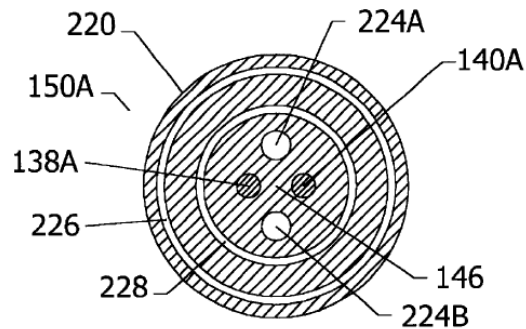


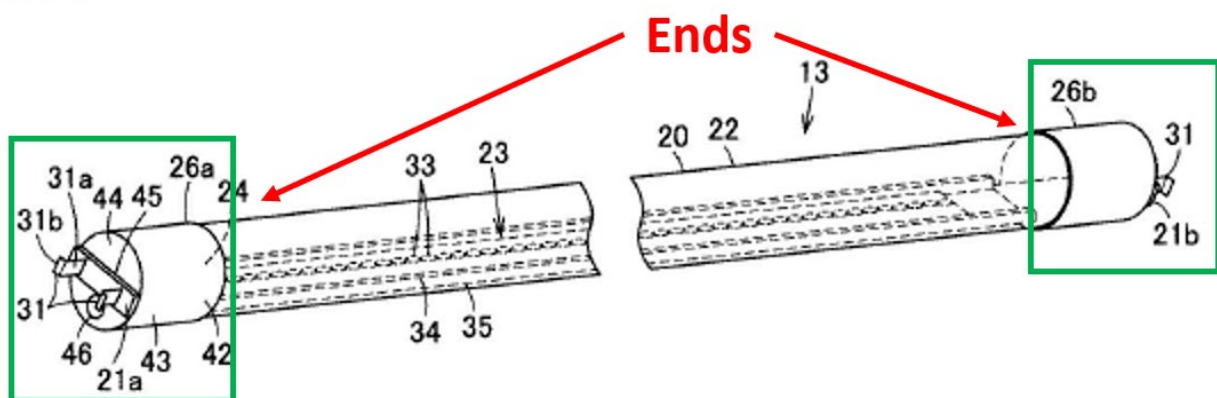
FIG. 19A

EX1010, FIGS. 19, 19A.

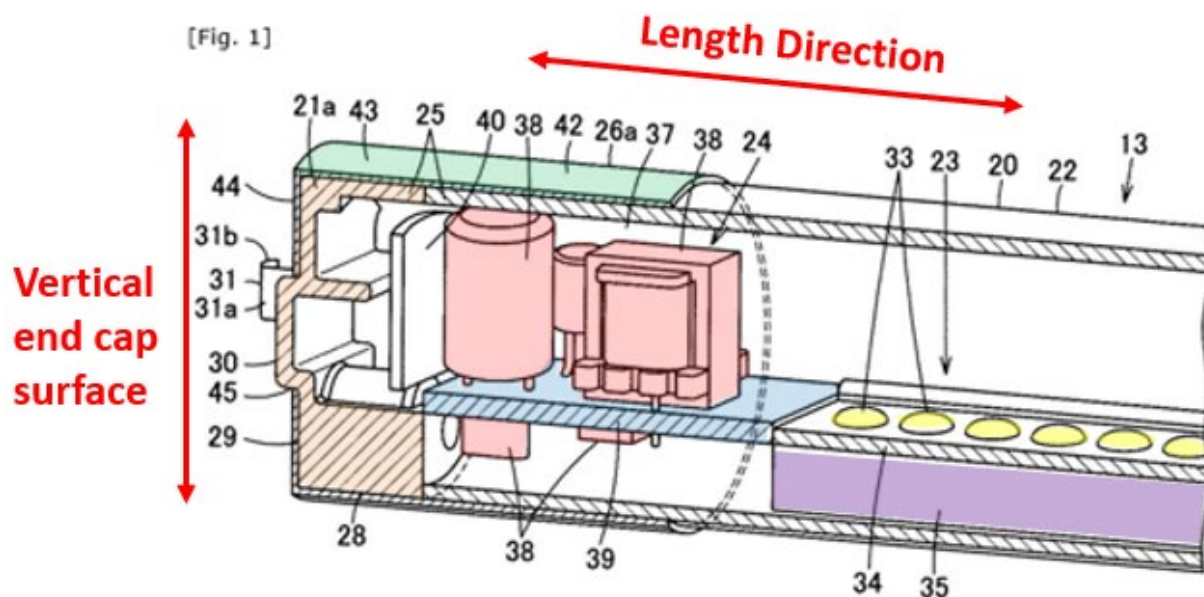
(h) Claim 22 The LED tube lamp according to claim 20, wherein the surface of the end cap is vertical to the length direction of the glass tube.

130. It is my opinion that the combination of Ono, Holec, and Leong renders obvious that the surface of the end cap is vertical to the length direction of the glass tube. Ono teaches non-combustible covers 26a/26b disposed over caps 21a/21b that have surface that is vertical to length of glass tube 20.

[Fig. 2]



[Fig. 1]



EX1006, FIGS. 1, 2.

- (i) *Claim 25 The LED tube lamp according to claim 20, wherein the plurality of openings are separately in a shape of a circle.*

131. It is my opinion that the combination of Ono, Holec, and Leong renders obvious multiple openings in the shape of a circle. Leong discloses that its end caps 150A, 150B include two vent holes 224A, 224B that are “cylindrical”/circular in shape as shown in FIGS. 19 and 19A below.

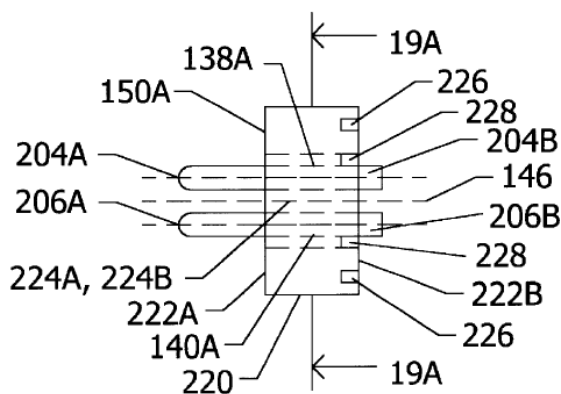


FIG. 19

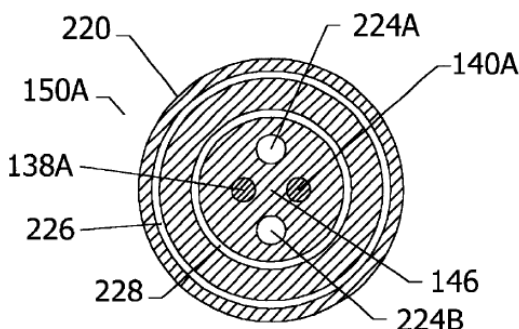


FIG. 19A

EX1010, 40:30-41:15, FIGS. 19, 19A.

- (j) *Claim 28 The LED tube lamp according to claim 20, wherein at least a part of the openings are arranged along an arc and spaced apart from each other.*

132. It is my opinion that the combination of Ono, Holec, and Leong renders obvious an LED tube lamp where the openings are arranged along an arc and spaced apart from each other. Leong discloses that its end caps 150A, 150B include two vent holes 224A, 224B in vertical alignment with the center line 146 of the end caps. EX1010, 40:41-43. As explained above, Leong's vent holes 224A, 224B are incorporated into the Ono's end cap. Section VII.A.2. As shown in FIG. 19A below, the vent holes 224A, 224B are arranged in an arc and are spaced apart from each other:

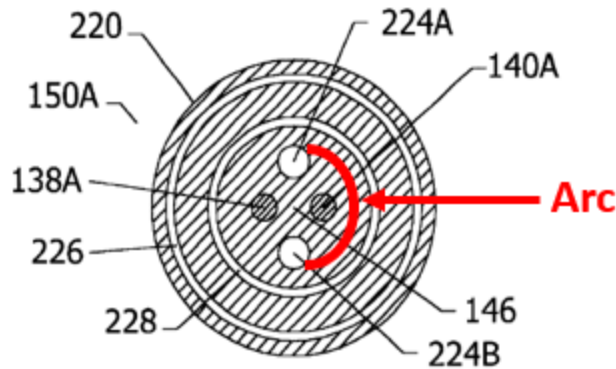


FIG. 19A

EX1010, FIG. 19A.

(k) Limitation 29[p] An LED tube lamp, comprising:

133. It is my opinion that the combination of Ono, Holec, and Leong renders obvious an LED tube lamp. See Limitation 19[p], §VII.A.3(a).

(l) Limitation 29[a] a glass tube;

134. It is my opinion that the combination of Ono, Holec, and Leong renders obvious a glass tube. See Limitation 19[a], §VII.A.3(b).

(m) Limitation 29[b] a plurality of LED light sources;

135. It is my opinion that the combination of Ono, Holec, and Leong renders obvious a plurality of LED light sources. See Limitation 19[b], §VII.A.3(c).

(n) Limitation 29[c] two end caps respectively at two opposite ends of the glass tube;

136. It is my opinion that the combination of Ono, Holec, and Leong renders obvious two end caps respectively at two opposite ends of the glass tube. See Limitation 19[c], §VII.A.3(d).

- (o) *Limitation 29[d] a power supply in one of the end caps or separately in both of the end caps; and***

137. It is my opinion that the combination of Ono, Holec, and Leong renders obvious a power supply in one of the end caps or separately in both of the end caps. See Limitation 19[d], §VII.A.3(e).

- (p) *Limitation 29[e] an LED light strip on an inner surface of the glass tube forming a freely extending end portion at one end along a longitudinal direction of the glass tube, the freely extending end portion directly soldered to the power supply, the plurality of LED light sources being on the LED light strip;***

138. It is my opinion that the combination of Ono, Holec, and Leong renders obvious an LED light strip on an inner surface of the glass tube forming a freely extending end portion at one end along a longitudinal direction of the glass tube, the freely extending end portion directly soldered to the power supply, the plurality of LED light sources being on the LED light strip. See Limitation 19[e], §VII.A.3(f).

- (q) *Limitation 29[f] wherein each of the end caps comprises: an end wall;***

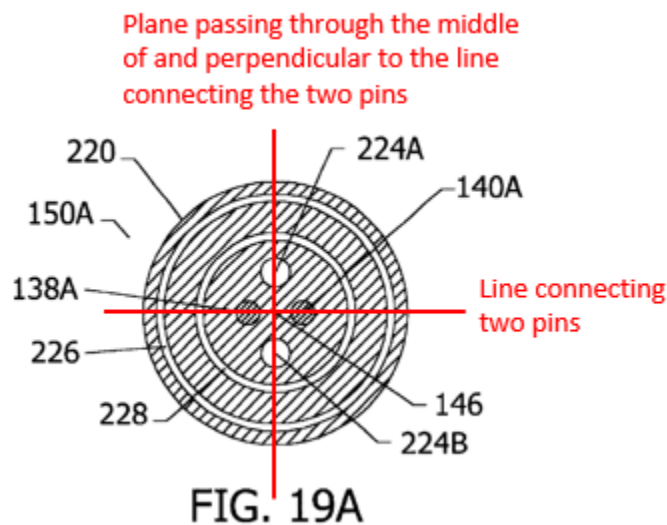
139. It is my opinion that the combination of Ono, Holec, and Leong renders obvious each of the end caps including an end wall. See Limitation 19[c], §VII.A.3(d).

- (r) *Limitation 29[g] two pins on the end wall; and***

140. It is my opinion that the combination of Ono, Holec, and Leong renders obvious two pins on the end wall. See Limitation 19[c], §VII.A.3(d).

- (s) *Limitation 29[h] at least two openings on the end wall symmetric to each other with respect to a plane passing through the middle of a line connecting the two pins and perpendicular to the line connecting the two pins*

141. It is my opinion that the combination of Ono, Holec, and Leong renders obvious at least two openings on the end wall symmetric to each other with respect to a plane passing through the middle of a line connecting the two pins and perpendicular to the line connecting the two pins. *See* Limitation 19[c], §VII.A.3(d). Leong further discloses that its end caps 150A, 150B include two vent holes 224A, 224B that are symmetric to each other with respect to a plane passing through the middle of a line connecting the two pins and perpendicular to the line connecting the two pins. EX1010, 40:41-43.



EX1010, FIG. 19A. As explained above, Leong's vent holes 224A, 224B are incorporated into the Ono's end cap. §VII.A.2.

**(t) Claim 35 The LED tube lamp according to claim 19,
wherein the LED light strip is a bendable circuit sheet.**

142. It is my opinion that the combination of Ono, Holec, and Leong renders obvious an LED light strip that is a bendable circuit sheet. Holec teaches that “the present invention is directed towards flexible lighting circuit boards and more directly towards *flexible [e.g., bendable] LED circuit boards.*” EX1009, 6:43-47, 1:19-26, 7:1-6, 11:23-65, Cl. 2. Moreover, as discussed in §V.C, bendable circuit sheets used for mounting LEDs were well-known.

**(u) Claim 36 The LED tube lamp according to claim 19,
wherein the end cap comprises a metal part.**

143. It is my opinion that the combination of Ono, Holec, and Leong renders obvious an end cap that includes a metal part. Ono teaches that “non-combustible covers 26a, 26b are made of a metal material such as aluminum or a steel plate.” EX1006, [0019], [0039], Cl. 5.

**(v) Claim 37 The LED tube lamp according to claim 29,
wherein the LED light strip is a bendable circuit sheet.**

144. It is my opinion that the combination of Ono, Holec, and Leong renders obvious the LED light strip is a bendable circuit sheet. *See* Claim 35, §VII.A.3(t).

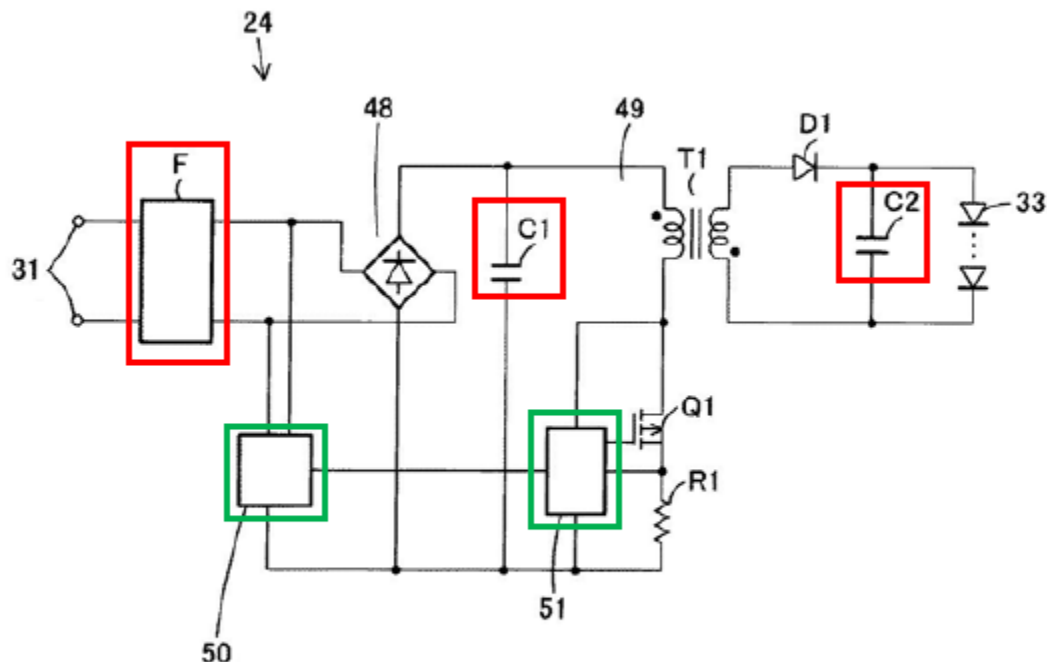
**(w) Claim 38 The LED tube lamp according to claim 29,
wherein the end cap comprises a metal part.**

145. It is my opinion that the combination of Ono, Holec, and Leong renders obvious the end cap comprises a metal part. *See* Claim 36, §VII.A.3(u).

- (x) **Claim 39** The LED tube lamp according to claim 20, wherein the current-limiting element comprises a resistor, a capacitor, an inductor, or any combination thereof.

146. It is my opinion that the combination of Ono, Holec, and Leong renders obvious a current-limiting element comprises a resistor, a capacitor, an inductor, or any combination thereof. As discussed in §VII.A.3(g) (claim 20) and shown in FIG. 3 below, Ono teaches its lighting circuit 24 includes a [red] smoothing capacitor C1 and/or [red] electrolytic capacitor C2 that limit current and/or resistor R1. EX1006, [0021]. A capacitor or resistor limits current. EX1003, ¶@@.

[Fig. 3]



48: Rectifying means
49: Lighting means
50: Power supply type detecting means or frequency detecting means
51: Control means

EX1006, FIG. 3.

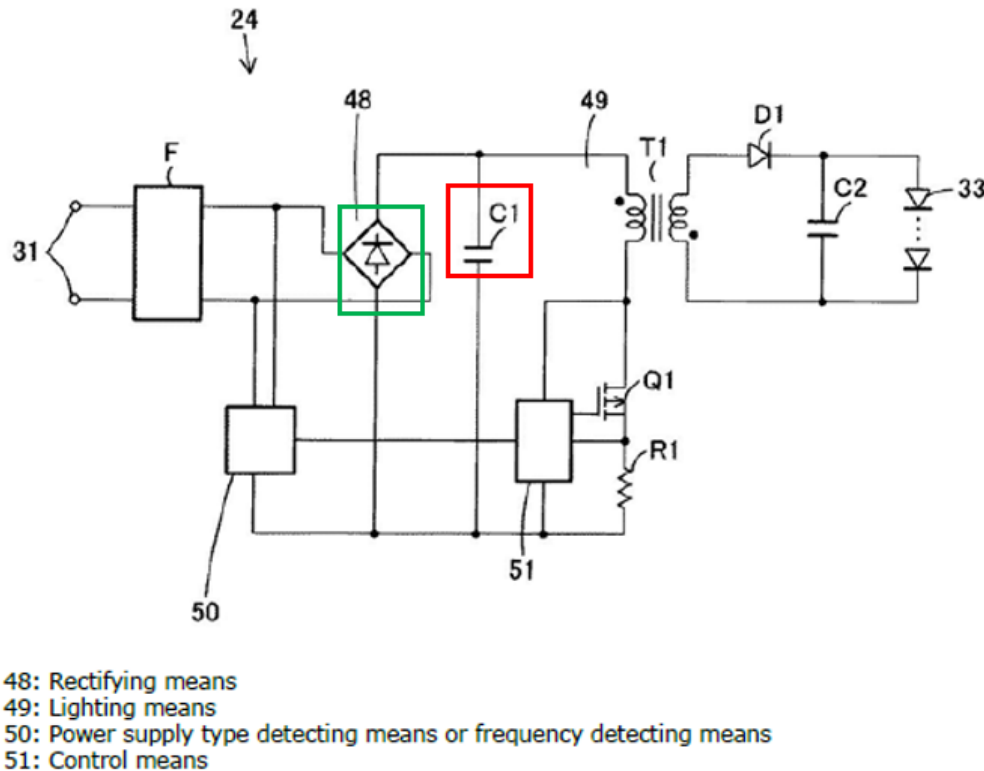
(y) ***Claim 42 The LED tube lamp according to claim 19, wherein the power supply comprises a rectifying circuit and a filtering circuit disposed in at least one of the end caps, and the plurality of openings are for dissipating heat from the power supply.***

147. It is my opinion that the combination of Ono, Holec, and Leong renders obvious a power supply with a rectifying circuit and a filtering circuit disposed in at least one of the end caps, and the plurality of openings are for dissipating heat from the power supply. As discussed in §VII.A.3(e) (limitation 19[d]), Ono teaches lighting circuit 24 is disposed in a cap 21a with non-combustible covers 26a. And as discussed in §VII.A.3(g) (claim 20), Leong's end caps 150A, 150B include two vent holes 224A, 224B that operate to "dissipate[e] the heat at the two lamp ends" including heat "from LED circuit board 152 including the circuitry for LED array 158." EX1010, 31:26-36, 8:50-58, 20:19-24, 26:25-30, 7:16-19, 46:26-27, 46:42-44, 50:14-16, 52:32-35, 52:49-51.

148. Ono further teaches that lighting circuit 24 includes a rectifying circuit, as [green] rectifying means 48, and a filtering circuit, as [red] smoothing capacitor C1: "the input end of a rectifying means 48 is connected to the pair of terminals 31 in cap 21a via a noise filter circuit F, ***a smoothing capacitor C1*** is connected to the output end of the rectifying means 48, and a lighting means 49 is connected to the ***smoothing capacitor C1*** to convert the rectified and smoothed power supply voltage to a predetermined direct current output and supply the output to the light emitting

elements 33.” EX1006, [0021]. A POSITA would understand that smoothing capacitor C1 is a filtering circuit.

[Fig. 3]



EX1006, FIG. 3.

(z) ***Claim 44 The LED tube lamp according to claim 29, wherein the power supply comprises a current-limiting element disposed in at least one of the end caps, and the at least two openings are for dissipating heat from the power supply.***

149. It is my opinion that the combination of Ono, Holec, and Leong renders obvious the power supply comprises a current-limiting element disposed in at least one of the end caps, and the at least two openings are for dissipating heat from the power supply. See Claim 20, §VII.A.3(g).

(aa) Claim 45 The LED tube lamp according to claim 44, wherein the current-limiting element comprises a resistor, a capacitor, an inductor, or any combination thereof.

150. It is my opinion that the combination of Ono, Holec, and Leong renders obvious the current-limiting element comprises a resistor, a capacitor, an inductor, or any combination thereof. *See* Claim 39, §VII.A.3(x).

(bb) Claim 47 The LED tube lamp according to claim 29, wherein the power supply comprises a rectifying circuit and a filtering circuit disposed in at least one of the end caps, and the at least two openings are for dissipating heat from the power supply.

151. It is my opinion that the combination of Ono, Holec, and Leong renders obvious the power supply comprises a rectifying circuit and a filtering circuit disposed in at least one of the end caps, and the at least two openings are for dissipating heat from the power supply. *See* Claim 42, §VII.A.3(y).

(cc) Claim 49 The LED tube lamp according to claim 19, wherein the power supply further comprises a circuit board with two second bond pads.

152. It is my opinion that the combination of Ono, Holec, and Leong renders obvious a power supply including a circuit board with two second bond pads. Ono's light source unit 23 and lighting circuit 24 are connected using Holec's circuit board connection method.

153. Holec describes overlapping circuit boards to provide an interconnection. EX1009, 8:50-9:8. This allows a direct connection between two circuit boards. *Id.*

In Holec, a [red] top board 6 or 13 includes conductive pads and a [green] bottom board 5 or 39 includes conductive pads. *Id.*, 8:50-9:8, 12:52-59, FIGS. 8, 11a, 11b, 12, 13a, 13b. The conductive pads are soldered directly to one another with overlapping joints 26. *Id.*, 9:26-28, 12:52-59.

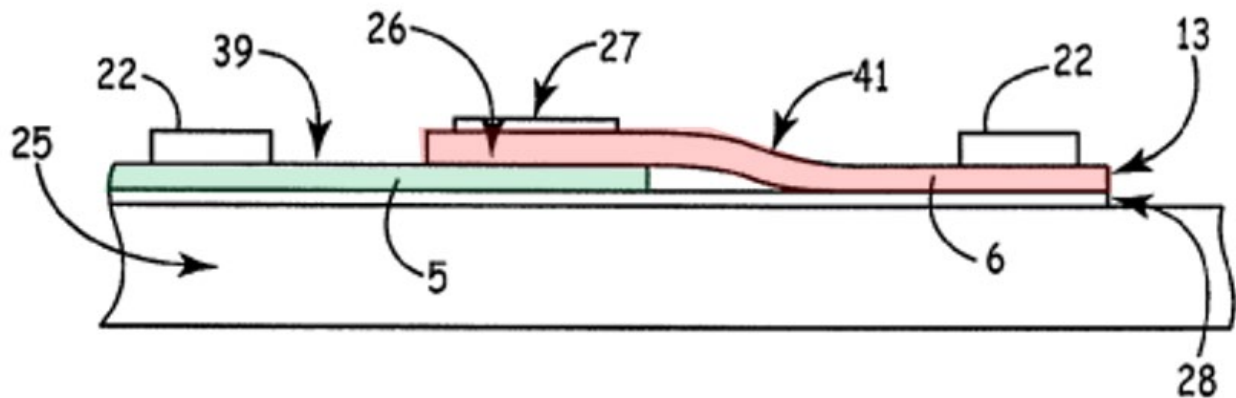


FIG. 8

Id., FIG. 8.

154. In the Ono-Holec-Leong combination, both the board 34 of the light source unit 23 and board 39 of the lighting circuit 24 include at least two conductive pads, as described in Holec and shown in FIGS. 11a, 11b, 12, 13a, and 13b below in green.

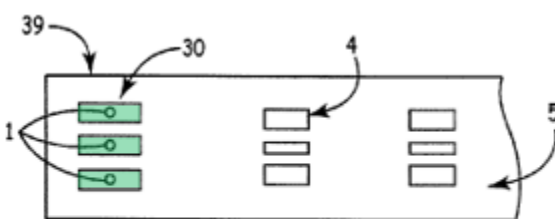


FIG. 11a

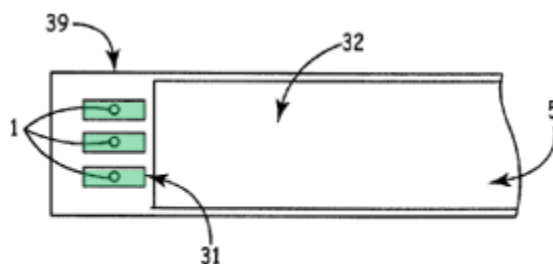


FIG. 11b

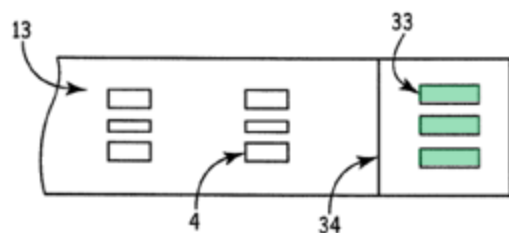


FIG. 12

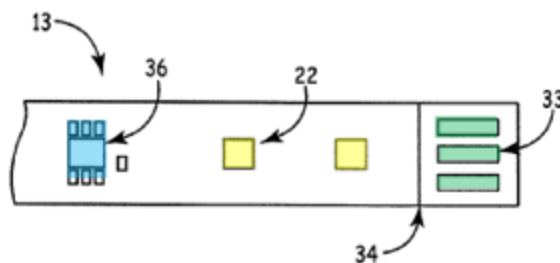


FIG. 13a

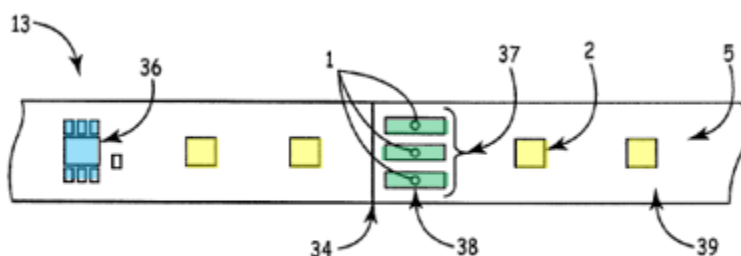


FIG. 13b

EX1009, 1a, 11b, 12, 13a, and 13b. Solder is used to couple the conductive pads on each board such that the LED light strip and power supply PCB are electrically connected.

(dd) Claim 50 The LED tube lamp according to claim 49, wherein each of the second bond pads comprises a through-hole.

155. It is my opinion that the combination of Ono, Holec, and Leong renders obvious that the power supply's second bond pads include a through-hole. As shown in FIGS. 11a, 11b, and 13b above, Holec teaches that "a plated through hole[s] 1" can be used to provide connection between the overlapping boards. EX1009, 8:50-67, Abstract, Cl. 1, 8.

(ee) **Claim 54** *The LED tube lamp according to claim 19, wherein the light bar comprises two first bond pads at a first end.*

156. It is my opinion that the combination of Ono, Holec, and Leong renders obvious an LED light strip with two first bond pads at a first end. §VII.A.3(cc) (claim 49). Ono's light source unit 23 and lighting circuit 24 are connected using Holec's circuit board connection method. Holec describes overlapping circuit boards to provide an interconnection. EX1009, 8:50-9:8. This allows a direct connection between two circuit boards. *Id.* In Holec, a [red] top board 6 or 13 includes conductive pads and a [green] bottom board 5 or 39 includes conductive pads. *Id.*, 8:50-9:8, 12:52-59, FIGS. 8, 11a, 11b, 12, 13a, 13b. The conductive pads are soldered directly to one another with overlapping joints 26. *Id.*, 9:26-28, 12:52-59.

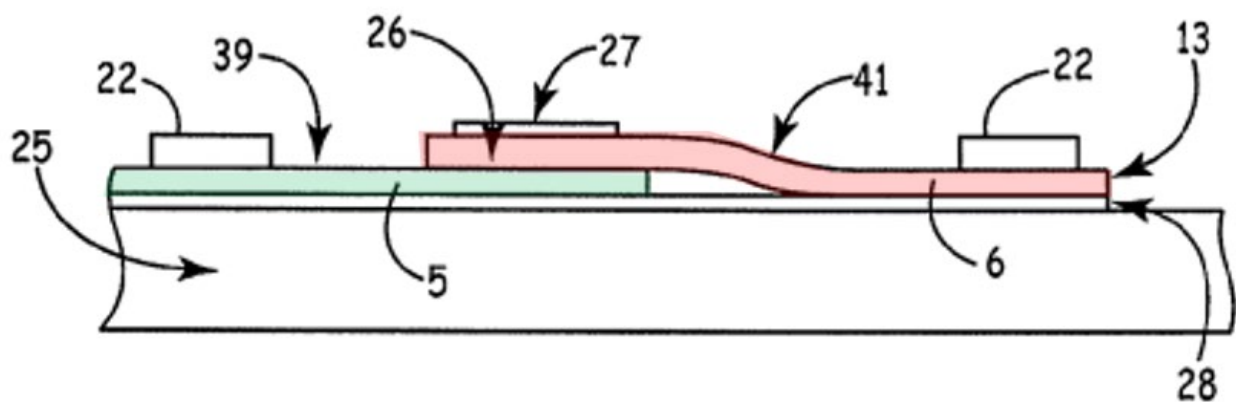


FIG. 8

Id., FIG. 8.

157. In the Ono-Holec-Leong combination, both the board 34 of the light source unit 23 and board 39 of the lighting circuit 24 include at least two conductive pads, as described in Holec and shown in FIGS. 11a, 11b, 12, 13a, and 13b below in green.

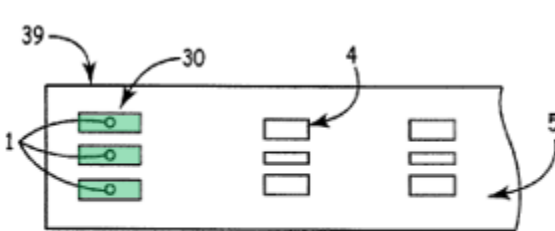


FIG. 11a

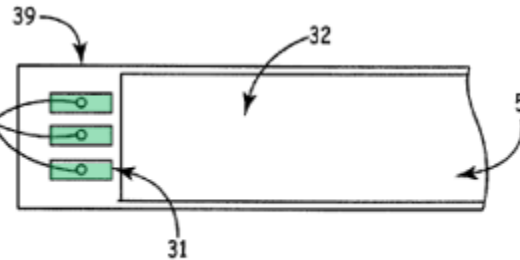


FIG. 11b

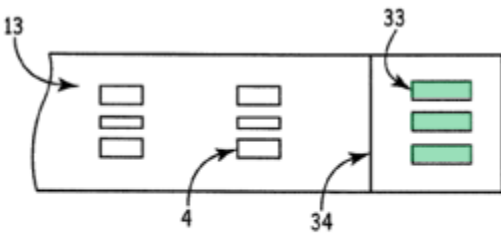


FIG. 12

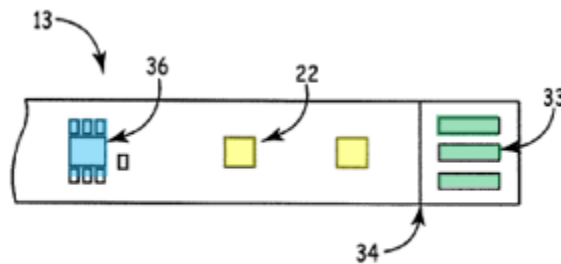


FIG. 13a

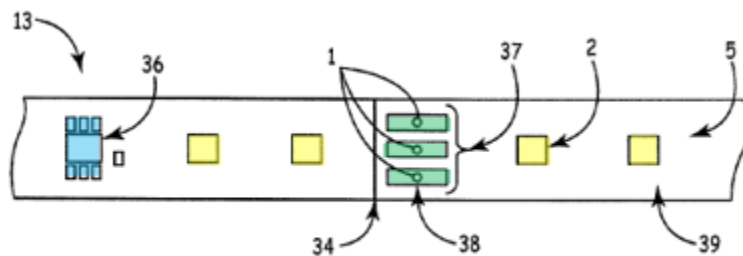


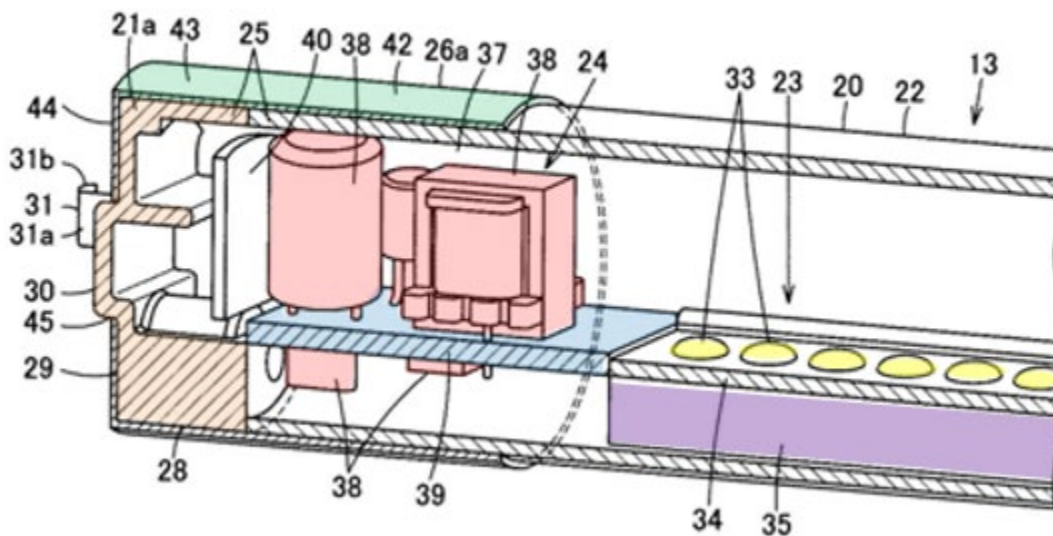
FIG. 13b

EX1009, 1a, 11b, 12, 13a, and 13b. Solder is used to couple the conductive pads on each board such that the LED light strip and power supply PCB are electrically connected.

(ff) ***Claim 58 The LED tube lamp according to claim 19, wherein the power supply comprises a printed circuit board and the light bar comprises a bendable circuit sheet.***

158. It is my opinion that the combination of Ono, Holec, and Leong renders obvious that the power supply comprises a printed circuit board and the light bar comprises a bendable circuit sheet. Ono teaches that “[t]he lighting circuit 24 has a [blue] **circuit board 39** on which a plurality of [red] electronic components 38 have been mounted.” EX1006, [0017]. Specifically, “[l]ead components such as capacitors and inductors are mounted on the mounting surface of the circuit board 39, and surface mounted components such as resistors and switching elements are mounted on the wiring pattern surface.” *Id.*

[Fig. 1]



Id., FIG. 1.

159. Holec further teaches that the use of bendable circuit sheets specifically for LED circuit boards: “the present invention is directed towards flexible lighting circuit boards and *more directly towards flexible LED circuit boards.*” EX1009, 6:43-47, 1:19-26, 7:1-6, 11:23-65, Cl. 2.

(gg) *Claim 59 The LED tube lamp according to claim 29, wherein the power supply further comprises a circuit board with two second bond pads.*

160. It is my opinion that the combination of Ono, Holec, and Leong renders obvious the power supply further comprises a circuit board with two second bond pads. *See* Claim 49, §VII.A.3(cc).

(hh) *Claim 60 The LED tube lamp according to claim 59, wherein each of the second bond pads comprises a through-hole.*

161. It is my opinion that the combination of Ono, Holec, and Leong renders obvious each of the second bond pads comprises a through-hole. *See* Claim 50, §VII.A.3(dd).

(ii) *Claim 64 The LED tube lamp according to claim 29, wherein the light bar comprises two first bond pads at a first end.*

162. It is my opinion that the combination of Ono, Holec, and Leong renders obvious the light bar comprises two first bond pads at a first end. *See* Claim 54, §VII.A.3(ee).

(jj) *Claim 68 The LED tube lamp according to claim 29, wherein the power supply comprises a printed circuit board and the light bar comprises a bendable circuit sheet.*

163. It is my opinion that the combination of Ono, Holec, and Leong renders obvious the power supply comprises a printed circuit board and the light bar comprises a bendable circuit sheet. *See* Claim 58, §VII.A.3(ff).

B. Ground 2 - Claims 10-13, 16, 18, 33, and 34 are Obvious Over Ono-Holec-Leong and Further in View of Foo

1. Motivation to Combine Ono-Holec-Leong with Foo

164. As I explained in Ground 1, §§VII.A.1-VII.A.2, a POSITA would have been motivated to combine Ono, Holec, and Leong. It is also my opinion that a POSITA would also have been motivated to combine Ono-Holec-Leong with the surface roughness taught by Foo with a reasonable expectation of success for several reasons.

165. Ono teaches that tube 20 is “translucent” at least “in the direction of light emission.” EX1006, [0014], [Solution] [0002], [0007], [0013], [0032], Cl. 1. Leong similarly teaches that the LED tube “can be diffused or can be coated with a white translucent film to create a more dispersed light output similar to present fluorescent lamps.” EX1010, 7:7-10. Leong’s housing “is made of a translucent material such as plastic or glass and preferably having a diffused coating.” *Id.*, 19:13-17, 30:27-29, 45:49-56, 51:58-63. However, Ono and Leong do not specify the type of coating

or roughness of the coating that improves light emission and diffusion. In my opinion, a POSITA would have been motivated to look elsewhere for specifics.

166. Foo likewise teaches that “[b]y selecting a material having an appropriate combination of light diffusion, transmission and reflection characteristics, the casing can produce an evenly-distributed illumination along the length of the tube with high luminous efficiency.” EX1007, 3:17-22. Foo also teaches that “advantageously the material is constructed to have a surface roughness smaller than $0.8\mu\text{m}$...” *Id.*

167. In my opinion, incorporating Foo’s material with specific roughness characteristics would have been a known use of existing technology to provide capability for LED lamps. A POSITA would have been familiar with the uses and characteristics of rough films and treatments to improve lighting performance in LED tube lamps and to improve evenness of light distribution. *See, e.g.*, EX1020, [0018] (“the inner surface of the glass outer tube is covered with a light diffusion powder”), [0090]; EX1021, 7:18-45 (“Diffusion treatment on ... an inner surface of the case 320 allows diffusion of light from the LED module 10. Examples of the diffusion treatment include a method for applying silica, calcium carbonate, or the like to the inner surface of the case 320 such as a glass tube. ...include a light diffusion sheet or a light diffusion film provided to ... the inner surface ... of the case 320. Specifically, the examples include a semi-opaque light diffusion film formed by attaching, to at least one of the inner surface and the outer surface of the

case 320, resin containing light diffusion materials (fine particles) Such as silica and calcium carbonate, and white pigment.”), EX1008, 6:33-43 (“The tube 2 may be made of glass, molded plastic or other material and may be provided with a light diffusing layer or layers. The light diffusing layer may be provided by etching, application of a coating or film, by the translucent or semitransparent material of the lens, by forming an irregular surface pattern during formation of the lens or by other methods. In one embodiment the tube 2 comprises a glass tube that is etched, represented by cross hatching 12 in FIG. 5, on an inside surface to provide a first diffusing layer.”). Thus, when a POSITA selected a material to provide a rough surface on the interior surface of the LED lamp, the POSITA would have had had a reasonable expectation that such an implementation would be successful. Therefore, in my opinion, a POSITA would have been motivated to use the surface roughness disclosed by Foo in an LED lamp as taught by Ono, Holec, and Leong.

2. Modification of Ono-Holec-Leong with Foo

168. In my opinion, a POSITA would have been motivated to modify the Ono-Holec-Leong LED tube lamp with the surface roughness of Foo to create the Ono-Holec-Leong-Foo LED tube lamp.

169. The LED tube lamp of Ono-Holec-Leong combined with the surface roughness of Foo, would produce an LED lamp tube (e.g., the LED lamp of Ono) that includes at least a plurality of light sources (e.g., light emitting elements 33), a

glass lamp tube with two end caps and a power supply in an end cap (e.g., lighting circuit 24). A light strip with a freely extending end would be directly soldered to the power supply (e.g., shown by the boards associated with light source unit 23 and lighting circuit 24 of Ono or flexible circuit boards of Holec soldered in the overlapping manner of Holec). Further, at least a portion of an inner surface of the glass tube would be covered by a rough surface having a roughness from 0.1 to 40 μm , as taught by Foo.

3. *Element-by-Element Analysis*

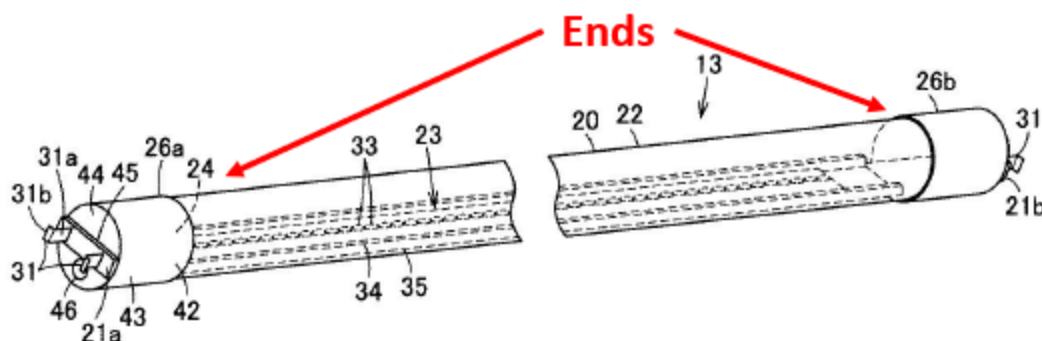
(a) *Limitation 10[p] An LED tube lamp, comprising:*

170. It is my opinion that the combination of Ono, Holec, Leong, and Foo renders obvious an LED tube lamp. *See* Limitation 19[p], Ground 1, §VII.A.3(a).

(b) *Limitation 10[a] a glass tube comprising an inner surface and an outer surface, at least part of the inner surface of the glass tube has a rough surface, the glass tube having two end portions;*

171. It is my opinion that the combination of Ono, Holec, Leong, and Foo renders obvious a glass tube comprising an inner surface and an outer surface, at least part of the inner surface of the glass tube has a rough surface, the glass tube having two end portions. Ono teaches that “[t]he lamp unit 22 includes a straight tube 20 that is at least partially translucent, and a cap 21a disposed on one end of the tube 20.” EX1006, [Solution]. The straight tube 20 may be made of “glass or a ceramic.” *Id.*, [0032].

[Fig. 2]



Id., FIG. 2. A POSITA would have understood the outer periphery of the glass tube 20 to be “an outer surface” and the inner periphery to be “an inner surface.”

172. Foo discloses that the “inner surface of the casing 10 may be constructed to have a surface roughness of smaller than $0.8\mu\text{m}$ to enhance the reflectance and reflux of the light.” EX1007, 10:18-20. In the Ono-Holec-Leong-Foo tube lamp, the inner surface of Ono’s tube 20 would have a rough surface as disclosed by Foo.

(c) *Limitation 10[b] a plurality of LED light sources;*

173. It is my opinion that the combination of Ono, Holec, Leong, and Foo renders obvious a plurality of LED light sources. *See* Limitation 19[b], Ground 1, §VII.A.3(c).

(d) *Limitation 10[c] two end caps respectively sleeving the two end portions of the glass tube;*

174. It is my opinion that the combination of Ono, Holec, Leong, and Foo renders obvious two end caps respectively sleeving the two end portions of the glass tube. *See* Limitation 19[c], Ground 1, §VII.A.3(d).

- (e) ***Limitation 10[d] a power supply in one of the end caps or separately in both of the end caps; and***

175. It is my opinion that the combination of Ono, Holec, Leong, and Foo renders obvious a power supply in one of the end caps or separately in both of the end caps. *See* Limitation 19[d], Ground 1, §VII.A.3(e).

- (f) ***Limitation 10[e] an LED light strip on the inner surface of the glass tube forming a freely extending end portion at one end along a longitudinal direction of the glass tube, the freely extending end portion directly soldered to the power supply, the plurality of LED light sources being on the LED light strip.***

176. It is my opinion that the combination of Ono, Holec, Leong, and Foo renders obvious an LED light strip on the inner surface of the glass tube forming a freely extending end portion at one end along a longitudinal direction of the glass tube, the freely extending end portion directly soldered to the power supply, the plurality of LED light sources being on the LED light strip. *See* Limitation 19[e], Ground 1, §VII.A.3(f).

- (g) ***Claim 11 The LED tube lamp according to claim 10, wherein the roughness of the rough surface is substantially from 0.1 to 40 μm.***

177. It is my opinion that the combination of Ono, Holec, Leong, and Foo renders obvious a glass tube with an inner surface having a roughness of the rough surface is substantially from 0.1 to 40 μm. Foo discloses that the “inner surface of the casing 10 may be constructed to have a surface roughness of smaller than 0.8μm to enhance the reflectance and reflux of the light.” EX1007, 10:18-20. In the Ono-

Holec-Leong-Foo tube lamp, the inner surface of Ono's tube 20 would have a surface roughness of smaller than $0.8\mu\text{m}$,

(h) Claim 12 The LED tube lamp according to claim 10, wherein each of the end caps comprises a plurality of openings thereon, and the two sets of the plurality of openings are symmetric to each other with respect to a virtual central axis of the end cap.

178. It is my opinion that the combination of Ono, Holec, Leong, and Foo renders obvious each of the end caps comprises a plurality of openings thereon, and the two sets of the plurality of openings are symmetric to each other with respect to a virtual central axis of the end cap. See Limitation 19[c], Ground 1, §VII.A.3(d). Leong further discloses that its end caps 150A, 150B include two vent holes 224A, 224B that are symmetric to each other with respect to central line 146 (e.g., virtual axis of the end cap). EX1010, 40:30-41:9.

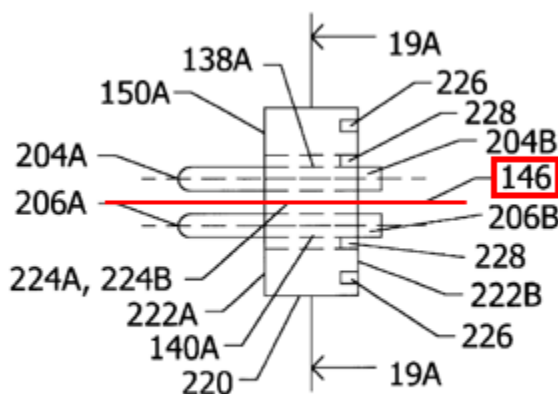


FIG. 19

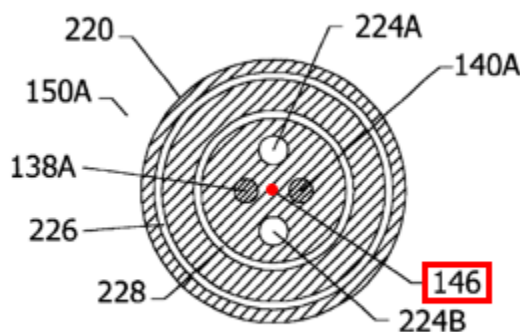


FIG. 19A

EX1010, FIGS. 19, 19A. As explained above, Leong's vent holes 224A, 224B are incorporated into the Ono's end cap. §VII.A.2.

- (i) Claim 13 The LED tube lamp according to claim 12, wherein the plurality of openings dissipate heat resulted from the power supply.**

179. It is my opinion that the combination of Ono, Holec, Leong, and Foo renders obvious the plurality of openings dissipate heat resulted from the power supply. *See* Claim 42, Ground 1, §VII.A.3(y).

- (j) Claim 16 The LED tube lamp according to claim 10, wherein the plurality of openings are separately in a shape of a circle.**

180. It is my opinion that the combination of Ono, Holec, Leong, and Foo renders obvious the plurality of openings are separately in a shape of a circle. *See* Claim 25, Ground 1, §VII.A.3(i).

- (k) Claim 18 The LED tube lamp according to claim 12, wherein at least a part of the openings are arranged along an arc and spaced apart from each other.**

181. It is my opinion that the combination of Ono, Holec, Leong, and Foo renders obvious at least a part of the openings are arranged along an arc and spaced apart from each other. *See* Claim 28, Ground 1, §VII.A.3(j).

- (l) Claim 33 The LED tube lamp according to claim 10, wherein the LED light strip is a bendable circuit sheet.**

182. It is my opinion that the combination of Ono, Holec, Leong, and Foo renders obvious the LED light strip is a bendable circuit sheet. *See* Claim 35, Ground 1, §VII.A.3(t).

(m) *Claim 34 The LED tube lamp according to claim 10, wherein the end cap comprises a metal part.*

183. It is my opinion that the combination of Ono, Holec, Leong, and Foo renders obvious that the end cap comprises a metal part. *See* Claim 36, Ground 1, §VII.A.3(u).

C. Ground 3 - Claims 1, 31, and 32 Are Obvious Over Ono-Holec and Further in View of Shimizu

1. Motivation to Combine Ono-Holec with Shimizu

184. As I explained in Ground 1, §§VII.A.1-VII.A.2, a POSITA would have been motivated to combine Ono and Holec for multiple reasons. It is also my opinion that a POSITA would also have been motivated to combine Ono-Holec with the heat shrink sleeve taught by Shimizu with a reasonable expectation of success for several reasons.

185. Ono teaches an LED tube that is directed to minimizing damage, including heat damage. EX1006, [0005]. Ono also teaches that tube 20 is “translucent” at least “in the direction of light emission.” EX1006, [0014], [Solution] [0002], [0007], [0013], [0032], Cl. 1. Holec likewise is directed to minimizing mechanical damage within an LED tube. EX1009, 5:17-24, 9:26-28 (“Connections and conductors are protected from damage or shorting by being covered by the connector body or overlapping joint 26.”). Shimizu similarly discloses an LED lamp including a heat shrinkable sleeve to improve heat dispersion, improved diffusion of light, and prevent shattering the glass tube in the event the tube is damaged. EX1005, [0010]

(“Even if the glass tube were to become damaged, the heat-shrinkable tube can prevent shattering of glass shards. Because the heat-shrinkable tube is translucent milky white, this enables the effect of diffusing the light that is emitted from the LED elements. ... Consequently, dispersion of emitted light and dispersion of heat in an LED lamp can be achieved inexpensively using a glass tube, and safety can be guaranteed in relation to damage to the glass tube.”). In my opinion, a POSITA would have been motivated to look at other options for dispersing heat, diffusing light, and minimizing damage in the event an LED tube shatters.

186. In my opinion, a POSITA would have found it obvious to try implementing Shimizu’s heat shrink sleeve with Ono’s LED tube because there were a finite number of identified, predictable solutions a POSITA would have pursued. For example, Shimizu teaches that by using a heat shrink sleeve “dispersion of emitted light and dispersion of heat in an LED lamp can be achieved inexpensively using a glass tube, and safety can be guaranteed in relation to damage to the glass tube.” EX1005, [0010], [0022]-[0024]. “The heat-shrinkable tube 9 causes the light emitted from the LED element 7 to be diffused.” *Id.*, [0017]. Ono describes an LED tube structure designed to “prevent external heat damage” and improve light emission. EX1006, [0027]. A POSITA would have recognized a design need for implementing Shimizu’s heat shrink sleeve to Ono’s LED tube for both the dispersion of heat and diffusion of emitted light. In doing so, a POSITA would have

expected this implementation to be successful and yield predictable results based on the stability of the technology and straight-forward implementation of the technology in Shimizu. *See also* §V.E.

187. In my opinion, a POSITA would have been motivated to include Shimizu's heat shrink sleeve onto Ono's LED lamp to reduce damage due to heat and damage caused by shattering of the LED tube. For example, Ono teaches improved safety and minimized damage through heat dissipation. EX1006, [0031], [0042]. Shimizu's heat shrink sleeve aids in the "dispersion of heat" and also "prevents scattering of broken shards when the glass tube 2 is damaged." EX1005, [0010], [0017], [0022], [0024]. Thus, in my opinion, a POSITA would have been motivated to include Shimizu's heat shrink sleeve on Ono's LED tube to improve overall safety of the LED tube.

188. In my opinion, a POSITA would have reasonably expected success in implementing Shimizu's heat shrink sleeve on Ono's LED lamp. Shimizu successfully implements its own heat shrink sleeve configuration in an identical application, *i.e.*, an LED lamp bulb for replacement of a conventional fluorescent bulb. EX1005, FIGS. 1-3. In my opinion, a POSITA would have understood that Shimizu's heat shrink sleeve could readily be incorporated into Ono's LED lamp. The technology for heat shrink sleeves on a tubular LED lamp was well developed, and such an installation would have been a straight-forward implementation of

known technology. *See* §V.E. As such, a POSITA would have reasonably expected to be successful in making the combination.

2. *Modification of Ono-Holec with Shimizu*

189. In my opinion, a POSITA would have been motivated to modify the Ono-Holec-Shimizu LED lamp to include the heat shrink sleeve of Shimizu installed on the outer surface.

3. *Element-by-Element Analysis*

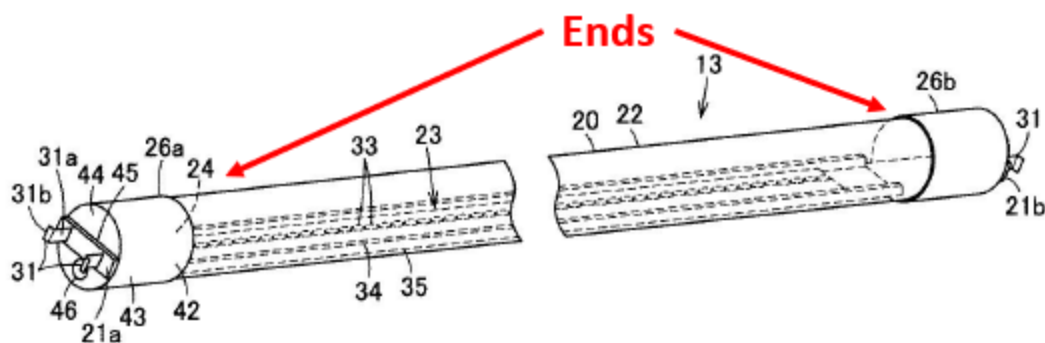
(a) *Limitation 1[p] An LED tube lamp, comprising:*

190. It is my opinion that the combination of Ono, Holec, and Shimizu renders obvious an LED tube lamp. *See* Limitation 19[p], Ground 1, §VII.A.3(a).

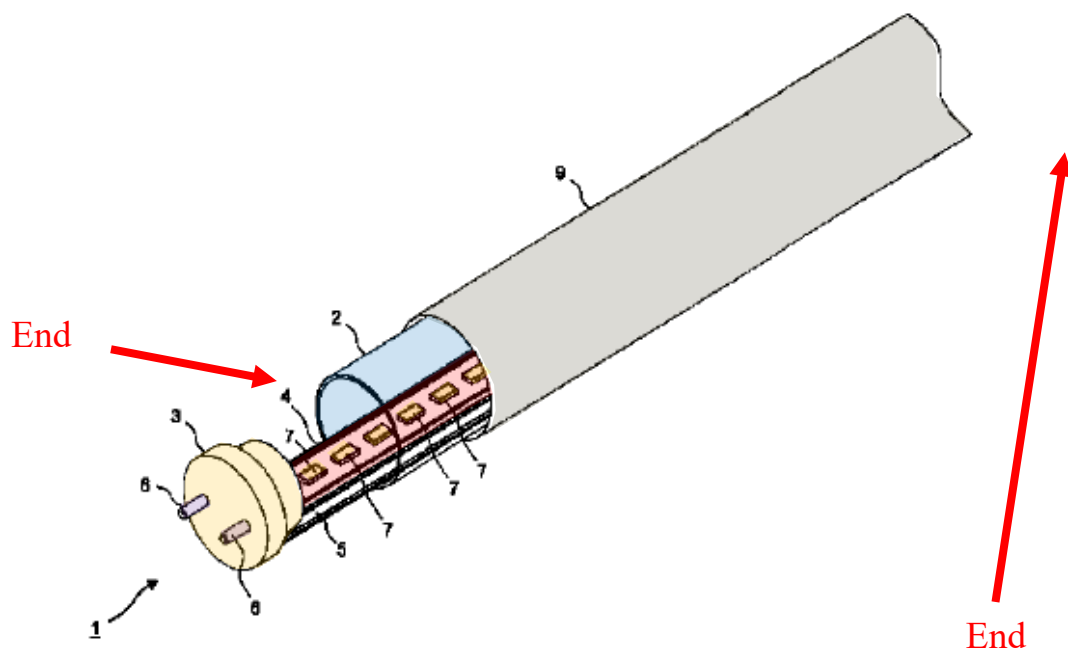
(b) *Limitation 1[a] a glass tube covered by a heat shrink sleeve and having two end portions;*

191. It is my opinion that the combination of Ono, Holec, and Shimizu renders obvious a glass tube covered by a heat shrink sleeve and having two end portions. Ono teaches that “[t]he lamp unit 22 includes a straight tube 20 that is at least partially translucent, and a cap 21a disposed on one end of the tube 20.” EX1006, [Solution]. The straight tube 20 may be made of “glass or a ceramic.” *Id.*, [0032].

[Fig. 2]



192. Shimizu describes “[a]n LED lamp, comprising: a [blue] glass tube that forms a cylinder,” as shown in Figure 1, and the tube has ends. EX1005, Claim 1; *see also id.*, [0008], [0012], [0013] (“Both ends of the glass tube 2 are closed by caps 3”). “The outer periphery of the glass tube 2 is covered with a [gray] translucent milky white heat-shrinkable tube 9.” EX1005, [0017].



EX1005, FIG. 1. Moreover, as discussed in §V.E, using heat shrink sleeves with LED tube lamps was well-known.

(c) *Limitation 1[b] a plurality of LED light sources;*

193. It is my opinion that the combination of Ono, Holec, and Shimizu renders obvious a plurality of LED light sources. See Limitation 19[b], Ground 1, §VII.A.3(c).

(d) *Limitation 1[c] two end caps respectively sleeving the two end portions of the glass tube;*

194. It is my opinion that the combination of Ono, Holec, and Shimizu renders obvious two end caps respectively sleeving the two end portions of the glass tube. See Limitation 19[c], Ground 1, §VII.A.3(d).

(e) *Limitation 1[d] a power supply in one of the end caps or separately in both of the end caps; and*

195. It is my opinion that the combination of Ono, Holec, and Shimizu renders obvious a power supply in one of the end caps or separately in both of the end caps. See Limitation 19[d], Ground 1, §VII.A.3(e).

(f) *Limitation 1[e] an LED light strip on an inner surface of the glass tube forming a freely extending end portion at one end along a longitudinal direction of the glass tube, the freely extending end portion directly soldered to the power supply, the plurality of LED light sources being on the LED light strip;*

196. It is my opinion that the combination of Ono, Holec, and Shimizu renders obvious an LED light strip on the inner surface of the glass tube forming a freely extending end portion at one end along a longitudinal direction of the glass tube, the freely extending end portion directly soldered to the power supply, the plurality of

LED light sources being on the LED light strip. *See* Limitation 19[e], Ground 1, §VII.A.3(f).

(g) *Limitation 1[f] wherein each of the end caps comprises: an end wall; and*

197. It is my opinion that the combination of Ono, Holec, and Shimizu renders obvious each of the end caps including an end wall. *See* Limitation 19[c], Ground 1, §VII.A.3(d).

(h) *Limitation 1[g] two conductive pins on the end wall.*

198. It is my opinion that the combination of Ono, Holec, and Shimizu renders obvious each of the end caps including two conductive pins on the end wall. *See* Limitation 19[c], Ground 1, §VII.A.3(d).

(i) *Claim 31 The LED tube lamp according to claim 1, wherein the LED light strip is a bendable circuit sheet.*

199. It is my opinion that the combination of Ono, Holec, and Shimizu renders obvious an LED light strip that is a bendable circuit sheet. *See* Claim 35, Ground 1, §VII.A.3(k).

(j) *Claim 32 The LED tube lamp according to claim 1, wherein the end cap comprises a metal part.*

200. It is my opinion that the combination of Ono, Holec, and Shimizu renders obvious an end cap that includes a metal part. *See* Claim 36, Ground 1, §VII.A.3(u).

D. Ground 4 - Claims 2, 3, and 9 Are Obvious Over Ono-Holec-Shimizu and Further in View of Leong

1. *Motivation to Combine Ono-Holec-Shimizu with Leong*

201. As I explained in Ground 1, §§VII.A.1-VII.A.2, a POSITA would have been motivated to combine Ono, Holec, and Leong for multiple reasons. As I also explained in Ground 3, §§VII.C.1-VII.C.2, a POSITA would have been motivated to combine Ono, Holec, and Shimizu for multiple reasons. In my opinion, a POSITA would also have been motivated to combine Ono-Holec-Shimizu with vent holes taught by Leong with a reasonable expectation of success for similar reasons.

2. *Modification of Ono-Holec-Shimizu with Leong*

202. In my opinion, a POSITA would have been motivated to modify the Ono-Holec-Shimizu-Leong LED lamp to include vent holes in the end caps as taught by Leong.

3. *Element-by-Element Analysis*

- (a) *Claim 2 The LED tube lamp according to claim 1, further comprising at least two openings on the end wall symmetric to each other with respect to a plane passing through the middle of a line connecting the two pins and perpendicular to the line connecting the two pins.***

203. It is my opinion that the combination of Ono, Holec, Shimizu, and Leong renders obvious an LED tube lamp including at least two openings on the end wall symmetric to each other with respect to a plane passing through the middle of a line connecting the two pins and perpendicular to the line connecting the two pins. *See*

Limitation 19[c], Ground 1, §VII.A.3(d) and Limitation 29[h], Ground 1, §VII.A.3(s).

(b) *Claim 3 The LED tube lamp according to claim 2, wherein the at least two openings are on a surface of the end wall on which the two pins are disposed.*

204. It is my opinion that the combination of Ono, Holec, Shimizu, and Leong renders obvious an LED tube lamp including at least two openings that are on a surface of the end wall on which the two pins are disposed. *See* Limitation 19[c], Ground 1, §VII.A.3(d).

(c) *Claim 9 The LED tube lamp according to claim 1, wherein at least a part of the openings are arranged along an arc and spaced apart from each other.*

205. It is my opinion that the combination of Ono, Holec, Shimizu, and Leong renders obvious an LED tube lamp where the openings are arranged along an arc and spaced apart from each other. *See* Claim 28, Ground 1, §VII.A.3(j).

VIII. CONCLUSION

206. 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.

May 30, 2023

Date

R. J. Baker
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