

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.

Case IPR2023-00272

Patent 10,830,397

DECLARATION OF MICHAEL LEBBY, Ph.D.

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PETITIONER'S EXHIBIT LIST

Exhibit	Shorthand	Description
1001	'397 Patent	U.S. Patent No. 10,830,397
1002	Jing	Chinese Patent No. CN203036295U to Jing Certified Translation
1003	Huang	U.S. Patent No. 9,151,475 to Huang
1004	Lebby	Declaration of Dr. Michael Lebby
1005	Foo	PCT Publication No. WO2013/152485 A1 to Foo
1006	Deng	Chinese Patent No. CN203797412U to Deng Certified Translation
1007	Zhao	U.S. Patent No. 9,970,640 to Zhao
1008	Halliwel	U.S. Patent No. 9,206,970 to Halliwel
1010		Excerpts of the File History of U.S. Patent No. 10,830,397
1011		CV of Dr. Michael Lebby
1012	Choi	U.S. Patent No. 9,788,321
1013	Guang	U.S. Patent No. 9,338,853
1014	Shimasaki	U.S. Patent No. 8,833,965
1015	Van Der Wel	U.S. Patent No. 9,146,017
1016	Wilcox	U.S. Patent No. 9,726,330
1017	Luk	U.S. Patent No. 6,846,094
1018	Demuynck	U.S. Patent No. 9,328,874
1019	Bisberg	U.S. Patent No. 8,558,255
1020	Nakamura	U.S. Patent No. 6,331,891
1021	Liu	<i>LED Packaging for Lighting Applications – Design, Manufacturing and Testing</i> , Sheng Liu et al., Chemical Industry Press (2011)
1022	Schubert	<i>Light-Emitting Diodes</i> , second edition, E. Fred Schubert, Cambridge University Press (2006)

I. INTRODUCTION

1. My name is Michael Lebby. I have been retained by Current Lighting Solutions, LLC d/b/a GE Current (“Current Lighting”) as an independent expert in the relevant art.

II. PROFESSIONAL BACKGROUND

2. I earned a Doctor of Philosophy (Ph.D) in 1987 from the University of Bradford, United Kingdom (UK). My Ph.D. thesis involved the design and fabrication of both optoelectronic and electronic semiconductor devices, and their associated characterization.

3. In 2004, I was awarded a Doctor of Engineering (D.Eng.) degree (a higher doctorate degree) from University of Bradford for my technical contributions to the field, with citation to “Technical Contributions to Optoelectronics.”

4. I also earned a Master of Business Administration (MBA) in 1984 and a Bachelor of Engineering (B.Eng.) in 1985, both from the University of Bradford. For my B.Eng. degree, I wrote my thesis on the computer aided testing of semiconductor devices.

5. I am a technologist and an internationally-recognized business leader with nearly 40 years of experience working in integrated photonics, electronics, and optoelectronics design and manufacturing. I am serving as an expert in the field of electronics and lighting technologies, including light-emitting diodes (LEDs).

6. Throughout the course of my educational and professional activities, I have worked extensively with devices like the LED devices and electronics at issue in this case. In general, I have worked in nearly every aspect of the optoelectronics and electronics business, ranging from epitaxial wafer growth, device design using modeling and simulation, device fabrication, circuit-design, testing, and qualification, to the implementation of devices into packages, both hermetic and non-hermetic, as well as analysis of package materials such as plastics (including plastic housings such as resin-packaged lead frame housings), metallic-based packages, semiconductor-based packages, ceramic-based packages, and printed circuit board electronics. I have also designed device packages (through-pin, surface mount, flip-chip, and various combinations thereof) for printed circuit board mounting. Many of the designed packages were implemented into modules and sub-system/luminaire applications. The modules have included fiber-optic, electronics, display, lighting, and sensing-based technologies.

7. I have also worked in commercially based industrial research-and-development laboratories to bring new optoelectronic, electronic, and photonic-based technologies from the research proof-of-concept phase through prototyping and qualified manufacturing for volume release. I have been both an entrepreneur (*e.g.*, Ignis Optics Inc, One Chip Photonics Inc., Lightwave Logic Inc.), as well as an intrapreneur (*e.g.*, Motorola, Intel, TE Connectivity (previously Tyco Electronics,

and AMP), AT&T Bell Labs). In these roles I created innovative new programs, both as entrepreneurial venture backed start-ups as well as intrapreneurial corporate funded programs/divisions. I have built these entities to develop electronics, optoelectronics, and photonics technology emerge from the laboratory and fabrication clean room to production factories.

8. I currently serve as CEO of Lightwave Logic Inc, a public company.

9. I also currently serve as a Technical Expert to the European Commission, where my work has focused on LEDs, displays, lighting, organic LEDs (OLEDs), photonics devices, and other optical devices.

10. In academia, I have served as a professor of optoelectronics at Glyndŵr University, Wales, UK. Google Scholar currently assigns me an h-index of 47, an i10-index of 168, and over 8700 citations.

11. With regard to professional organizations, I serve as a Fellow of the National Academy of Inventors (NAI), the Institute of Electrical and Electronic Engineers (IEEE), and the Optical Society of America (OSA).

12. I regularly speak at technical conferences and have appeared in panels and interviews many times. I have served as chairman of the International PIC conference based in Europe since its conception in 2015.

13. I am a co-inventor of the first oxide vertical cavity surface emitting laser (VCSEL), which is now implemented in various consumer applications,

including Apple's iPhone Face ID feature and PC laser mice. This invention issued on 25th October, 1994, as U.S. Patent No. 5,359,618, entitled "High Efficiency VCSEL and Method of Fabrication".

14. In addition, I have over 230 issued utility patents with the USPTO in subjects such as electronics, optoelectronics, photonics, packaging, transceiver modules, optical sub-assemblies, materials, epitaxial growth, device design, assembly, and various active and passive components (both electronic and optoelectronic).

15. My CV, which I understand is being submitted with this declaration, includes a listing of patents applications on which I am an inventor.

16. Because of my background, training, and experience, I am qualified as an expert to explain the background of the technology encompassed by the '397 Patent as well as to opine on the validity of the claims of the '397 Patent in view of the prior art references discussed herein.

III. COMPENSATION

17. My work on this matter is being billed at my customary rate of 450.00 per hour. Also, I am being reimbursed for reasonable expenses I incur in relation to my services. I will be paid regardless of the outcome of any proceeding that my work is used in.

IV. OVERVIEW OF TASK & BASIS FOR OPINIONS

18. I have been asked to review the '397 Patent. I have been asked to provide opinions related to certain issues from the perspective of a person of ordinary skill, having knowledge of the relevant art, as of December 5, 2014, and—except where otherwise noted—the opinions stated in this declaration are from that perspective. The qualifications and abilities of such a person are described in Section V below.

19. More particularly, I have been informed that this proceeding is currently at a preliminary stage during which the Patent Trial and Appeal Board will decide whether the Petition establishes a reasonable likelihood of at least one claim of the '397 Patent being invalid.

20. My opinions are based on my education, training, and experience as well as items that I reviewed to prepare my opinions, including the documents listed in the Exhibit List included with the Petition and any other items I reference in my below analysis.

21. I understand that other issues may arise that require further explanation, and I will provide that explanation if appropriate. As a result, I respectfully reserve the right to update and supplement this declaration and the information and opinions provided herein.

V. LEVEL OF SKILL IN THE RELEVANT ART

22. I understand that the level of ordinary skill may be reflected by the prior art of record, and that a person of ordinary skill in the art (“POSA”) to which the claimed subject matter pertains would have the capability of understanding the scientific and engineering principles applicable to the pertinent art.

23. I understand there are multiple factors relevant to determining the level of ordinary skill in the pertinent art, including (1) the levels of education and experience of persons working in the field at the time of the invention; (2) the sophistication of the technology; (3) the types of problems encountered in the field; (4) the prior art solutions to those problems; and (5) the rapidity with which innovations are made.

24. A POSA as of December 5, 2014—the ’397 Patent’s earliest claimed priority date—would have had at least a bachelor’s degree in electrical engineering, or an equivalent field, and at least one to two years of experience (either in academia or industry) in lighting design, including knowledge of light emitting diodes (LEDs) and related technology for driving LEDs. A person of ordinary skill in the art with a higher level of education may have fewer years of academic or industry experience, or vice versa. Such a POSA would have been familiar with the concepts and types of LED lighting technology described below.

VI. OVERVIEW OF THE TECHNICAL FIELD & PRIOR ART

25. Consumer interest in LED lamps in the mid-2010s was high due to the increased energy efficiency, long lifespan, and reduced use of toxic materials in LED lamps. However, consumers desired LED lamps that could be used in the light fixtures already in the consumer's home that were designed for traditional fluorescent lamps. Thus, a POSA would have understood the importance of any LED lamp being compatible with existing fluorescent light fixtures. A POSA would also have understood the need for increased reliability and lower manufacturing costs of LED tube lamp designs.

A. LED tube lamps

26. LED tube lamps are LED lighting devices that are used in place of fluorescent tube lamps. LED light sources can be disposed inside tubes made to fit into existing fluorescent light sockets or fixtures. *Id.*; *see, e.g.*, EX1013, 4:16-19. LED lamp tubes have been a relatively mature technology for many years. Light emission from a solid state material (electroluminescence) was known in the early

twentieth century, and LEDs were the subject of significant research as far back as the early 1960s. *See e.g.*, EX1021¹, 11/367, 20/367; EX1022², 13/434, 16/434.

27. LED lamp tubes can include diffusion elements applied to the tube, and a POSA would understand that there are several methods of diffusing light from LED tube lamps, including diffusion films. *See, e.g.*, EX1014, 7:18-45. One known technique involved applying a diffusion layer to a substrate via adhesive. *See, e.g.*, EX1021, 294/367, Figure 6.91. “The diffuser/diffusion film can effectively diffuse light and uniformly mixes light before it is emitted from the lamp to make the light emitting soft and comfortable, becoming the first choice of high-quality LED indoor lamps.” EX1021, 293/367. A POSA would have understood that all such methods diffuse light from LED tube lamps and help create a uniform light output. *See, e.g.* EX1015, 2:7-14.

B. LED Light Strips

28. LED light sources for use in tube lamps are typically mounted on LED light strips in arrays made of various materials, including traditional printed circuit

¹ Liu is a well-known textbook used as a general reference for LED packaging for lighting applications. Liu, with a copyright of 2011, was publicly available prior to the earliest claimed priority date of the '397 Patent.

² Schubert is a well-known textbook used as a general reference for LED technologies. Schubert, with a copyright of 2006, was publicly available prior to the earliest claimed priority date of the '397 Patent.

boards (PCBs). *See, e.g.*, EX1014, 4:40-44. PCBs were well-known for LED lighting applications and provided a versatile substrate for mounting LEDs.

29. LED strips for LED tube lamps were arranged in numerous ways within the tube, such as adhered directly on an inner surface of the tube or mounted on an intermediate structure. *See, e.g.*, EX1016, 10:46-49, EX1018, 8:9-14, 10:44-50, FIG. 6; EX1017, 1:63-66; EX1015, 6:5-39. Ultimately, there were many known ways of disposing an LED light strip within and on the inner surface of a lamp tube, each with the benefit of supporting and securing the LED light strip in place. A POSA would be familiar with manufacturing methods for LED light strips and for mounting LED chips. EX1019, 7:10-55, 7:56-8:5; EX1020.

C. PCBs

30. PCBs for LED tube lamps included flexible PCBs that could be used in lighting applications with different shapes. *See, e.g.*, EX1017, 1:63-66, 6:44-54; *see also* EX1018, 7:58-61. Flexible circuit boards were well-known for LED lighting applications and provided a versatile substrate for mounting LEDs. Other types of PCBs for LED tube lamps included less flexible PCBs having a greater degree of rigidity. For example, it was known to use aluminum to create an aluminum-based PCB having increased strength as compared to other types of PCBs. *See, e.g.*, EX1012, 1:13-16 (“The invention is generally related to an aluminum-based printed circuit board, and, more specifically, to an aluminum-based printed circuit board

having increased heat dissipation and ***bending strength properties***.”), 9:42-7. Some PCBs included a core or base layer strengthened with aluminum. *See, e.g.*, EX1012, 1:53-62; 3:30-35; 6:4-6; 7:41-43; 7:54-55; 8:35-38; claim 1.

D. End Caps

31. LED tube lamps included end caps at the ends of the LED tube lamps to enclose the LED strips within the tube. *See, e.g.*, EX1014, 5:32-39; EX1017, 5:24-30; EX1018, 1:35-2. The end caps included electrode pins for connecting to a lighting fixture. *See* EX1013, 7:39-46. It was also known to include openings in the end caps, such as to reduce pressure or heat within the tube. *See, e.g.*, EX1008, 8:61-94, FIG. 18; *see also* EX1006, ¶[0037], FIGS. 1 and 3.

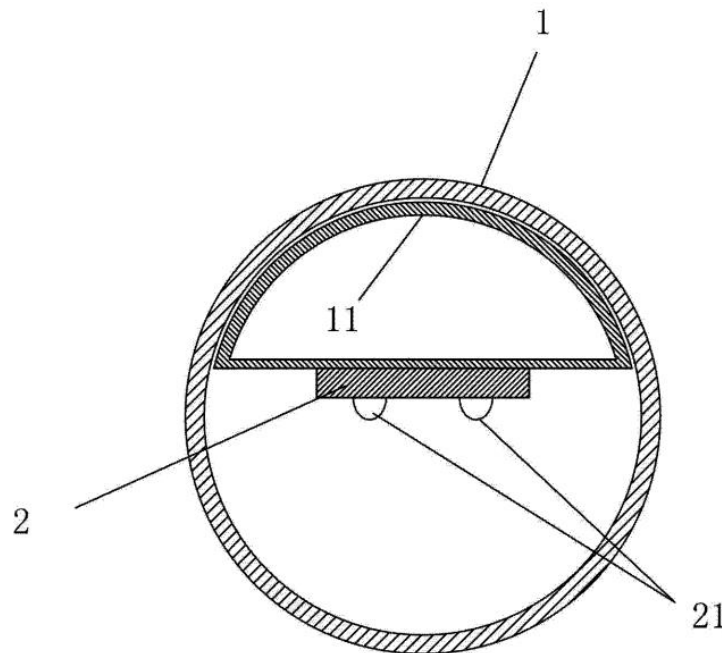
E. Heat Dissipation

32. It was known that operation of an LED lighting device generates heat, which, if not dissipated, can reduce performance and damage components of an LED lighting device. EX1021, 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.” EX1021, 167/367. As such, a POSA would have understood the importance of heat management in an LED lighting device.

F. Jing (EX1002)

33. Jing is titled “LED Fluorescent Lamp.” Jing was published on July 3, 2013. I understand that Jing qualifies as prior art to the ’397 Patent.

34. Jing describes an “LED fluorescent lamp in the prior art is composed of a glass lamp tube 1 [and] a light emitting component arranged in the lamp tube 1 . . . The light emitting component includes a bracket 11 made of aluminum profiles extending from one end of the lamp tube to the other end, and a circuit board 2 fixed on the bracket, which extends along the axis of the lamp tube and is equipped with LED lamp beads 21.” EX1002, ¶ [0002].



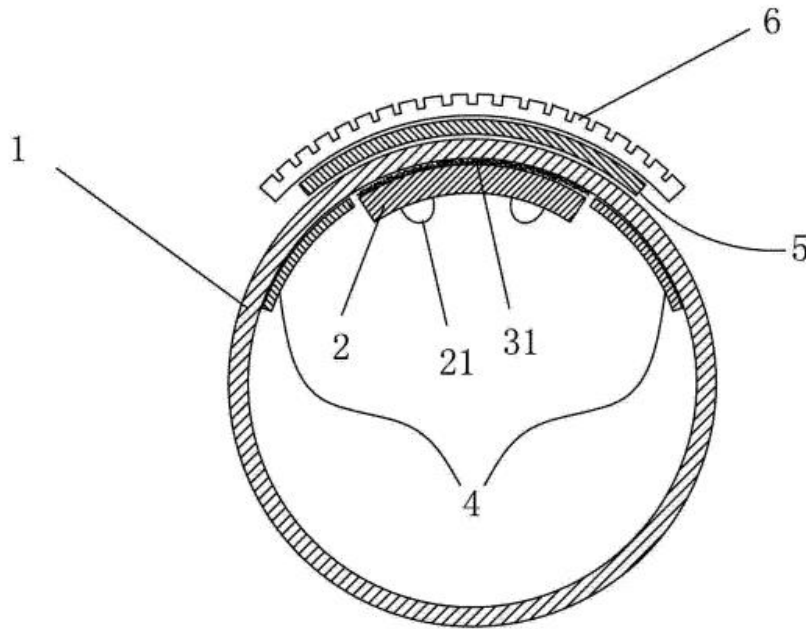
EX1002, FIG. 1.

35. “This structure has the following shortcomings: 1) Each fluorescent lamp needs to be equipped with a bracket with the same length as the lamp tube, so the manufacturing cost is high. 2) Due to the barrier of the bracket, when the LED light source in the enclosed space inside the lamp tube works, the heat generated is

transferred to the bracket through the circuit board, and then transferred from the bracket to the external space through the glass wall of the lamp tube. In this way, the heat resistance will be larger through two heat conduction exchange layers.” EX1002, ¶¶ [0004]-[0005].

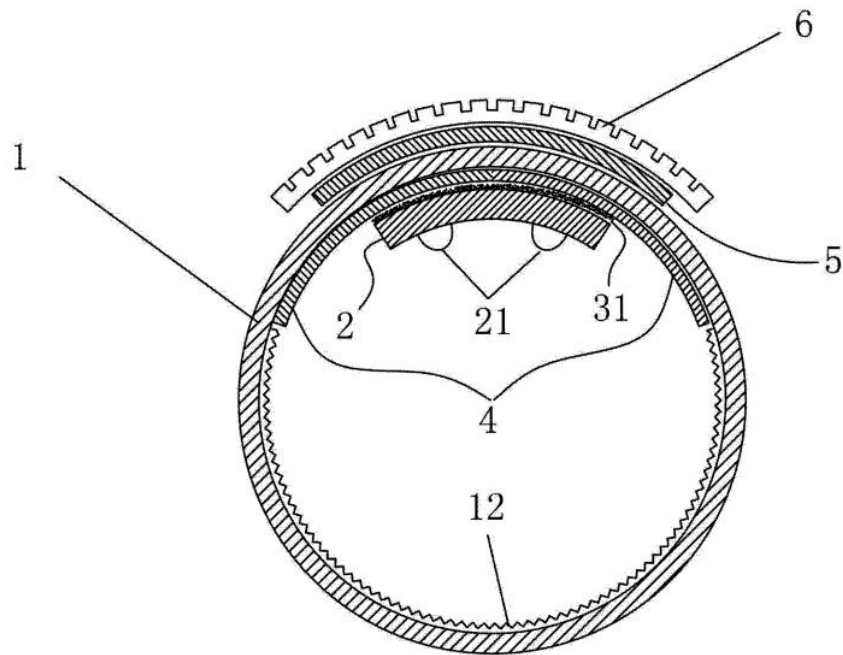
36. In “Invention Content,” Jing states that “[t]he technical problem to be solved is to reduce the manufacturing cost.” EX1002, ¶ [0006]. “This Utility Model sets reflective film layers on the inner and outer walls of the lamp tube, so that the light emitted from the LED light source to the back of the lamp tube can be fully utilized due to reflection, thereby correspondingly enhancing the luminance of the LED fluorescent lamp.” EX1002, ¶ [0018]. “The further improvement of the Utility Model is that the inner wall of the lamp tube 1 corresponding to the back of the circuit board 2 is coated with a film that can reflect light by electroplating, spraying or vacuum coating.” EX1002, ¶ [0032].

37. FIG. 2 of Jing illustrates an example of the reflective film layer 4



EX1002, FIG. 2.

38. Jing teaches that the LED fluorescent lamp “is composed of a lamp tube 1 with a circular section and glass material, a circuit board 2 arranged in the lamp tube 1 extending along the axis, and a plug with a driver arranged on both ends of the lamp tube 1 and electrically connecting the circuit board 2 with the external power supply.” EX1002, ¶ [0027]. “The inner wall of lamp tube 1 can be . . . an inner wall with all or part of the rough surface treatment (the rough surface treated inner wall is called sanding layer 12),” where “rough surface treatment refers to the treatment of sanding or spraying the inner wall of the lamp tube to make the light emitted by the lamp tube diffuse evenly and softly.” *Id.*

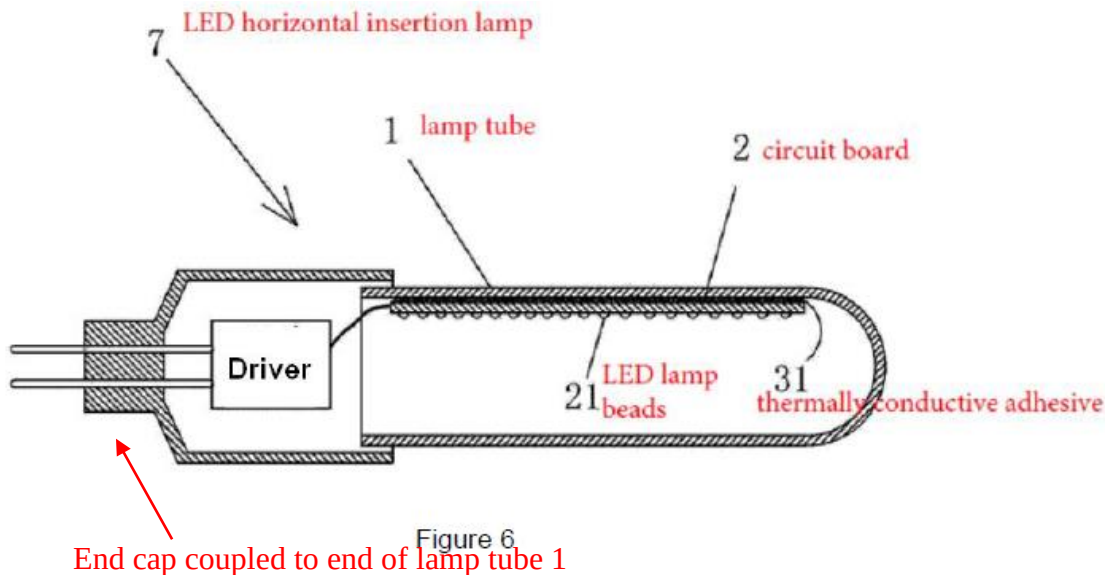


EX1002, FIG. 4.

39. Jing teaches that inner reflective film layer 4 “has two settings in the circumference direction of the inner wall of the lamp tube 1, that is continuous film layer or discontinuous film layer respectively.” See EX1002, ¶ [0032] *see also id.*, FIG. 2, above (illustrating the “continuous” configuration of inner reflective film layer 4) and FIG. 4, above (illustrating the “discontinuous” configuration of inner reflective film layer 4).

40. Jing teaches an embodiment in which the LED fluorescent lamp “is composed of . . . a plug with a driver arranged on both ends of the lamp tube 1 and electrically connecting the circuit board 2 with the external power supply.” EX1002, ¶ [0027]. In another embodiment, “one end is an open end, [and] the other end is a

closed LED horizontal insertion lamp 7, that is, the circuit board is installed into the lamp tube through the open end of the horizontal insertion lamp tube, and then the plug with the driver electrically connected to the external power supply is blocked on the open end, as shown in Figure 6.” *Id.*



EX1002, FIG. 6.³

G. Huang (EX1003)

41. Huang is titled “LED Tube Light.” Huang was published on October 6, 2015. I understand that Huang qualifies as prior art to the ’397 Patent.

42. Huang describes “an LED glass tube light is easily broken or damage[d] due to non-uniform external force.” EX1003, 1:9-11.

³ All colorized drawings herein are annotated.

43. Huang discloses an LED tube light that includes a glass tube 1, a base 2, and a light emitting unit 3. EX1003, 2:27-32. “The light emitting unit 3 includes a circuit board module 31, a plurality of LEDs 32, a socket connector 33, and an electronic unit 34.” *Id.*, 3:33-35. “The light emitting unit 3 takes a back surface of the circuit boards 311 to dispose on the mounting surface 211 of the base 2, and the circuit boards 311 are fixed on the base 2 by screws, adhesives, or other suitable means.” *Id.*, 3:60-63.

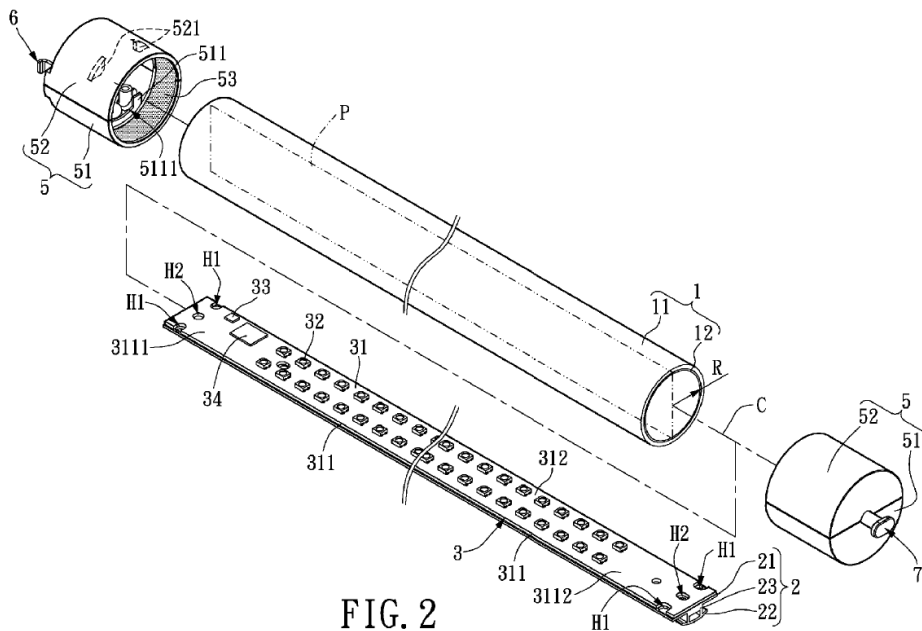


FIG. 2

EX1003, FIG. 2.

44. Huang discloses that the length of light emitting unit 3 is longer than the length of the main body region of glass tube 1. *Id.*, FIG. 3:

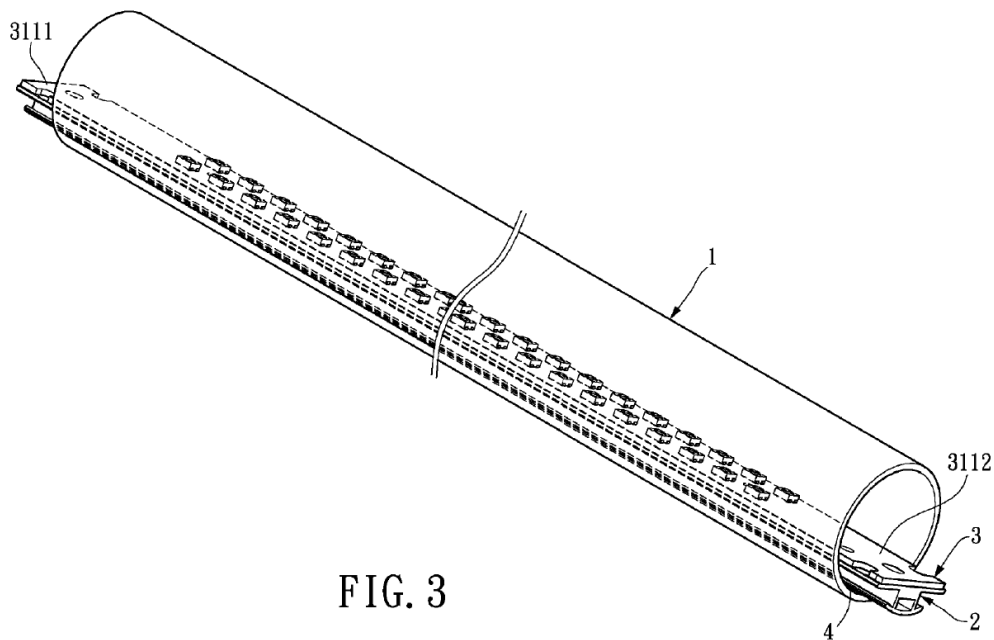


FIG. 3

EX1003, FIG. 3.

45. Huang describes that “[o]ne embodiment of the invention provides an LED tube light having better structural durability and lower breakage probability. The LED tube light is assembled by a glass tube, a base, a light emitting unit, and two lateral cover assemblies. The base has a length larger than the length of the glass tube.” EX1003, 1:19-24. “Base[d] on the above, when the lateral cover assemblies is loaded a force, the force is transferred to the base and then uniformly dispersed to the glass tube by installing the lateral cover assemblies on the base, so that the reliability of the glass tube is improved and the broken probability [sic] of the glass tube is reduced. *Id.*, 1:41-46.

46. Both base 2 and circuit board module 31 are longer than glass tube 1. For example, as shown in FIGS. 2 and 3 of Huang (above), both base 2 (including mounting surface 211) and light emitting unit 3 (including circuit board module 31) extend out of each end of, and are longer than, glass tube 1. EX1003, FIGS. 2 and 3, 3:33-35. Further, base 2 provides mounting surface 211 for light emitting unit 3, and that because “[t]he base has a length larger than the length of the glass tube,” light emitting unit 3 (and circuit board module 31) are also longer than glass tube 1. EX1003, FIG. 3, 1:19-24.

H. Foo (EX1003)

47. 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 ’397 Patent.

48. Foo describes “a need for a LED light tube that increases luminous efficiency and has reduced loss of light energy.” EX1005, 3/29. “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.*

49. Foo describes an LED light tube 100 that includes casing 10, a plurality of LED light sources, and two end caps 50. EX1005, 7/29. “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.” EX1005, 11/29. Foo discloses that “the casing has an inner surface with a surface roughness smaller than $0.8\mu\text{m}$.” EX1005, 13/29. “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*). EX1005, 4/29.

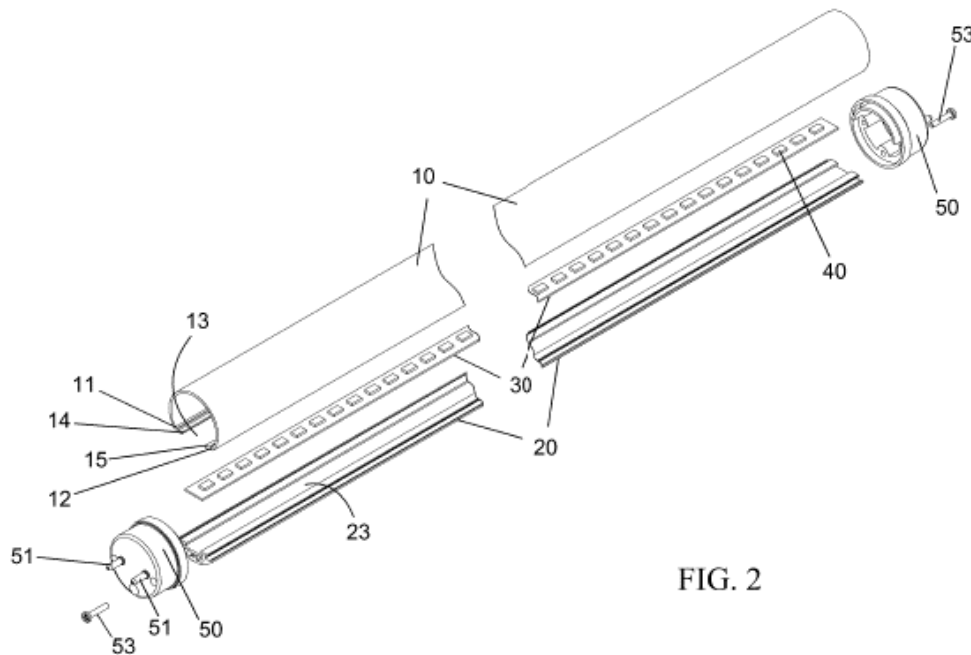


FIG. 2

EX1005, FIG. 2.

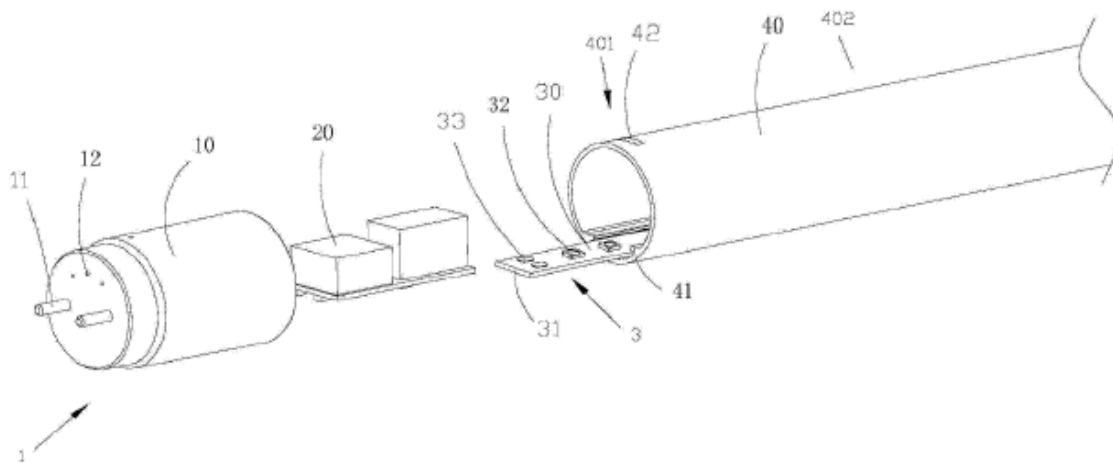
I. Deng (EX1006)

50. Deng is titled “LED Tube.” Deng was published on August 27, 2014.

I understand that Deng qualifies as prior art to the '397 Patent.

51. Deng describes LED 1 that includes “hollow tube body 40, end covers 10 connecting the ends of the tube body 40, and a light source 3 fixedly mounted inside the tube body 40.” EX1006, ¶ [0024]. “In order to dissipate heat of the LED tube 1, air vents 12 for heat dissipation are opened on the end faces of the end covers 10. Air 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.” *Id.*, ¶ [0037]. Deng further describes that “air vents for heat dissipation are opened on the end faces of the end covers.” *Id.*, 3/13.

52. “In order to improve the overall resistance of the LED tube 1 to electric leakage, the end covers 10 are also made of an insulating material, and copper pins 11 for power-on are arranged on the end faces of the end covers 10. Each of the copper pins 11 runs through the end face of the corresponding end cover 10, one end of the copper pin 11 is connected to the driver power supply unit 20 in the tube body 40, and the other end is for connecting an external power supply. In this way, the insulating effect of the LED tube 1 can be improved comprehensively, making the LED tube 1 safer in the installation and use processes.” EX1006, ¶ [0036].

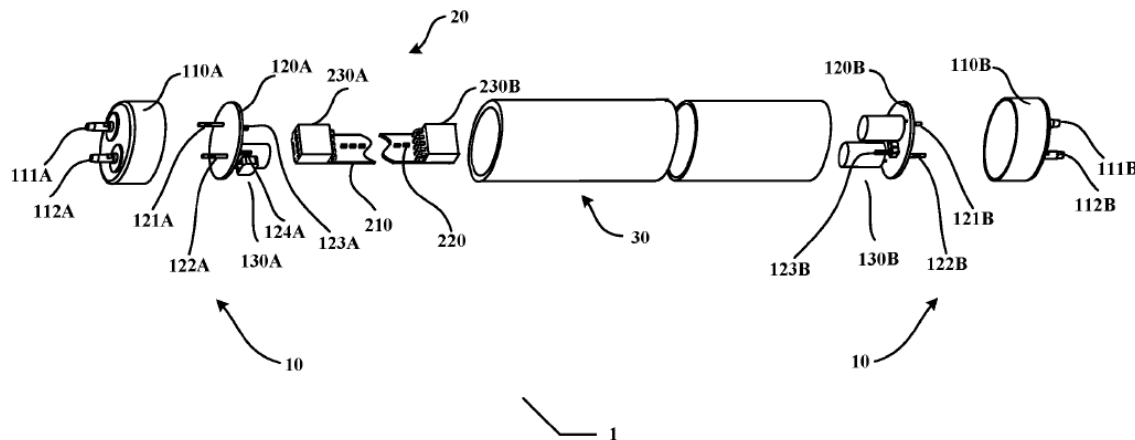


EX1006, FIG. 1.

J. Zhao (EX1007)

53. Zhao is titled “LED FLUORESCENT LAMP DRIVING POWER SOURCE AND LED FLUORESCENT LAMP.” Zhao was published on May 15, 2018. I understand that Zhao qualifies as prior art to the ’397 Patent.

54. Zhao describes an LED incandescent lamp 1 that includes tube body 30 and end caps 110A, 110B. EX1007, 8:26-29, FIG. 4. Zhao describes “enclosing both ends of the incandescent lamp tube body by the end cap 110 with the aid of adhesives such as light mud.” EX1007, 6:36-42. “When the assembly of LED incandescent lamp 1 is completed, the end caps 110A and 110B of the LED drive power supply 10 enclose both ends of the tube body 30. In the present embodiment, inner surfaces of the end caps 110A and 110B and the outer surface of the tube body 30 can be adhered together by using adhesives (e.g., light mud), and meanwhile, the base plate can be also fixed to inside the end caps.” *Id.*, 8:42-50.



EX1007, FIG. 4

K. Halliwell (EX1008)

55. Halliwell is titled “Linear LED Lamp Tube with Internal Driver and Interconnect to Line Voltage and Methods of Installing the Same.” Halliwell discloses an LED lamp tube 10 that “comprises at least one light emitting diode (LED) 17).” EX1008, 11:31-33. “The LEDs are mounted on reflective back plate 19 by any of various methods generally known and understood in art ... in certain embodiments, reflective back plate 19 may divide the tube into two chambers of nearly equal volume.” *Id.*, 11:48-54. “In certain embodiments, the end caps 11 are secured to the reflective back plate 19 via screws or some other securing mechanism.” *Id.*, 8:56-58.

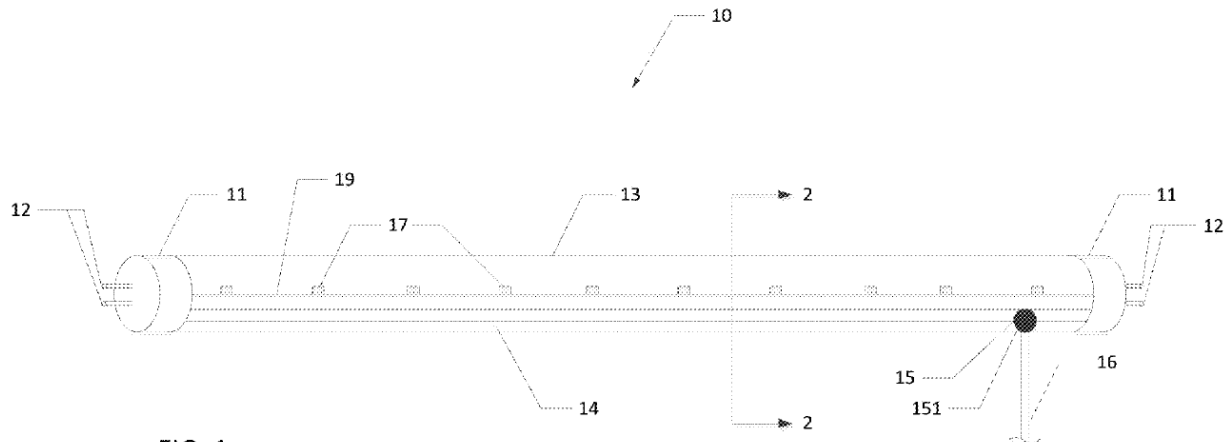


FIG. 1

EX1008, FIG. 1.

56. “[T]he body of the lamp tube 10 comprises a lens 13.” EX1008, 4:62-66. “[T]he lens 13 may be made of Smart Glass, or some other material that can transition from clear to frosted and/or vice versa.” *Id.*, 5:49-53.

57. “[D]river circuitry 18 is disposed within the body of LED lamp tube 10.” EX1008, 12:11-12. “[D]river circuitry 18 may comprise a circuit portion configured to convert the input alternating current (AC) line voltage to a direct current (DC) voltage.” *Id.*, 12:12-15, 12:15-29, 12:59-66, 13:25-33 (“The output of the driver circuitry 18 is fed to one or more LEDs 17 which may be connected in series or in parallel. The LEDs 17 the use the electrical power to emit light.”). Halliwell describes that “the driver circuitry may be mounted on the reflective back plate 19” and “the driver circuitry may be mounted in an end cap 11 disposed on an end of LED tube lamp 10.” *Id.*, 12:30-37 Driver circuitry 18 can also be “disposed within the chamber defined by the back cover 14 and reflective back plate 19” (*id.*,

12:30-32) and, as shown in FIG. 16, interior electrical wires 165 and 166 are “coming up from the chamber defined by the back cover 14 and the reflective back plate 19 and soldered onto an electrical contact point on reflective back plate 19” (*id.*, 13:44-61).

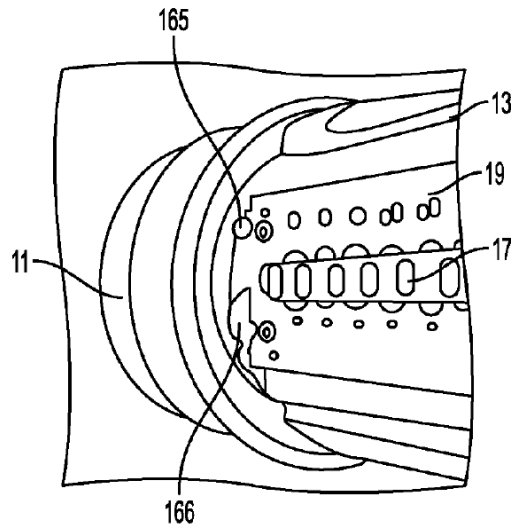


FIG. 16

58. As shown in FIGS. 7-9, 16, and 17, reflective back plate 19 extends into end caps 11:

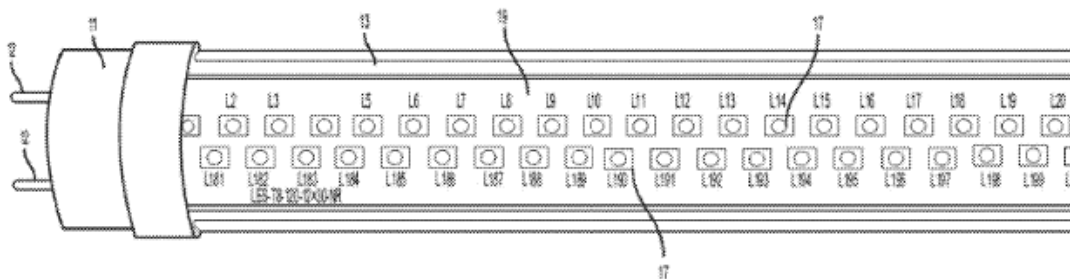


FIG. 7

EX1008, FIG. 7.

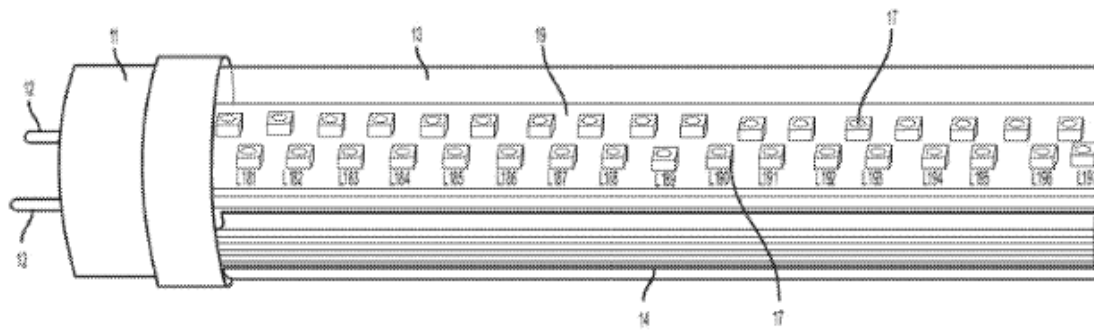


FIG. 8

EX1008, FIG. 8.

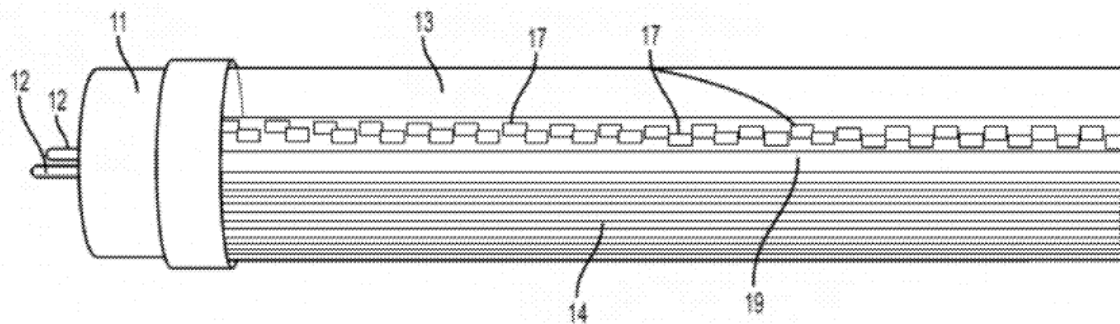


FIG. 9

EX1008, FIG. 9.

59. A POSA would have understood that reflective back plate 19 with mounted LEDs 17 disclose an LED light strip. Halliwell teaches that “the LED lamp tube comprises: a substantially elongate[d] member comprising a first end surface, a second end surface, and an intermediate surface substantially between the first and second end surfaces.” EX1008, 2:14-19, 2:26-3:57. “The first and second end surfaces may likewise comprise the at least one end cap 11.” *Id.*, 5:10-15, 8:10-12; FIGS. 1, 6-12, 16-18. A POSA would also have understood that because reflective

back plate 19 extends into the portion of LED tube lamp 10 covered by end caps 11 (second end surfaces), reflective back plate 19 is longer than a main body region (or intermediate surface) of LED tube lamp 10.

60. FIG. 17 illustrates that reflective back plate 19 may include an identifier or other information:

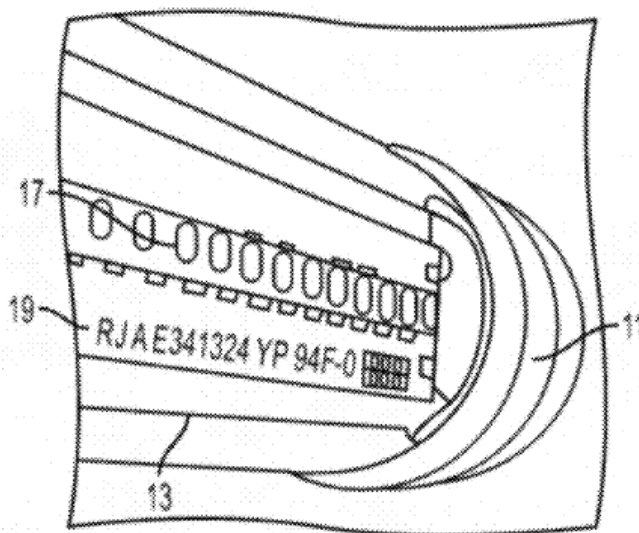


FIG. 17

EX1008, FIG. 17.

VII. THE '397 PATENT

61. The '397 patent is directed to "illumination devices, and more particularly to an LED tube lamp and its components including the light sources, electronic components, and end caps." EX1001, 1:64-67. The '397 patent describes that "existing LED tube lamps have certain drawbacks." *Id.*, 2:21-22.

62. “First, the typical circuit board is rigid and allows the entire lamp tube to maintain a straight tube configuration when the lamp tube is partially ruptured or broken, and this gives the user a false impression that the LED tube lamp remains usable and is likely to cause the user to be electrically shocked upon handling or installation of the LED tube lamp.” EX1001, 2:23-28.

63. “Second, the rigid circuit board is typically electrically connected with the end caps by way of wire bonding, in which the wires may be easily damaged and even broken due to any move during manufacturing, transportation, and usage of the LED tube lamp and therefore may disable the LED tube lamp.” EX1001, 2:29-34.

64. “Third, the existing LED tube lamps are bad in heat dissipation, especially have problem in dissipating heat resulting from the power supply components inside the end caps. The heat resulting from the power supply components may cause a high temperature around end cap and therefore reduces life span of the adhesive and simultaneously disables the adhesion between the lamp tube and the end caps.” EX1001, 2:35-41.

65. “In addition, an LED light source is a point light source. Light rays emitted from the LED light source are highly concentrated and are hard to be evenly distributed.” EX1001, 2:42-44.

66. The ’397 Patent purports to solve one or more of these problems. “The present invention provides an LED tube lamp. According to one embodiment, the

LED lamp includes a glass lamp tube, an end cap, a power supply, and an LED light strip. The end cap is disposed at one end of the glass lamp tube . . . and includes at least one opening on surface to dissipate heat resulting from the power supply.” EX1001, 3:1-7. “[T]he at least one opening disposed on the surface of the end cap may help to dissipate heat resulting from the power supply by passing through the end cap such that the reliability of the LED tube lamp could be improved.” *Id.* at 4:8-12.

67. “In addition, the present invention further provides an LED tube lamp to overcome the issue that light rays emitted from the LED light source are highly concentrated and are hard to be evenly distributed.” EX1001, 4:20-23. The ’397 Patent purportedly solves this problem using a “reflective film . . . disposed on the inner surface of the lamp tube,” a “diffusion film . . . coated on an inner surface of the lamp tube,” and a “portion of the inner surface which is not covered by the reflective film . . . formed with a rough surface.” *Id.*, 4:26-27, 4:39-40, and 4:64-65. “In the above-mentioned embodiments, light rays emitted from the LED light source in the lamp tube can be distributed in a more even manner by the rough surface, the reflective film, and/or the diffusion film.” *Id.*, 5:1-4.

68. FIG. 5 illustrates openings 304 in end cap 3:

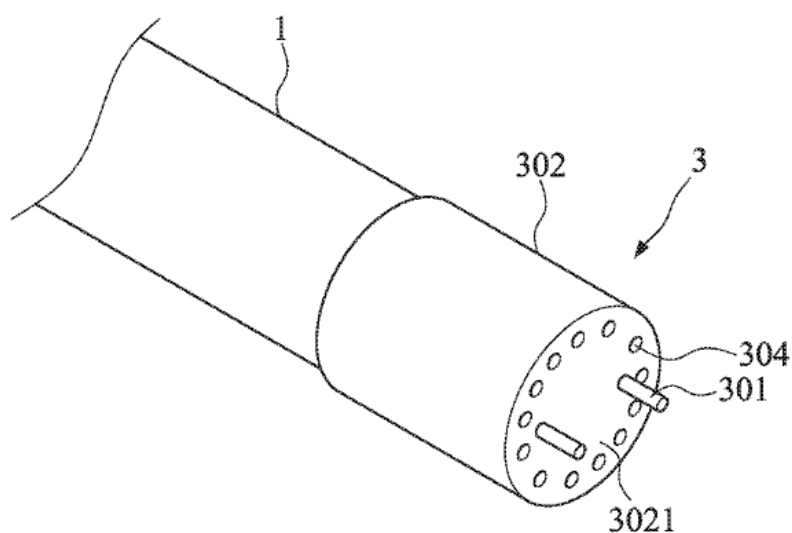


FIG.5

EX1001, 8:38-40 and FIG. 5.

69. FIG. 30 illustrates “one or more reflective films 12 disposed on the inner surface of the glass lamp tube 1”:

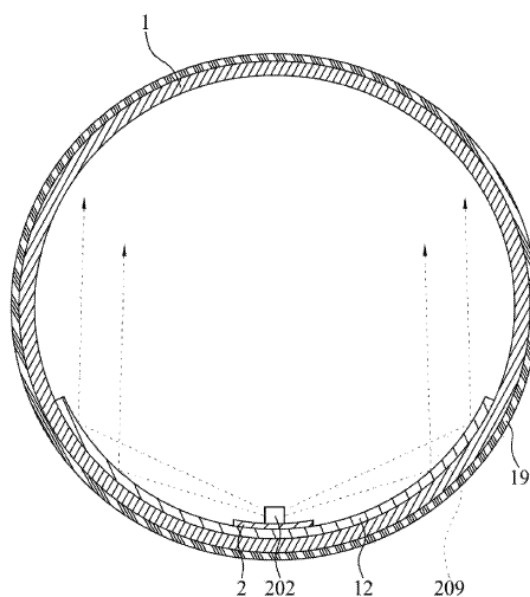


FIG.30

EX1001, 11:55-57 and FIG. 30. “In some embodiments, the part of the inner surface which is not covered by the reflective film 12 is formed with the rough surface.” *Id.*, 12:4-6.

70. FIG. 31 illustrates diffusion film 13:

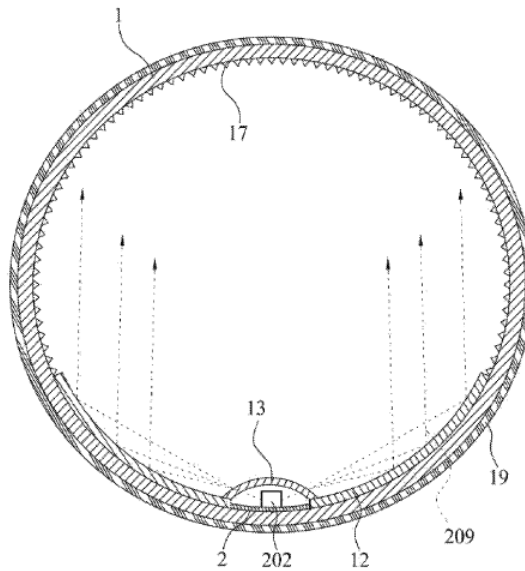


FIG.31

EX1001, 12:10-14 and FIG. 31.

71. As I explained above in Section VI, these features of the '397 Patent were well-known in the art before the effective filing date of the '397 Patent.

A. Challenged Claims

72. I understand that Claims 1-6, 8-12, and 14-18 of the '397 Patent are challenged claims. Claims 1, 8, and 14 are independent. Claims 2-6 depend from independent Claim 1, Claims 9-12 depend from independent Claim 8, and claims 15-18 depend from independent Claim 14. '397 Claim 1 reads:

1[p] An LED tube lamp, comprising:

1[a] a glass lamp tube, wherein at least a portion of an inner surface of the glass lamp tube is covered by a rough surface and the roughness of the rough surface is higher than that of the outer surface of the glass lamp tube;

1[b] two end caps, each of the two end caps coupled to a respective end of the glass lamp tube;

1[c] an LED light strip disposed on an inner surface of the glass lamp tube with a plurality of LED light sources mounted on the LED light strip;

1[d] a power supply disposed at one end or two ends of the glass lamp tube, the power supply electrically connected to the plurality of LED light sources; and

1[e] a reflective film disposed on a portion of the inner surface of the glass lamp tube,

1[f] wherein the glass lamp tube comprises a main body region and two rear end regions, each of the two rear end regions coupled to a respective end of the main body region and each of the two end caps coupled to a respective rear end region,

[[g] and further wherein a length of the light strip is longer than a length of the main body region of the glass lamp tube.

73. '397 Claim 2 reads:

2 The LED tube lamp of claim 1, wherein a portion of the inner surface of the glass lamp tube is covered by the rough surface and another portion of the inner surface of the glass lamp tube is covered by the reflective film.

74. '397 Claim 3 reads:

3 The LED tube lamp of claim 2, wherein a portion of the inner surface which is not covered by the reflective film is covered by the rough surface.

75. '397 Claim 4 reads:

4 The LED tube lamp of claim 3, wherein the roughness of the rough surface ranges from 0.1 to 40 μm .

76. '397 Claim 5 reads:

5 The LED tube lamp of claim 4, wherein each of the two end caps comprises an insulating end wall, two conductive pins and at least one opening, the insulating end wall is substantially perpendicular to an axial direction of the glass lamp tube, and the two conductive pins and the opening are arranged on the insulating end wall.

77. '397 Claim 6 reads:

6 The LED tube lamp of claim 5, wherein each of the two end caps sleeves with a respective rear end region, and wherein an outer diameter of each of the end cap is substantially the same as the outer diameter of the main body region.

78. '397 Claim 8 reads:

8[p] An LED tube lamp, comprising:

8[a] a glass lamp tube;

8[b] a diffusion film coated on an inner surface of the glass lamp tube;

8[c] an LED light strip disposed on the inner surface of the glass lamp tube with a plurality of LED light sources mounted on the LED light strip;

8[d] a reflective film disposed on the inner surface of the glass lamp tube;

8[e] two end caps, each of the two end caps coupled to a respective end of the glass lamp tube; and

8[f] a power supply disposed at one end or two ends of the glass lamp tube, the power supply electrically connected to the plurality of LED light sources,

8[g] wherein the diffusion film has a rough surface, the roughness of the rough surface is higher than that of an outer surface of the glass lamp tube,

8[h] and wherein a portion of the inner surface of the glass lamp tube is covered by the rough surface and a portion of the inner surface of the glass lamp tube is covered by the reflective film,

8[i] wherein the glass lamp tube comprises a main body region and two rear end regions, each of the two rear end regions coupled to a respective end of the main body region and each of the two end caps coupled to a respective rear end region,

8[j] and further wherein a length of the light strip is longer than a length of the main body region of the glass lamp tube.

79. '397 Claim 9 reads:

9 The LED tube lamp of claim 8, wherein a portion of the inner surface of the glass lamp tube not covered by the reflective film is covered by the rough surface.

80. '397 Claim 10 reads:

10 The LED tube lamp of claim 9, wherein the glass lamp tube and the two end caps are secured by a gel, and the gel is disposed between an inner surface of each of the two end caps and an outer surface of each of the two rear end regions.

81. '397 Claim 11 reads:

11 The LED tube lamp of claim 10, wherein each of the two end caps comprises an insulating end wall, two conductive pins and at least one opening, the insulating end wall is substantially perpendicular to an axial direction of the glass lamp tube, and the two conductive pins and the opening are arranged on the insulating end wall.

82. '397 Claim 12 reads:

12 The LED tube lamp of claim 10, wherein each of the two end caps sleeves with a respective rear end region, and wherein an outer diameter of each of the end cap is substantially the same as an outer diameter of the main body region.

83. '397 Claim 14 reads:

14[p] An LED tube lamp, comprising:

14[a] a glass lamp tube having an inner surface;

14[b] an LED light strip disposed on the inner surface of the glass lamp tube with a plurality of LED light sources mounted on the LED light strip;

14[c] two end caps, each of the two end caps coupled to a respective end of the glass lamp tube; and

14[d] a power supply disposed at one end or two ends of the glass lamp tube, the power supply electrically connected to the plurality of LED light sources,

14[e] wherein the inner surface of the glass lamp tube is covered by a reflective layer and a rough layer, the roughness of the rough layer is higher than that of an outer surface of the glass lamp tube,

14[f] wherein the glass lamp tube comprises a main body region and two rear end regions, each of the two rear end regions coupled to a respective end of the main body region and each of the two end caps coupled to a respective rear end region,

14[g] and further wherein a length of the light strip is longer than a length of the main body region of the glass lamp tube.

84. '397 Claim 15 reads:

15 The LED tube lamp of claim 14, wherein a portion of the inner surface which is not covered by the reflective layer is covered by the rough layer.

85. '397 Claim 16 reads:

16 The LED tube lamp of claim 15, wherein the glass lamp tube and the two end caps are secured by a gel, wherein the gel is disposed between an inner surface of each of the two end caps and an outer surface of each of the two rear end regions.

86. '397 Claim 17 reads:

17 The LED tube lamp of claim 16, wherein each of the two end caps comprises an insulating end wall, two conductive pins and at least one opening, the insulating end wall is substantially perpendicular to an axial direction of the glass lamp tube, and the two conductive pins and the opening are arranged on the insulating end wall.

87. '397 Claim 18 reads:

18 The LED tube lamp of claim 16, wherein each of the two end caps sleeves with a respective rear end region, and wherein an outer diameter of each of the end cap is substantially the same as an outer diameter of the main body region.

B. Prosecution History

88. I have reviewed the prosecution history of the '397 Patent. The '397 Patent issued from an application filed on December 18, 2019, U.S. Patent

Application No. 16/719,861. EX1010, 171/412. The Examiner did not make any rejection of the claims during prosecution of the '397 Patent. The Examiner issued a Notice of Allowance on August 19, 2020. EX1010, 322/412. In the Notice of Allowance, the Examiner identified the following reasons for allowance for independent Claims 1, 8, and 14:

89. For Claim 1, the Examiner indicated that “the prior art of record failed to teach all of the features of the claimed invention which includes . . . a reflective film disposed on a portion of the inner surface of the glass lamp tube, wherein the glass lamp tube comprises a main body region and two rear end regions, each of the two rear end regions coupled to a respective end of the main body region and each of the two end caps coupled to a respective rear end region, and further wherein a length of the light strip is longer than a length of the main body region of the glass lamp tube.” EX1010, 327-328/412 (emphasis in original).

90. For Claim 8, the Examiner indicated that “the prior art of record failed to teach all of the features of the claimed invention which includes . . . wherein the glass lamp tube comprises a main body region and two rear end regions, each of the two rear end regions coupled to a respective end of the main body region and each of the two end caps coupled to a respective rear end region, and further wherein a length of the light strip is longer than a length of the main body region of the glass lamp tube.” EX1010, 328/412 (emphasis in original).

91. For Claim 14, the Examiner indicated that “the prior art of record failed to teach all of the features of the claimed invention which includes . . . wherein the glass lamp tube comprises a main body region and two rear end regions, each of the two rear end regions coupled to a respective end of the main body region and each of the two end caps coupled to a respective rear end region, and further wherein a length of the light strip is longer than a length of the main body region of the glass lamp tube.” EX1010, 328-329/412 (emphasis in original).

C. Claim Construction

92. For purposes of this IPR proceeding, I apply the common and ordinary meanings of claim terms in the '397 Patent. At this time, no claim terms require explicit construction.

1. “*disposed on*”

93. The '397 specification differentiates between “disposed on” and “in contact with.” See, e.g., EX1001, 12:21-25. In my opinion, in light of the '397 specification, a POSA would understand “disposed on” to be broader than “in contact with” by potentially including structures directly disposed on, as well as indirectly disposed on (e.g., via an intervening structure or material), a surface or other structure. EX1004, ¶@@. FIG. 30 of the '397 patent illustrates one such example in which LED light strip 2 is indirectly disposed on glass tube 1 via reflective film 12:

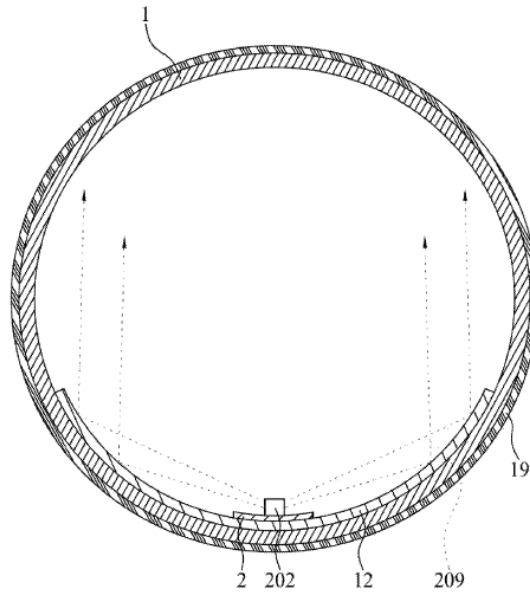
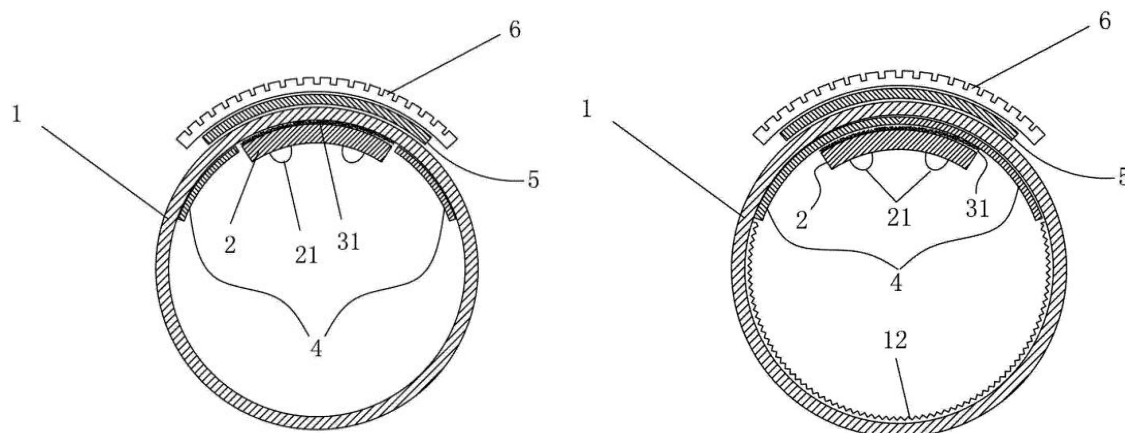


FIG.30

EX1001, FIG. 30.

94. Moreover, to the extent Patent Owner may attempt to construe “disposed on” as requiring either a direct or indirect relation, the proposed grounds below address both options. Specifically, I explain below, Jing discloses the claimed LED light strip both directly and indirectly “disposed on” the claimed inner surface of the glass lamp tube. *See* EX1002, FIG. 4 (illustrating circuit board 2 indirectly disposed on lamp tube 1 via inner reflective film layer 4); *see also* §VIII.A.1(a) (citing FIG. 2 of Jing, in which circuit board 2 is directly disposed on lamp tube 1).



EX1002, FIGS. 2 and 4.

2. “electrically connected”

95. “Electrically connected” is found in claims 1, 8, and 14. I do not believe this term needs explicit construction, but I note that the ’397 specification expressly indicates that the term is broad enough to cover both direct and indirect connections. Specifically, the ’397 Patent teaches that “the LED light sources 202 and the power supply 5 are electrically connected by the LED light strip 2.” EX1001, 14:31-33.

VIII. COMPARISON OF PRIOR ART TO ’989 PATENT’S CHALLENGED CLAIMS

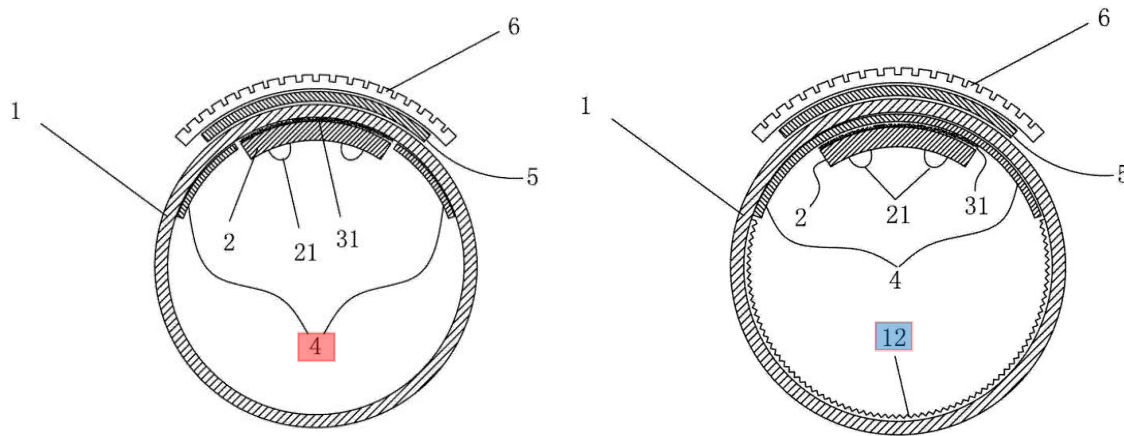
A. Ground 1 – Claims 1-3, 8, 9, 14, and 15 are Obvious over Jing in view of Huang

1. Motivation to Combine

(a) Jing

96. A POSA would understand that various figures and examples disclosed by Jing are illustrative and that a POSA could combine different teachings of Jing with a reasonable expectation of success. To the extent that Patent Owner may

contend that FIGS. 2 and 4 of Jing represent distinct embodiments, a POSA would understand that the discontinuous configuration of inner reflective film layer 4 shown in FIG. 2 (red) could be combined with frosted layer 12 of FIG. 4 (blue) with a reasonable expectation of success based on at least the following.



EX1002, FIGS. 2 and 4.

97. A POSA would have been motivated to use discontinuous inner reflective film layer 4 shown in FIG. 2 (red) with frosted layer 12 of FIG. 4 (blue) with the expectation of success for several reasons. First, a POSA would understand that modifying the configuration shown in FIG. 2 to include frosted layer 12 of FIG. 4 would achieve the benefits disclosed by Jing by “mak[ing] the light emitted by the lamp tube diffuse evenly and softly.” EX1002, ¶[0027]. Therefore, a POSA would be motivated to modify the configuration shown in FIG. 2 to include frosted layer 12 of FIG. 4 in order to enhance distribution and uniformity of emitted light. EX1002, ¶[0027] (describing FIGS. 2, 3, 4, and 5 as “the LED fluorescent lamp of the Utility Model”).

98. Further, a POSA would recognize that discontinuous inner reflective film layer 4 of FIG. 2 (red) is not between board 2 and lamp tube 1. EX1002, FIG. 4. As a result, the configuration shown in FIG. 2 has greater manufacturing ease and flexibility (as compared to the configuration in FIG. 4) because a different layer or material (other than inner reflective film layer 4) could be disposed between board 2 and lamp tube 1, such as an adhesive or other material, instead of inner reflective film layer 4. See EX1002, FIG. 3 (showing fixing layer 3 (thermally conductive adhesive layer 3) between board 2 and lamp tube 1).

99. In addition, Jing explicitly discloses that a length and configuration of inner reflective film layer 4 can be changed: “[t]he specific length can be determined according to the special use of LED fluorescent lamps. For example, when consumers need a small light emission angle, the length of the inner reflective film layer 4 can be longer.” EX1002, ¶[0034].

(b) Jing and Huang

100. A POSA would have been motivated to search for ways to reduce increase reliability of the LED fluorescent lamp through routine experimentation. Huang teaches one such technique for improving reliability. Huang teaches extending a structure outside the glass tube to increase reliability of an LED tube light: “Thus, the length of the base 2 is larger than the length of the glass tube 1 for providing the lateral cover assemblies 5 to be fixed on the end portions of the base

2 by a fixing means (e.g., screw or buckled). The force is transferred from the lateral cover assemblies 5 to the glass tube 1 via the base 2, so that the force is uniformly dispersed to the glass tube 1 for preventing the glass tube 1 from loading the force directly and reducing the broken possibility of the glass tube 1 resulted from concentrating the force on a specific point.” EX1003, 6:59-67; *see also id.*, 1:22-24, 1:41-46, 8:15-22, FIG. 3. Thus, a POSA would have understood that one way of increasing reliability is to lengthen a structure in order to disperse force applied to the glass tube, improving reliability.

101. Because Jing teaches omitting a metal bracket (or base) for the LED lamp, a POSA would have been motivated to search for another way of improving force dispersion and increasing reliability (instead of using base 2 of Huang). EX1002, Summary, ¶[0018]. A POSA would have known that aluminum structures can provide rigidity and force dispersion for the glass tube, since for example both Jing and Huang teach that a base or bracket may be formed of aluminum. EX1002 ¶[0003] (“a bracket 11 made of aluminum profiles extend[s] from one end of the lamp tube to the other end”); EX1003, 2:44-47 (“base 2 may be made of materials ... such as metallic material (e.g., aluminum)”). A POSA would therefore have searched for another component, such as an aluminum component, to lengthen in order to achieve the benefits of Huang, such as improved force dispersion and increased reliability.

102. A POSA would have identified the circuit board 2 of Jing as such a component. A POSA would also have known that one or more configurations of circuit board 2 disclosed by Jing be used to improve force dispersion and reliability. For example, because Jing discloses that circuit board 2 may be “made of ***aluminum-based printed circuit board PCB***, flexible PCB or glass fiber PCB,” a POSA would have known that circuit board 2 has rigidity sufficient to support the lengthening without introducing breakage or a large amount of bending. EX1002, ¶¶ [0016], [0027], [0028], claim 10; *see also* my discussion above at §VI.C (discussing EX1012, 1:13-16).

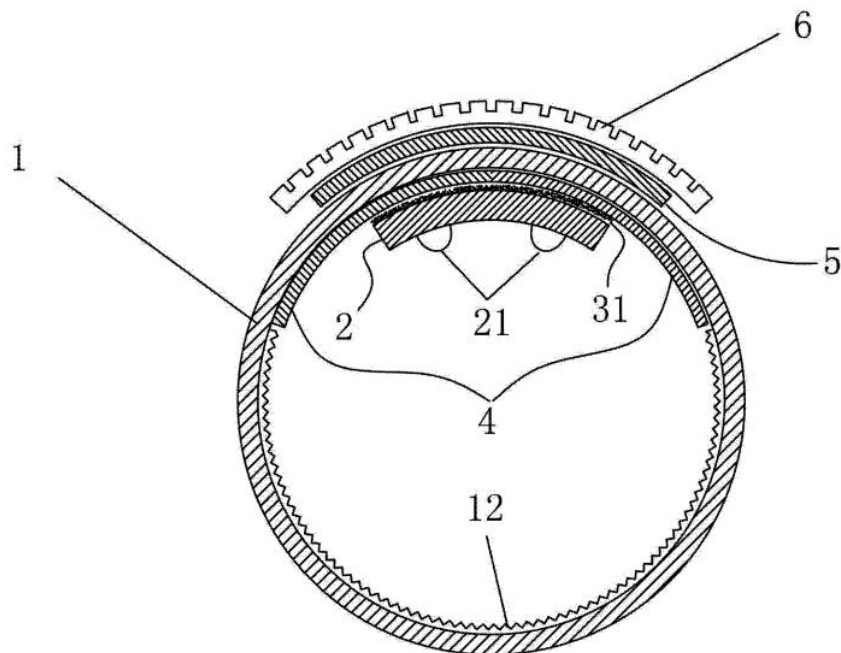
103. A POSA would have known that an aluminum PCB can provide strength, as I discussed in §VI.C above. Accordingly, a POSA would have understood that circuit board 2 of Jing can support lengthening without suffering breakage or other such effects.

104. Therefore, a POSA would have found it obvious to lengthen circuit board 2 of Jing to achieve the reliability benefits disclosed by Huang. A POSA would have arrived at this design through routine experimentation and with a reasonable expectation of success.

2. Modification of Jing in view of Huang

105. Combining the LED fluorescent lamp of Jing with the circuit board length taught by Huang would produce an LED lamp tube (e.g., the LED fluorescent

lamp of Jing) that includes at least a light strip (e.g., board 2 of Jing) and a glass lamp tube (e.g., lamp tube 1 of Jing). EX1002, FIG. 4:



EX1002, FIG. 4.

106. The light strip would be longer than a main body region of the glass lamp tube, as disclosed by Huang. EX1003, FIG. 3:

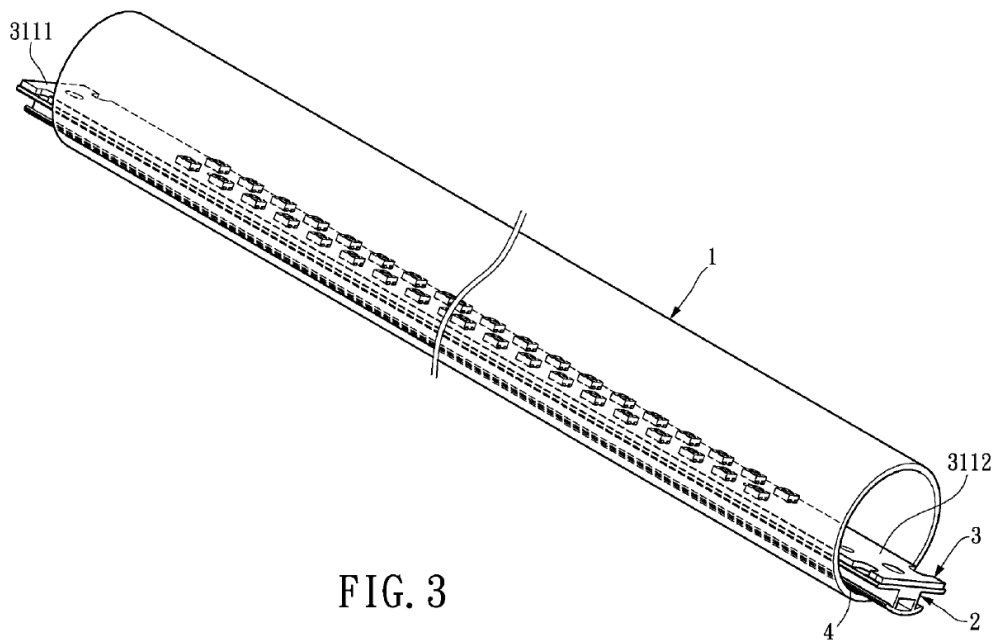


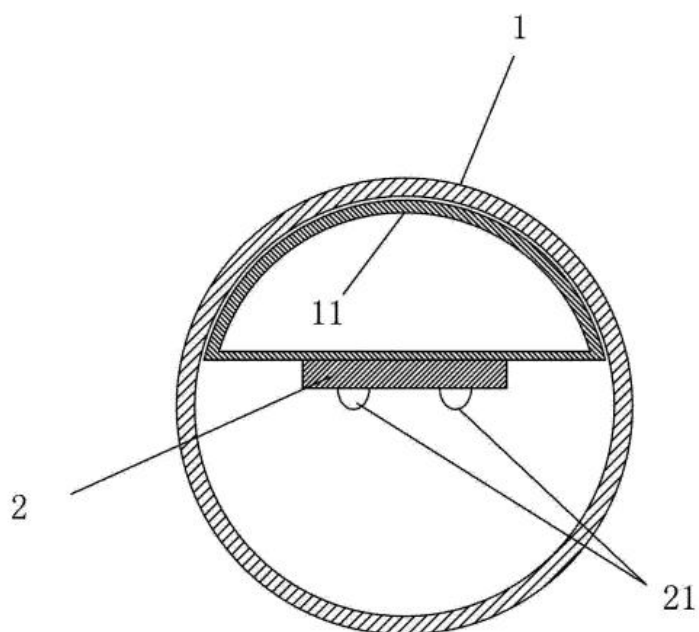
FIG. 3

EX1003, FIG. 3.

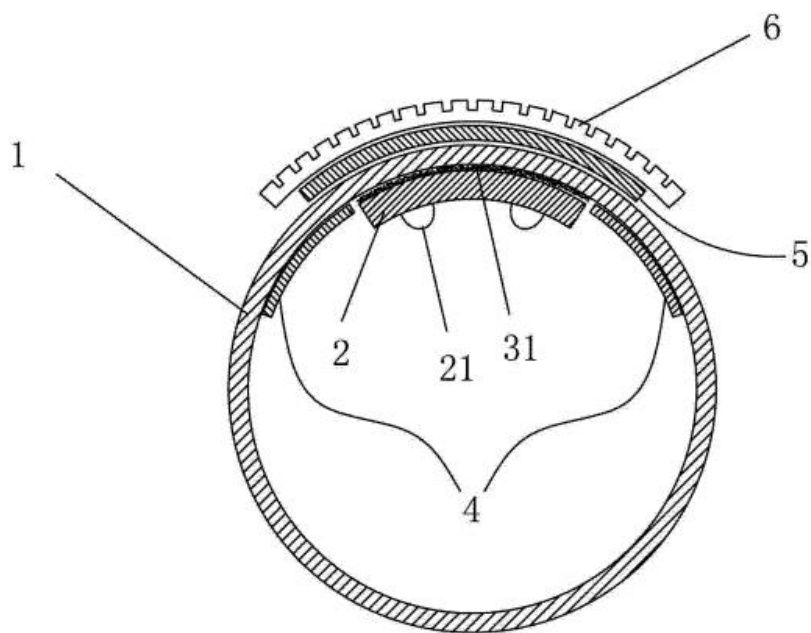
3. *Element-by-Element Analysis*

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

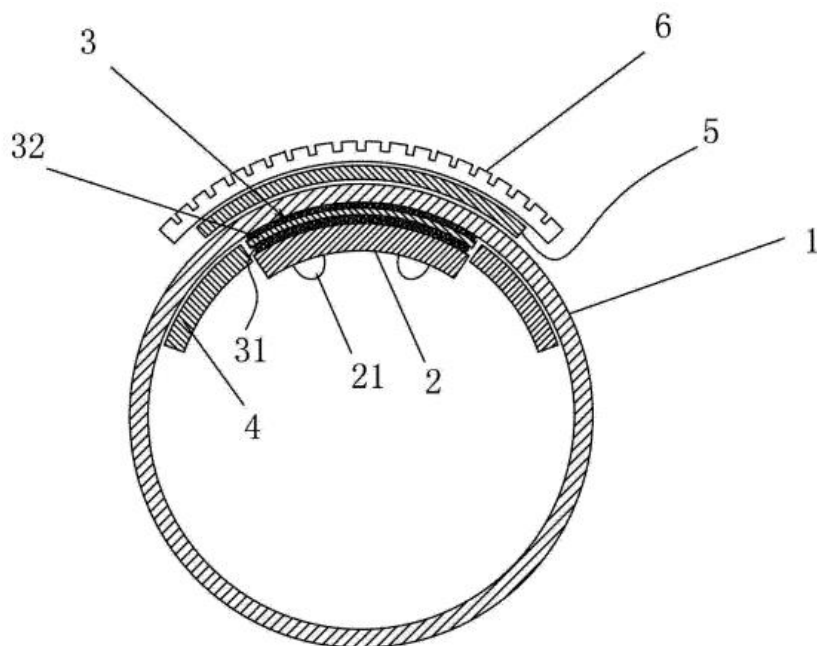
107. My opinion is that the combination of Jing and Huang renders obvious this limitation. Jing describes that “[t]his Utility Model covers a fluorescent lamp, in particular to an assembly structure of an LED component in a fluorescent lamp tube.” EX1002, ¶ [0001]. “As shown in Figure 2, 3, 4 and 5, the LED fluorescent lamp . . . is composed of a lamp tube 1 with a circular section and glass material” *Id.*, ¶ [0027]; see also *id.*, Summary, ¶¶ [0008], [0011], [0012], [0014], [0018]-[0024], FIGS. 2, 4:



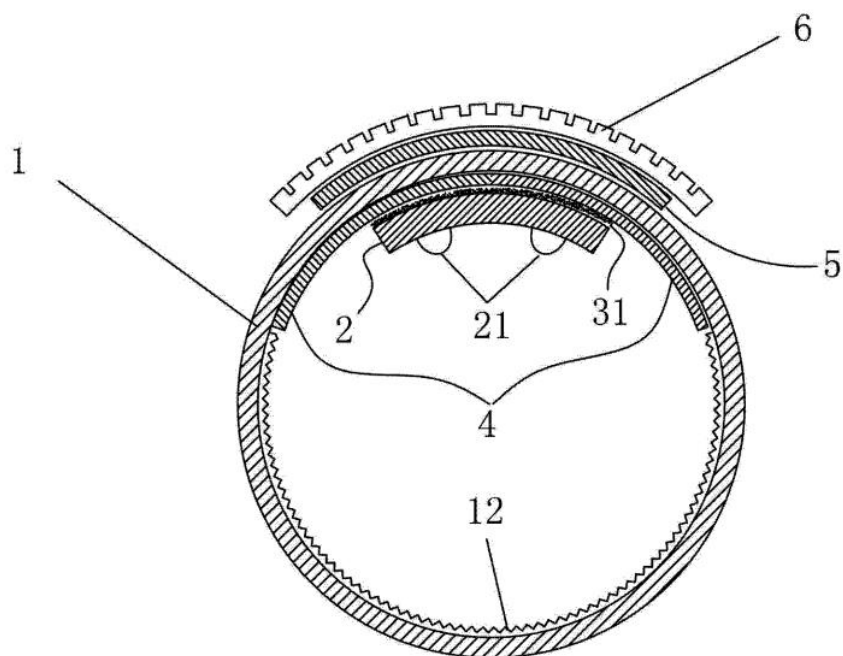
EX1002, FIG. 1.



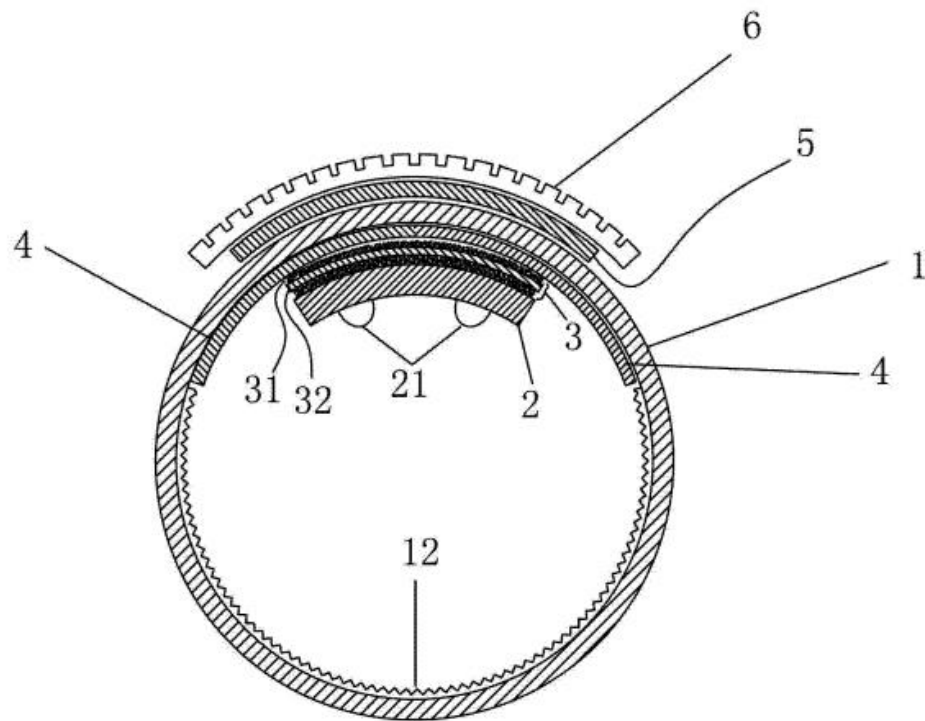
EX1002, FIG. 2.



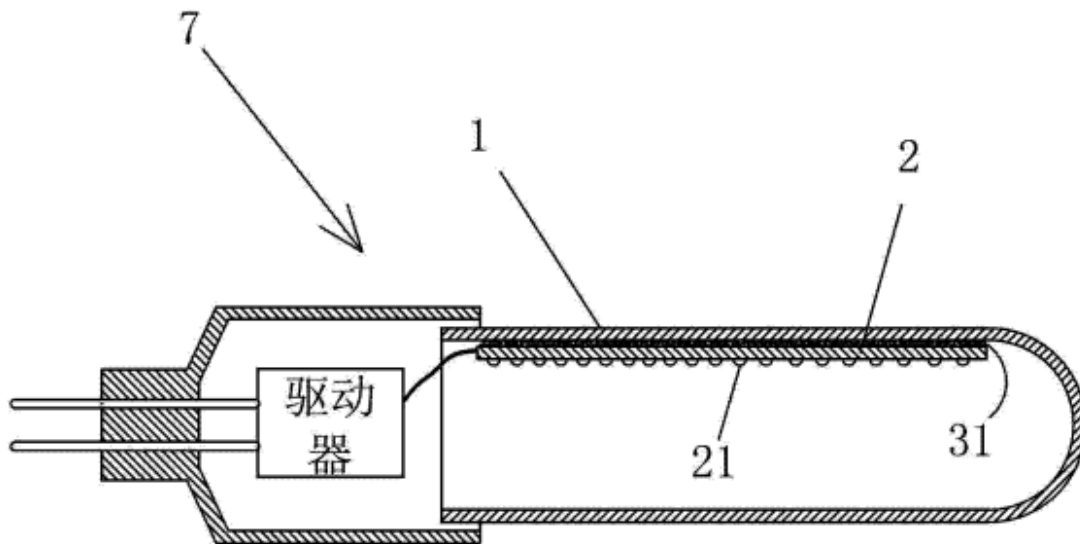
EX1002, FIG. 3.



EX1002, FIG. 4.



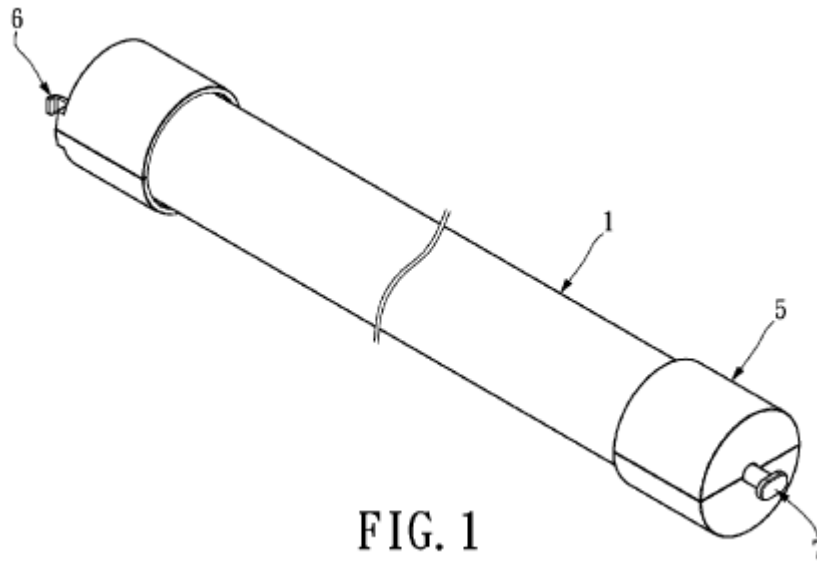
EX1002, FIG. 5.



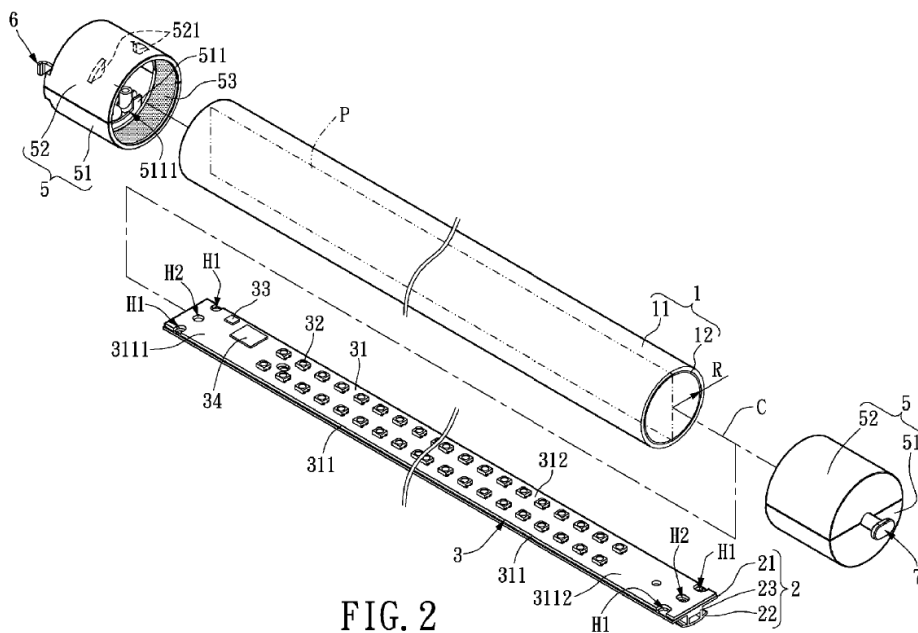
EX1002, FIG. 6.

108. Huang teaches that “[t]he invention relates to an elongated shape LED tube; more particularly to an LED glass tube light.” EX1003, 1:6-7. Huang discloses

that “FIGS. 1 and 2 . . . show a perspective view and an exploded view of an LED tube light EX1003, 2:27-32; *see also id.*, Abstract, 1:6-7, 1:19-52, 7:1-48, FIGS. 1-3:



EX1003, FIG. 1.



EX1003, FIG. 2.

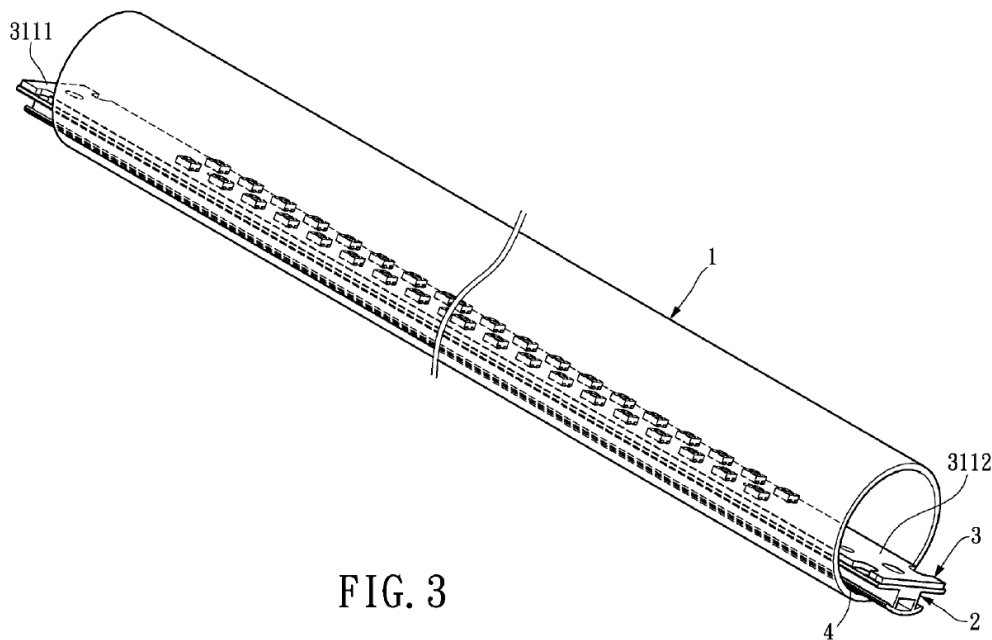


FIG. 3

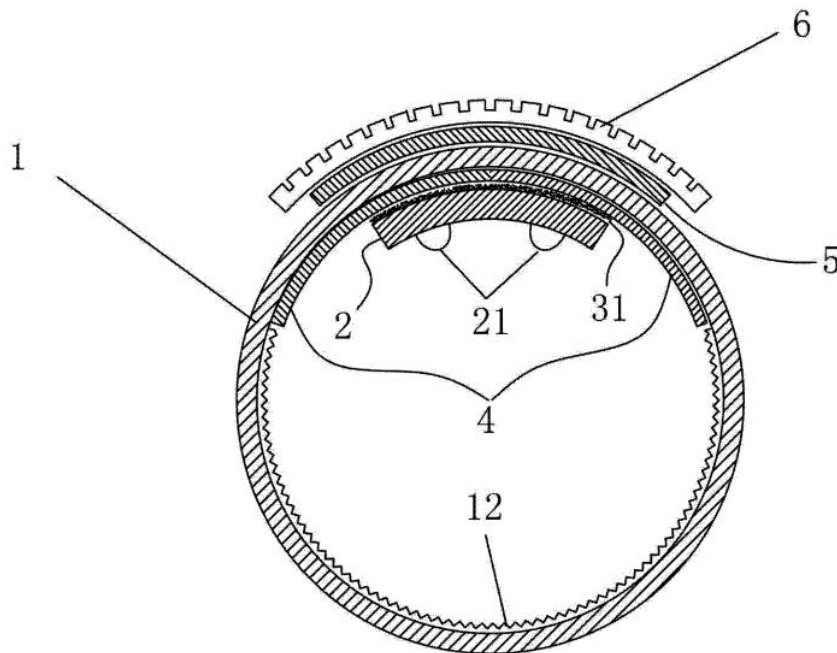
EX1003, FIG. 3.

(b) Limitation 1[a] - a glass lamp tube, wherein at least a portion of an inner surface of the glass lamp tube is covered by a rough surface and the roughness of the rough surface is higher than that of the outer surface of the glass lamp tube;

109. My opinion is that this limitation is rendered obvious by Jing-Huang. “As shown in Figure 2, 3, 4 and 5, the LED fluorescent lamp . . . is composed of a lamp tube 1 with a circular section and glass material” EX1002, ¶ [0027]; *see also id.*, Summary, ¶¶ [0008], [0011], [0012], [0014], [0018]-[0024], FIGS. 2, 4. Huang discloses that “[t]he invention relates to an elongated shape LED tube; more particularly to an LED glass tube light.” EX1003, 1:6-7; *see also id.*, Abstract, 1:6-7, 1:19-52, 7:1-48, FIGS. 1-3.

110. Jing discloses that “[t]he inner wall of lamp tube 1 can be . . . an inner wall with all or part of the rough surface treatment (the rough surface treated inner wall is called sanding layer 12).” EX1002, ¶ [0027] (emphasis added). “[R]ough surface treatment refers to the treatment of sanding or spraying the inner wall of the lamp tube to make the light emitted by the lamp tube diffuse evenly and softly.” *Id.* (emphasis added).

111. Jing also refers to sanding layer 12 as “frosted layer 12.” EX1002, ¶¶ [0026], [0013], [0035], claim 6. “On the inner wall of the lamp tube 1, the area without inner reflective film layer [4] can be the inner wall of the frosted layer.” *Id.*, ¶ [0035].



EX1002, FIG. 4.

112. My opinion is that a POSA would understand that sanding (frosted) layer 12 of Jing has a roughness higher than that of the outer surface of lamp tube 1 of Jing. First, Jing illustrates that no sanding layer 12 is applied to the outer surface of lamp tube 1. See EX1002, FIGS. 4 and 5. A POSA would understand that the outer surface of lamp tube 1 is therefore glass material and that such glass material is of less roughness than sanding layer 12. See EX1002, ¶ [0027] (emphasis added). A POSA would also understand that the glass material of the outer surface of the lamp tube 1 is of less roughness than sanding layer 12 due to performing “rough surface treatment [that] refers to the treatment of sanding or spraying the inner wall of the lamp tube.” See EX1002, ¶ [0027] (emphasis added).

113. Second, FIGS. 4 and 5 of Jing also disclose that sanding layer 12 has a roughness greater than that of the outer surface of lamp tube 1 of Jing. As illustrated in FIGS. 4 and 5 of Jing, sanding layer 12 has a jagged surface not present on the outer surface of lamp tube 1, which a POSA would understand to mean that sanding layer 12 has a roughness greater than that of the outer surface of lamp tube 1.

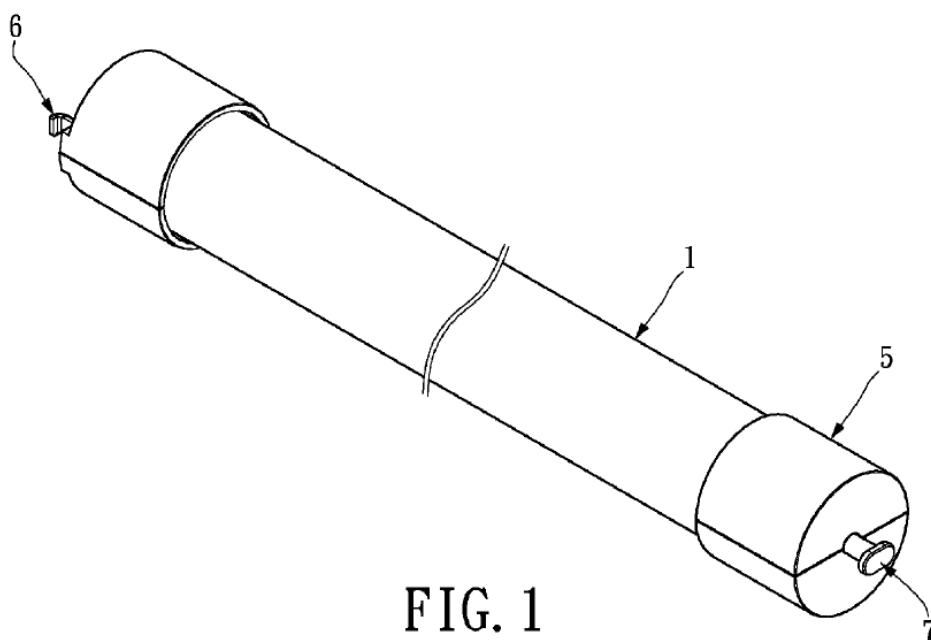
114. Third, based on Jing’s disclosure that the rough surface treatment of the inner wall of lamp tube 1 “make[s] the light emitted by the lamp tube diffuse evenly and softly,” a POSA would understand the roughness of the inner surface of lamp tube 1 to be greater than that of the outer surface of lamp tube 1. EX1002, ¶ [0027] (emphasis added). For example, because light travels from inside lamp tube 1 to

outside lamp tube 1, a POSA would understand that the inner surface of lamp tube 1 is more rough than the outer surface of lamp tube 1 to enable light diffusion from inside lamp tube 1 to outside lamp tube 1.

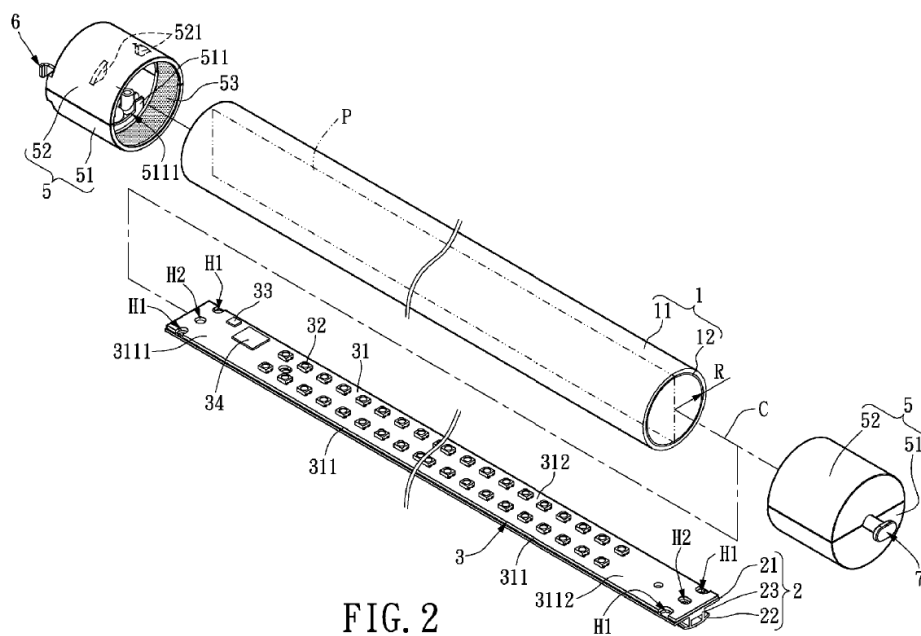
(c) Limitation 1[b] - two end caps, each of the two end caps coupled to a respective end of the glass lamp tube;

115. My opinion is that this limitation is rendered obvious by Jing-Huang. Jing discloses “a plug with a driver arranged on both ends of the lamp tube 1.” EX1002, ¶ [0027] (emphasis added); *see also id.*, ¶ [0003] (“...the LED fluorescent lamp in the prior art is composed of a glass lamp tube 1, a light emitting component arranged in the lamp tube 1, and a plug with a driver electrically connected to the light emitting component at both ends of the lamp tube.”) A POSA would therefore understand that the plugs at both ends of lamp tube 1 disclose the claimed two end caps each coupled to a respective end of the glass lamp tube.

116. Huang additionally discloses an LED tube light that includes glass tube 1 and two lateral cover assemblies 5. EX1003, 2:27-32; *see also id.*, Abstract, 1:22-46, 2:44-61, 5:18-35, 6:18-23, 6:51-57. As illustrated in FIGS. 1 and 2, the two cover assemblies 5 are end caps coupled to respective ends of glass tube 1:



EX1003, FIG. 1.

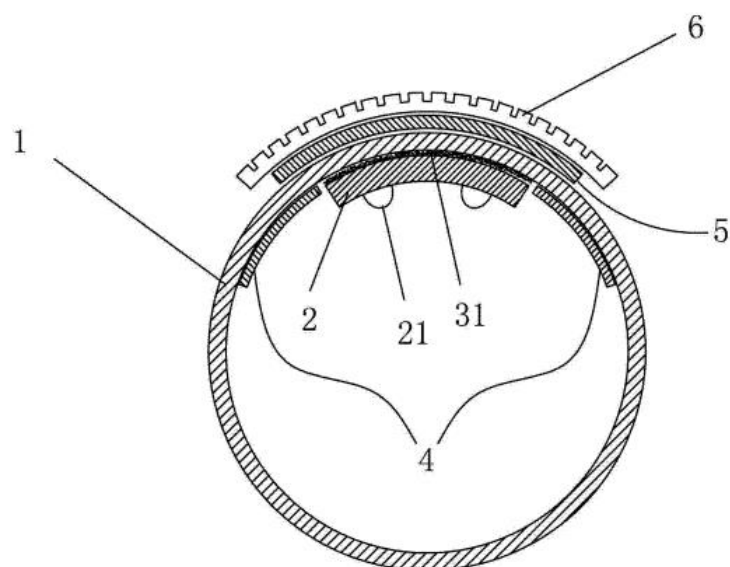


EX1003, FIG. 2.

(d) Limitation 1[c] - an LED light strip disposed on an inner surface of the glass lamp tube with a plurality of LED light sources mounted on the LED light strip;

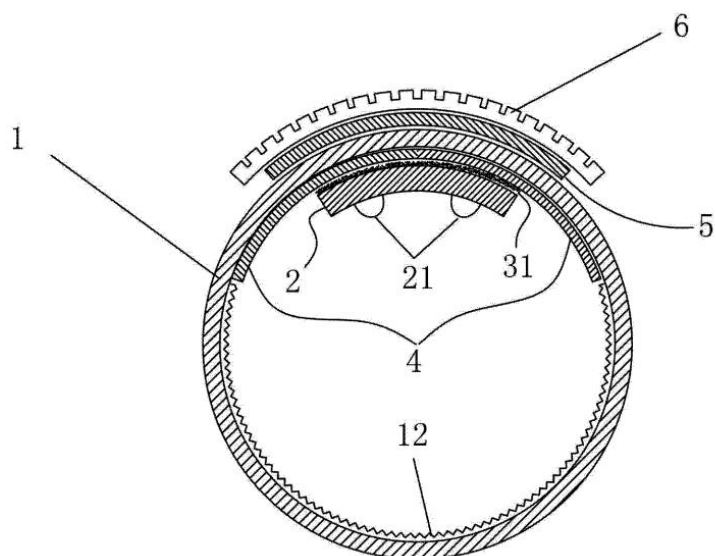
117. My opinion is that this limitation is rendered obvious by Jing-Huang. Jing discloses that “one to three rows of light strips composed of LED lamp beads 21 are welded” on circuit board 2. EX1002, ¶ 0027. “The circuit board 2 extends from one end of the lamp tube 1 to the other end.” EX1002, ¶ [0028]. Further, “circuit board 2 is fixedly connected with the inner wall of the lamp tube 1; similarly, when the circuit board 2 is made of flexible PCB, the circuit board 2 can be fixedly connected with the inner wall of the lamp tube 1 through the fixing layer 3. This structure can fix the circuit board 2 onto the inner wall of the lamp tube 1 without using the tube bracket, thereby greatly reducing the manufacturing cost of the LED fluorescent lamp.” EX1002, ¶ 0028 (emphasis added).

118. FIG. 2 of Jing illustrates that board 2 is disposed on lamp tube 1:



EX1002, FIG. 2.

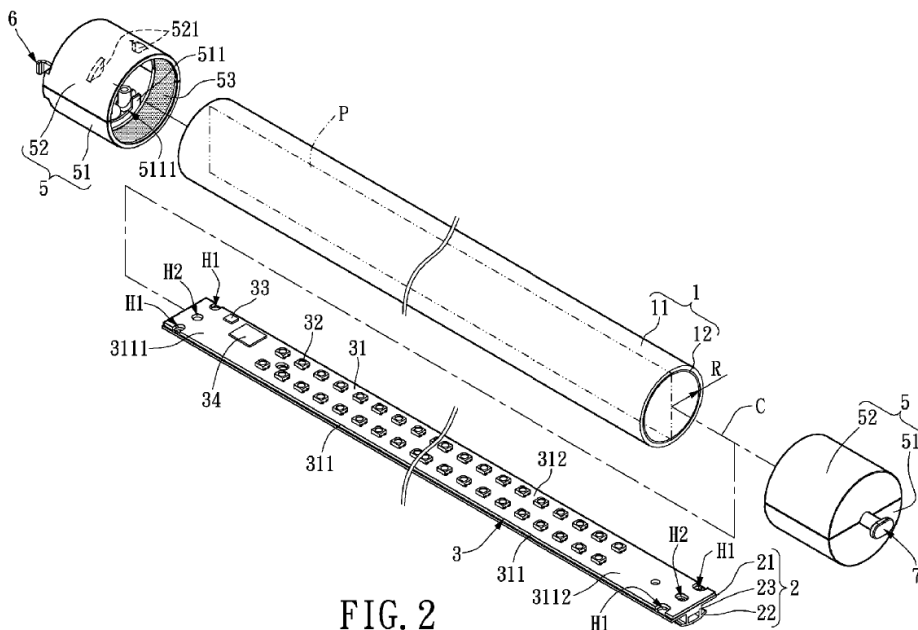
119. FIG. 4 of Jing illustrates also illustrates that board 2 is disposed on lamp tube 1 (via inner reflective film layer 4):



EX1002, FIG. 4.

120. Therefore, Jing discloses an LED light strip disposed on an inner surface of lamp tube 1 with a plurality of LED light sources mounted on the LED light strip. EX1002, FIGS. 2-6; *see also id.*, Summary, [0008], claim 1, FIG. 2, 5.

121. Huang discloses an LED tube light that includes glass tube 1, base 2, light emitting unit 3, and glue 4, where light emitting unit 3 includes a plurality of LEDs 32. EX1003, 2:27-32, 3:33-35; *see also id.*, 3:42-49, 4:34-36, FIGS. 2 and 3. “The base 2 and the light emitting unit 3 are inserted into the glass tube 1, and the circular arc surface 221 of the connecting portion 22 is adhered to the inner surface of the glass tube 1 by the glue 4 (e.g., silica gel).” EX1003, 3:64-67 (emphasis added).



EX1003, FIG. 2.

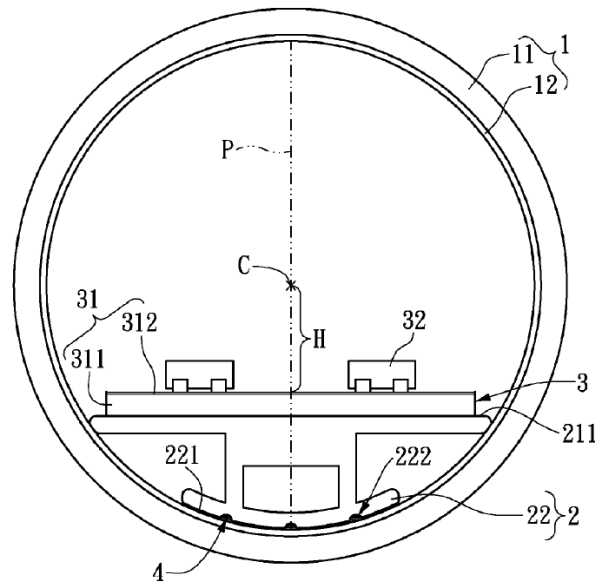


FIG. 3A

EX1003, FIG. 3A.

122. A POSA would understand that light emitting unit 3 of Huang discloses an LED light strip disposed (e.g., via base 2 and glue 4) on an inner surface of glass tube 1 with a plurality of LED light sources (LEDs 32) mounted on the LED light strip. EX1003, FIG. 2.

(e) Limitation 1[d] - a power supply disposed at one end or two ends of the glass lamp tube, the power supply electrically connected to the plurality of LED light sources; and

123. My opinion is that this limitation is rendered obvious by Jing-Huang. Jing discloses “a plug with a driver arranged on both ends of the lamp tube 1 and electrically connecting the circuit board 2 with the external power supply (Or one end is an open end, the other end is a closed LED horizontal insertion lamp 7, that

is, the circuit board is installed into the lamp tube through the open end of the horizontal insertion lamp tube, and then the plug with the driver electrically connected to the external power supply is blocked on the open end, as shown in Figure 6).” EX1002, ¶ [0027]; *see also id.*, ¶ [0003], FIG. 6 (emphasis added).

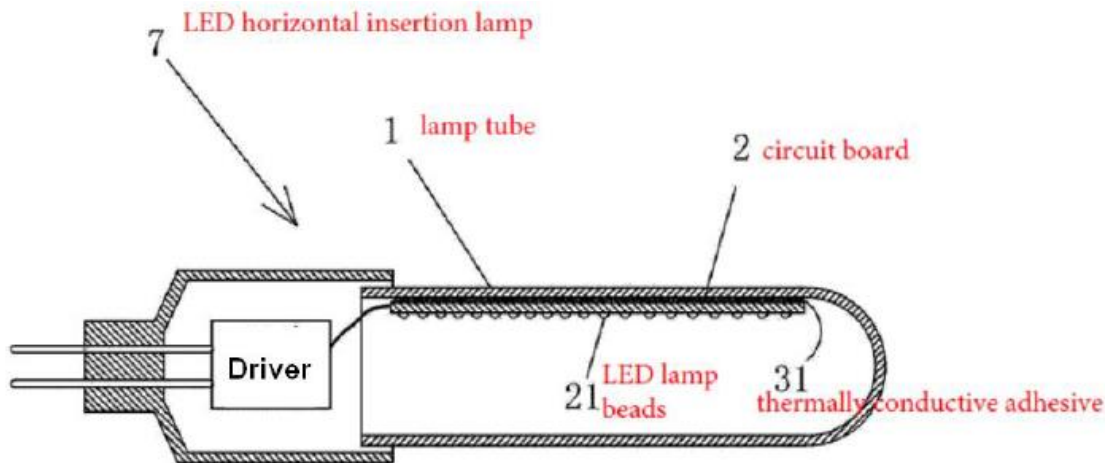


Figure 6

EX1002, FIG. 6. Jing also discloses that, “a plug with a driver [is] arranged on both ends of the lamp tube 1.” EX1002, ¶[0027] (emphasis added); *see also id.*, ¶[0003] (“...the LED fluorescent lamp in the prior art is composed of a glass lamp tube 1, a light emitting component arranged in the lamp tube 1, and a plug with a driver electrically connected to the light emitting component at both ends of the lamp tube.”).

124. In my opinion, a POSA would understand that the driver of Jing discloses a power supply. For example, a POSA would understand that the “external

power supply” of Jing is an electricity source providing electricity to the driver via the plug and that the driver performs functions (such as, for example, rectification and filtering) to provide the electricity to circuit board 2 and LED lamp beads 21. Further, Jing discloses that the driver may be disposed either at “one end” of lamp tube 1 or at “both ends of the lamp tube 1.” EX1002, ¶ [0027]. Therefore, a POSA would understand that the driver of Jing discloses a power supply that is disposed at one end or two ends of lamp tube 1 and that is electrically connected to the LED lamp beads 21. EX1002, ¶ [0027].

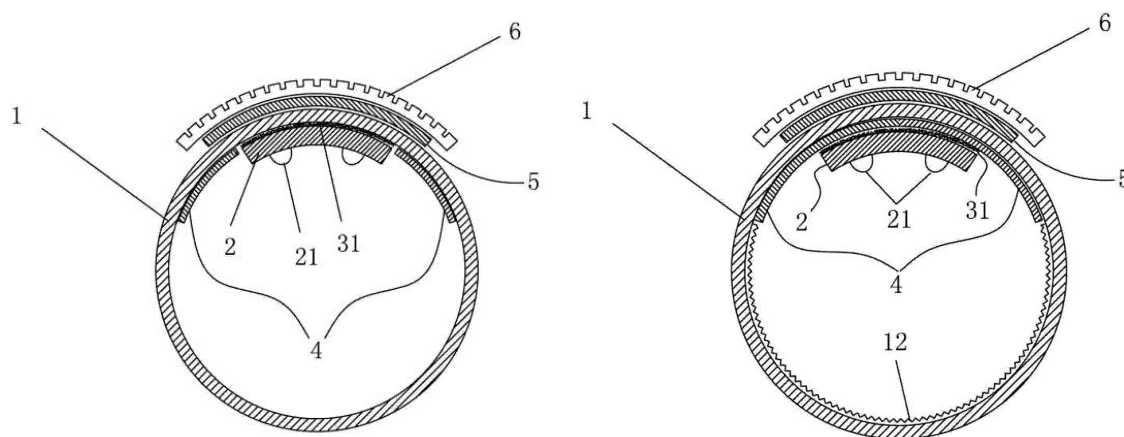
125. Huang similarly teaches that “two conductive terminals installed to one of the lateral cover assemblies, wherein the circuit board module has a socket connector and an electronic unit mounted on the circuit board and arranged between the conductive terminals and the LEDs, and wherein the socket connector is electrically connected to the LEDs by the circuit board and the terminals by at least one wire.” EX1003, claim 8, 3:33-35, 3:50-55, 8:33-36, FIGS. 2, 4A.

(f) Limitation 1[e] - a reflective film disposed on a portion of the inner surface of the glass lamp tube,

126. My opinion is that this limitation is rendered obvious by Jing-Huang. Jing discloses that “reflective film layers on the inner and outer walls of the lamp tube, so that the light so that the light emitted from the LED light source to the back of the lamp tube can be fully utilized due to reflection, thereby correspondingly

enhancing the luminance of the fluorescent lamp.” EX1002, Summary. Jing further describes that “[a]n inner reflective film layer is arranged on the inner wall of the lamp tube corresponding to the back of the circuit board. The inner reflective film layer is set as a continuous film layer or a discontinuous film layer in the circumference direction of the inner wall of the lamp tube.” EX1002, ¶ [0012]. “The inner and external reflective film layer are electric coating, spray coating, vacuum coating or aluminum foil layer.” EX1002, ¶ [0016].

127. “The further improvement . . . is that the inner wall of the lamp tube 1 corresponding to the back of the circuit board 2 is coated with a film that can reflect light by electroplating, spraying or vacuum coating. An aluminum foil layer can also be pasted, hereinafter referred to as inner reflective film layer 4. The inner reflective film layer 4 can be either a metal film layer or a PVC reflective film layer made by a new process in the prior art.” EX1002, ¶ [0032] (emphasis added); *see also id.*, ¶¶ [0013], [0018], [0026], [0034], [0035].



EX1002, FIGS. 2 and 4.

(g) Limitation 1[f] - wherein the glass lamp tube comprises a main body region and two rear end regions, each of the two rear end regions coupled to a respective end of the main body region and each of the two end caps coupled to a respective rear end region,

128. My opinion is that this limitation is rendered obvious by Jing-Huang. Jing describes that “the LED fluorescent lamp of the Utility Model is composed of a lamp tube 1 with a circular section and glass material, a circuit board 2 arranged in the lamp tube 1 extending along the axis, and a plug with a driver arranged on both ends of the lamp tube 1 EX1002, ¶ [0027] (emphasis added). Jing also teaches that “the LED fluorescent lamp in the prior art is composed of a glass lamp tube 1, a light emitting component arranged in the lamp tube 1, and a plug with a driver electrically connected to the light emitting component at both ends of the lamp tube.” EX1002, ¶ [0003]. A POSA would understand that ends of the lamp tube 1 of Jing are “two rear end regions” and that the portion of the lamp tube 1 between the ends of the lamp tube 1 are a “main body region” of the lamp tube 1.

129. Huang likewise discloses an LED tube light that includes glass tube 1 and two lateral cover assemblies 5, where “[t]he two lateral cover assemblies are respectively covered around the two end portions of the glass tube.” EX1003, 1:24-28, 2:27-32; *see also id.*, Abstract, 2:44-61, 5:18-35, 6:18-23, 6:51-57. A POSA would understand that the glass tube 1 of Huang includes two end portions and a

main body region. For example, a POSA would understand that the “two end portions of the glass tube” of Huang disclose the claimed two rear end regions and that the portion of the glass tube between (or other than) the “two end portions of the glass tube” discloses the claimed main body region. EX1003, 1:24-28.

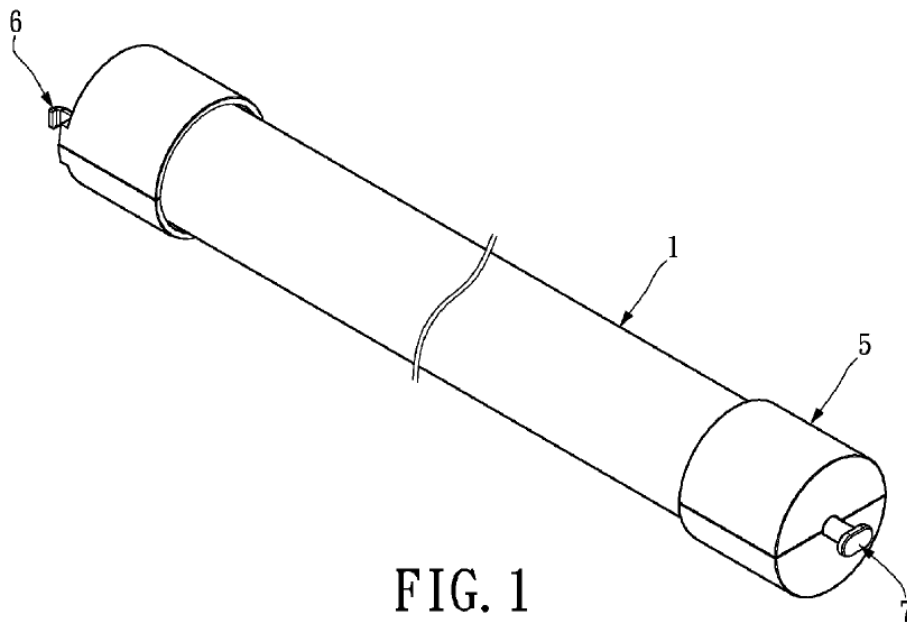
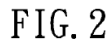


FIG. 1

EX1003, FIG. 1.



(h) Limitation 1[g] - and further wherein a length of the light strip is longer than a length of the main body region of the glass lamp tube.

131. Huang discloses that the length of light emitting unit 3 is longer than the length of the main body region of glass tube 1. EX1003, FIG. 3:

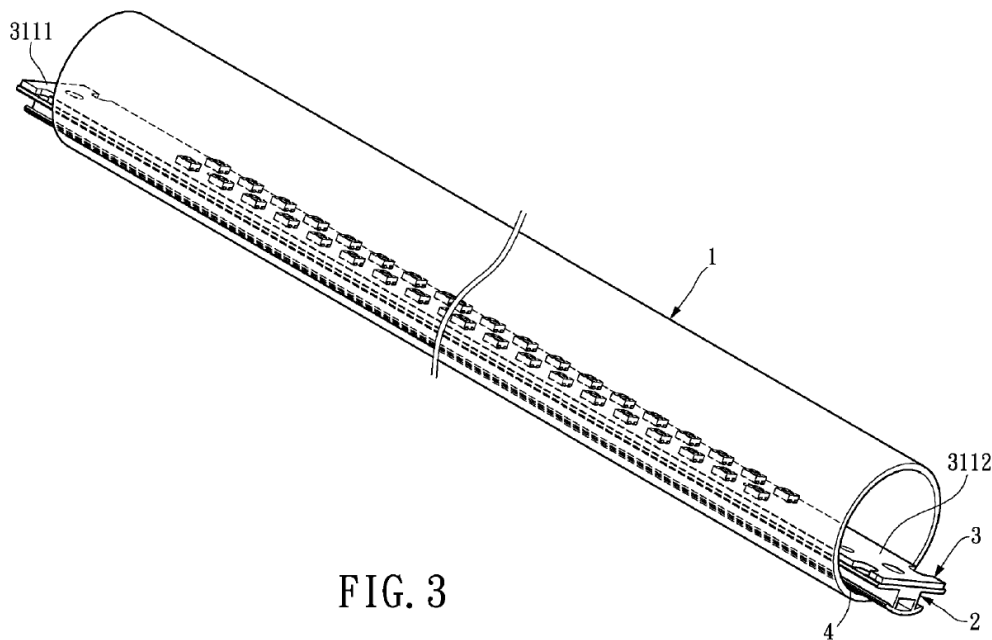


FIG. 3

EX1003, FIG. 3; *see also id.*, FIG. 2, 2:44-58.

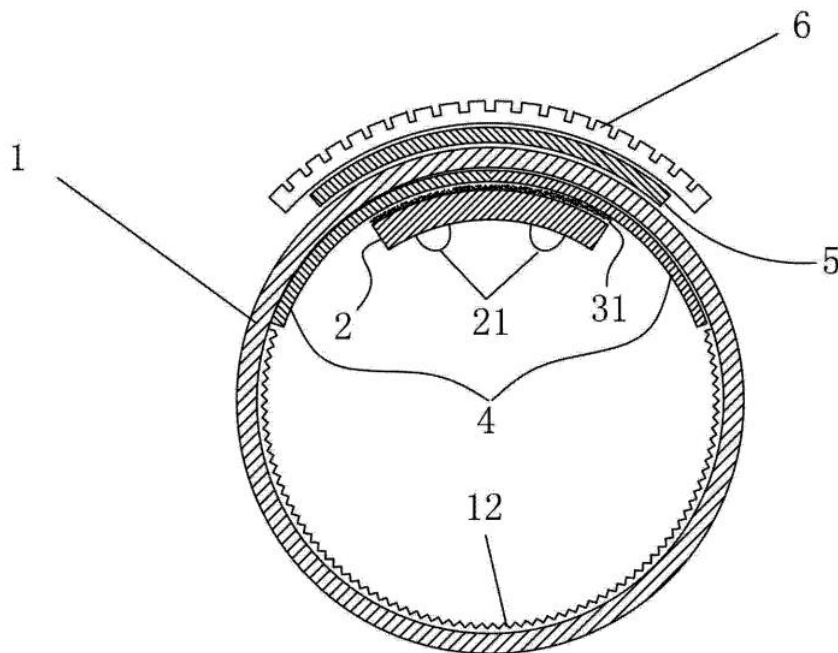
132. As shown in FIG. 3 of Huang, light emitting unit 3 extends within and outside of glass tube 1. EX1003, FIG. 3.; *see also id.*, Abstract (“The base has a length larger than the length of the glass tube, wherein two opposite end portions of the base are arranged out of a region defined by orthographically projecting from the glass tube to the base.”); 1:24-28 (“The base has a length larger than the length of the glass tube.”); 2:52-56 (“The length L2 of the base 2 is larger than the length L1 of the glass tube 1. Specifically, the two opposite end portions of the base 2 are arranged out of a region defined by orthographically projecting from the glass tube 1 to the base 2.”). A POSA would therefore understand that light emitting unit 3, mounted on base 2, is longer than the entirety of glass tube 1. EX1003, 1:24-28; 3:60-63 (“The light emitting unit 3 takes a back surface of the circuit boards 311 to

dispose on the mounting surface 211 of the base 2, and the circuit boards 311 are fixed on the base 2 by screws, adhesives, or other suitable means.”); 6:18-23. Further, because light emitting unit 3 is longer than the entirety of glass tube 1, a POSA would also understand that light emitting unit 3 is longer than the portion of the glass tube between (or other than) the “two end portions of the glass tube” (i.e., the claimed main body region). EX1003, 1:24-28.

(i) Claim 2 - The LED tube lamp of claim 1, wherein a portion of the inner surface of the glass lamp tube is covered by the rough surface and another portion of the inner surface of the glass lamp tube is covered by the reflective film.

133. This claim is rendered obvious by Jing-Huang. As discussed above with reference to Claim 1, Jing discloses the claimed rough surface (frosted layer 12, also referred to as sanding layer 12) and the claimed reflective film (inner reflective film layer 4. Further, “[o]n the inner wall of the lamp tube 1, the area without inner reflective film layer [4] can be the inner wall of the frosted layer.” EX1002, ¶ [0035]. “The inner wall of the lamp tube without the inner reflective film layer is the inner wall of the frosted layer.” EX1002, ¶ [0013]; *see also id.*, claim 6, ¶¶ [0018], [0026], [0034]. A POSA would understand that a portion of the inner surface of lamp tube 1 of Jing includes frosted layer 12 and that another portion of

the inner surface of the lamp tube 1 of Jing is covered by inner reflective film layer 4.



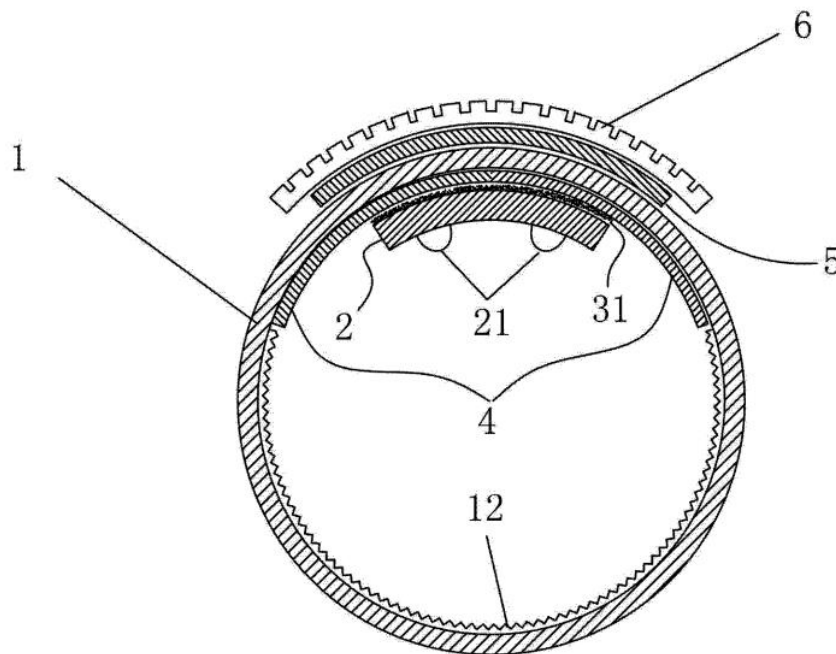
EX1002, FIG. 4.

(j) Claim 3 - The LED tube lamp of claim 2, wherein a portion of the inner surface which is not covered by the reflective film is covered by the rough surface.

134. This claim is rendered obvious by Jing-Huang. As discussed above at with reference to Claims 1 and 2, Jing discloses the claimed rough surface (frosted layer 12, also referred to as sanding layer 12) and the claimed reflective film (inner reflective film layer 4. Further, “[o]n the inner wall of the lamp tube 1, the area without inner reflective film layer [4] can be the inner wall of the frosted layer.”

EX1002, ¶ [0035]. “The inner wall of the lamp tube without the inner reflective film

layer is the inner wall of the frosted layer.” EX1002, ¶ [0013]; *see also id.*, claim 6, ¶¶ [0018], [0026], [0034]. A POSA would understand that a portion of the inner surface of lamp tube 1 of Jing includes frosted layer 12 and that another portion of the inner surface of the lamp tube 1 of Jing is covered by inner reflective film layer 4.



EX1002, FIG. 4.

(k) Limitation 8[p] - An LED tube lamp, comprising:

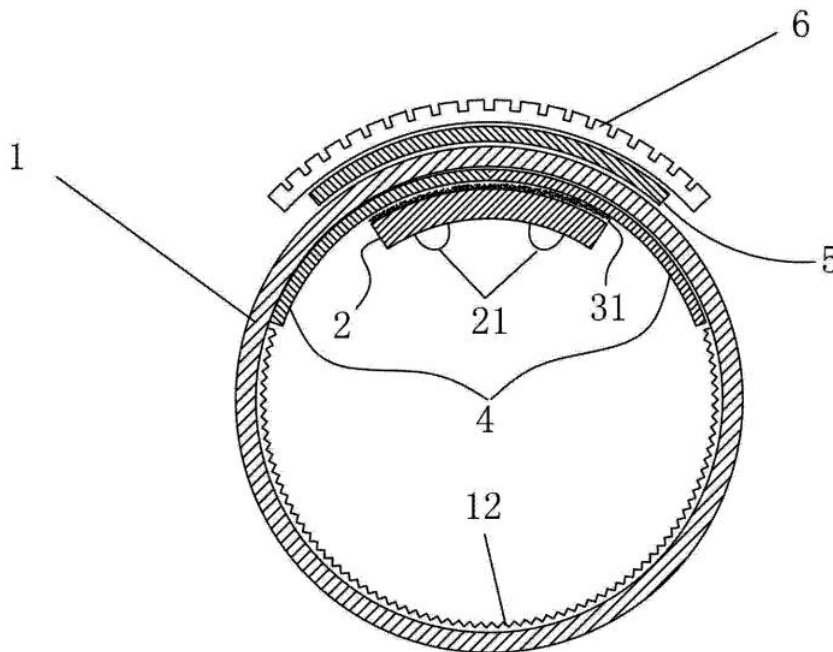
135. In my opinion, this limitation is rendered obvious by Jing-Huang. *See* Limitation 1[p], with reference to Claim 1, above.

(l) Limitation 8[a] - a glass lamp tube;

136. My opinion is that this limitation is rendered obvious by Jing-Huang. *See* Limitation 1[a], with reference to Claim 1, above.

(m) Limitation 8[b] - a diffusion film coated on an inner surface of the glass lamp tube;

137. My opinion is that this limitation is rendered obvious by Jing-Huang. “The inner wall of lamp tube 1 can be . . . an inner wall with all or part of the rough surface treatment (the rough surface treated inner wall is called sanding layer 12),” where “rough surface treatment refers to the treatment of sanding or spraying the inner wall of the lamp tube to make the light emitted by the lamp tube diffuse evenly and softly.” EX1002, ¶ [0027] (emphasis added); *see also id.*, Claim 6, ¶¶ [0013], [0026], [0035].



EX1002, FIG. 4.

138. By “mak[ing] the light emitted by the lamp tube diffuse evenly and softly,” and by being formed by “sanding or spraying the inner wall of the lamp

tube,” sanding layer 12 is a diffusion film that is coated on the inner surface of lamp tube 1 (by “). EX1002, [0027]. Hence, a POSA would understand that sanding layer 12 discloses the claimed diffusion film coated on an inner surface of the glass lamp tube.

(n) Limitation 8[c] - an LED light strip disposed on the inner surface of the glass lamp tube with a plurality of LED light sources mounted on the LED light strip;

139. My opinion is that this limitation is rendered obvious by Jing-Huang. See Limitation 1[c], with reference to Claim 1, above.

(o) Limitation 8[d] - a reflective film disposed on the inner surface of the glass lamp tube;

140. My opinion is that this limitation is rendered obvious by Jing-Huang. See Limitation 1[e], with reference to Claim 1, above.

(p) Limitation 8[e] - two end caps, each of the two end caps coupled to a respective end of the glass lamp tube; and

141. My opinion is that this limitation is rendered obvious by Jing-Huang. See Limitation 1[b], with reference to Claim 1, above.

(q) Limitation 8[f] - a power supply disposed at one end or two ends of the glass lamp tube, the power supply electrically connected to the plurality of LED light sources,

142. My opinion is that this limitation is rendered obvious by Jing-Huang.

See Limitation 1[d], with reference to Claim 1, above.

(r) Limitation 8[g] - wherein the diffusion film has a rough surface, the roughness of the rough surface is higher than that of an outer surface of the glass lamp tube,

143. My opinion is that this limitation is rendered obvious by Jing-Huang.

As discussed for Limitation 8[b], with reference to Claim 8, above, sanding layer 12 of Jing discloses the claimed diffusion film. Further, as discussed for Limitation 1[a], with reference to Claim 1, above, sanding layer 12 discloses the claimed rough surface having a roughness higher than that of an outer surface of the lamp tube 1. It is my opinion that a POSA would understand that sanding layer 12 discloses the claimed diffusion film having a rough surface, the roughness of the rough surface is higher than that of an outer surface of the glass lamp tube.

(s) Limitation 8[h] - and wherein a portion of the inner surface of the glass lamp tube is covered by the rough surface and a portion of the inner surface of the glass lamp tube is covered by the reflective film,

144. My opinion is that this limitation is rendered obvious by Jing-Huang. As discussed for Limitation 8[b], with reference to Claim 8, above, sanding layer 12 of Jing discloses the claimed diffusion film having the claimed rough surface. Further, as discussed with reference to Claim 2, above, a portion of the inner surface of lamp tube 1 is covered by sanding layer 12, and a portion of the inner surface of lamp tube 1 is covered by inner reflective film layer 4 (the claimed reflective film). It is my opinion that a POSA would therefore understand that Jing discloses the claimed portion of the inner surface of the glass lamp tube covered by the rough surface and the claimed portion of the inner surface of the glass lamp tube covered by the reflective film.

(t) Limitation 8[i] - wherein the glass lamp tube comprises a main body region and two rear end regions, each of the two rear end regions coupled to a respective end of the main body region and each of the two end caps coupled to a respective rear end region,

145. My opinion is that this limitation is rendered obvious by Jing-Huang. See Limitation 1[f], with reference to Claim 1, above.

(u) Limitation 8[j] - and further wherein a length of the light strip is longer than a length of the main body region of the glass lamp tube.

146. My opinion is that this limitation is rendered obvious by Jing-Huang. See Limitation 1[g], with reference to Claim 1, above.

(v) Claim 9 - wherein a portion of the inner surface of the glass lamp tube not covered by the reflective film is covered by the rough surface.

147. My opinion is that this claim is rendered obvious by Jing-Huang. See my discussion of Claim 2, above.

(w) Limitation 14[p] - An LED tube lamp, comprising:

148. My opinion is that this limitation is rendered obvious by Jing-Huang. See Limitation 1[p], with reference to Claim 1, above.

(x) Limitation 14[a] - a glass lamp tube having an inner surface;

149. My opinion is that this limitation is rendered obvious by Jing-Huang. See Limitation 1[a], with reference to Claim 1, above.

(y) Limitation 14[b] - an LED light strip disposed on the inner surface of the glass lamp tube with a plurality of LED light sources mounted on the LED light strip;

150. My opinion is that this limitation is rendered obvious by Jing-Huang. See Limitation 1[c], with reference to Claim 1, above.

(z) Limitation 14[c] - two end caps, each of the two end caps coupled to a respective end of the glass lamp tube; and

151. My opinion is that this limitation is rendered obvious by Jing-Huang. See Limitation 1[b], with reference to Claim 1, above.

(aa) Limitation 14[d] - a power supply disposed at one end or two ends of the glass lamp tube, the power supply electrically connected to the plurality of LED light sources,

152. My opinion is that this limitation is rendered obvious by Jing-Huang. See Limitation 1[d], with reference to Claim 1, above.

(bb) Limitation 14[e] - wherein the inner surface of the glass lamp tube is covered by a reflective layer and a rough layer, the roughness of the rough layer is higher than that of an outer surface of the glass lamp tube,

153. My opinion is that this limitation is rendered obvious by Jing-Huang. As discussed for Limitation 1[a], with reference to Claim 1, above, sanding layer 12 of Jing discloses the claimed rough surface of claim 1. A POSA would also understand sanding layer 12 to disclose the claimed rough layer. Further, as discussed for Limitation 1[e] and claim 2, above, Jing discloses a reflective layer on an inner portion of the glass tube.

(cc) Limitation 14[f] - wherein the glass lamp tube comprises a main body region and two rear end regions, each of the two rear end regions

coupled to a respective end of the main body region and each of the two end caps coupled to a respective rear end region,

154. My opinion is that this limitation is rendered obvious by Jing-Huang.

See Limitation 1[f], with reference to Claim 1, above.

(dd) Limitation 14[g] - and further wherein a length of the light strip is longer than a length of the main body region of the glass lamp tube.

155. My opinion is that this limitation is rendered obvious by Jing-Huang.

See Limitation 1[g], with reference to Claim 1, above.

(ee) Claim 15 - wherein a portion of the inner surface which is not covered by the reflective layer is covered by the rough layer.

156. It is my opinion that this claim is rendered obvious by Jing-Huang. See my discussion of Claim 2, above.

B. Ground 2 – Claims 1-3, 8, 9, 14, and 15 Are Obvious Over Jing and Halliwell

1. Motivation to combine

157. A POSA would have been motivated to search for ways to improve performance and reliability of the LED fluorescent lamp of Jing through routine experimentation. For example, Jing discloses that heat resistance is one problem that can exist in an LED lamp, resulting in poor heat dissipation for the LED lamp. EX1002, ¶[0005]. A POSA would know that poor heat dissipation can result in damage to or failure of one or more components of an LED lamp.

158. Halliwell discloses that an internal component of an LED lamp (in the form of back cover 14) can be configured to more efficiently dissipate heat. EX1008, 7:45-60. A POSA would have known that other internal components of an LED lamp can also be used to dissipate heat from circuit board 2 of Jing. A POSA would have recognized that increasing the length of circuit board 2 of Jing could improve performance by improving heat distribution and reducing heat resistance. For example, a POSA would have known that increasing the length of circuit board 2 would enable greater spacing between components on circuit board 2. A POSA would have known that the greater spacing between the components would reduce heat transfer between the components. The POSA would also have known that the reduced heat transfer would reduce likelihood of component failure (e.g., due to overheating or heat damage), improving reliability.

159. A POSA would have also known that increasing the length of circuit board 2 of Jing would increase the surface area of circuit board 2. The POSA would have known that the increased surface area would enable the POSA to increase the quantity or size of components on circuit board 2 (such as LEDs). As a result, by increasing the length of circuit board 2, a POSA would have been able to modify parameters of the LED fluorescent lamp, such by increasing brightness or to adding different types (e.g., colors) of LEDs, improving performance.

160. A POSA would have also understood that increasing the length of circuit board 2 would an area available for other purposes. For example, the POSA would have known that by increasing the length of circuit board 2, area may be available for marking circuit board 2 or displaying information on circuit board 2. A POSA would have known that such information can simplify some manufacturing processes, such as by identifying a model number of the LED fluorescent lamp or placement of components on circuit board 2, potentially reducing manufacturing cost.

161. A POSA would have understood that increasing the length of circuit board 2 would not substantially increase manufacturing cost of the LED fluorescent lamp and that the proposed benefits substantially outweigh any increased cost resulting from the increased length. The POSA would therefore have attempted to increase the length of circuit board 2.

162. A POSA would have found it obvious to try to increase the length of circuit board 2 with an expectation of success. For example, a POSA would have realized that, as shown on the left of FIG. 6 of Jing, circuit board 2 can be lengthened by at least a distance D :

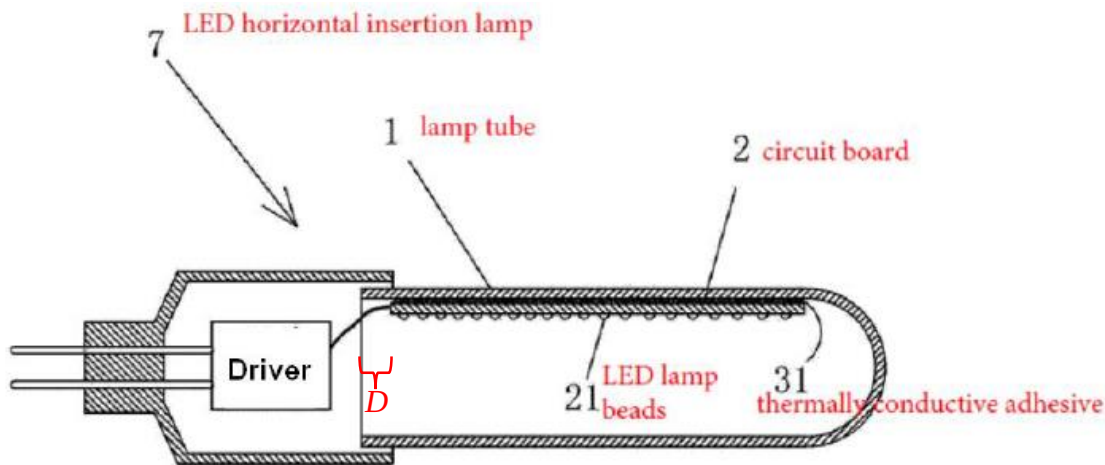


Figure 6

EX1002, FIG. 6. Similarly, circuit board 2 of Jing can be similarly lengthened on the right side when in a configuration having two end caps. EX1002, ¶[0027] (the LED lamp “is composed of ... a plug with a driver arranged on both ends of the lamp tube 1 and electrically connecting the circuit board 2 with the external power supply”).

163. A POSA would have known that circuit board 2 of Jing has rigidity sufficient to support the lengthening. For example, because Jing discloses that circuit board 2 may be “made of aluminum base PCB,” a POSA would have known that circuit board 2 has rigidity sufficient to support the lengthening without introducing breakage or a large amount of bending. EX1002, ¶¶ [0016], [0027], [0028], claim 10; *see also* my discussion of PCBs, at VI.C, above (discussing EX1012, 1:13-16).

164. In lengthening circuit board 2, a POSA would have looked to Halliwell. A POSA would have found it obvious to modify the length of circuit board 2 of Jing with the length taught by Halliwell to achieve one or more of the above-described benefits that would have been known to the POSA, such as improved performance and reliability. A POSA would have known, for example, and as illustrated in FIG. 17 of Halliwell, that the additional surface area of circuit board 2 would allow for marking the circuit board 2 with an identifier or other information, which may assist during a manufacturing process and which may potentially reduce manufacturing cost, or for the mounting of all or portions of driver circuit or connections to the driver circuit, as taught by Halliwell:

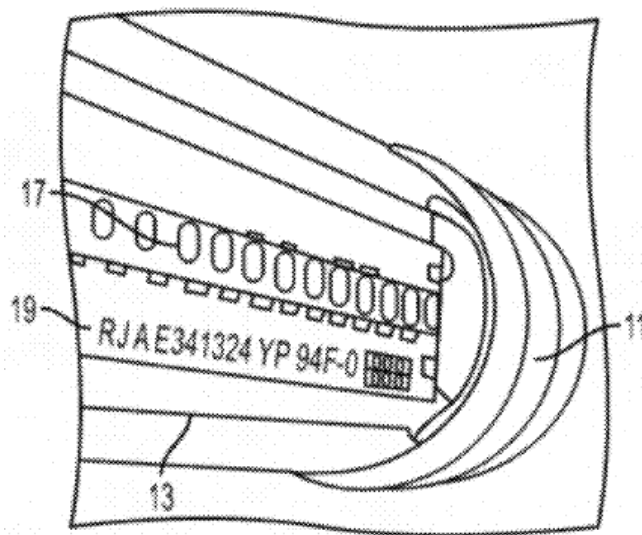


FIG. 17

EX1008, FIG. 17, FIG. 16, 12:30-45, 13:44-61.

2. *Modification with Halliwell*

165. Combining the LED fluorescent lamp of Jing with the length taught by Halliwell would produce an LED lamp tube (e.g., the LED fluorescent lamp of Jing) that includes at least a light strip (e.g., board 2 of Jing) and a glass lamp tube (e.g., lamp tube 1 of Jing). EX1002, FIG. 4. The light strip would be longer than a main body region of the glass lamp tube, as disclosed by Halliwell. EX1008, FIGS. 7-9 and 17.

3. *Element-by-Element Analysis*

(a) **Limitation 1[p]**

166. My opinion is that this limitation is rendered obvious by Jing-Halliwell. Jing-Halliwell teaches an LED tube lamp. See my discussion of Jing for Limitation 1[p], above, in Ground 1. Halliwell likewise discloses an LED lamp tube 10 that “comprises at least one light emitting diode (LED) 17).” EX1008, 11:31-33.

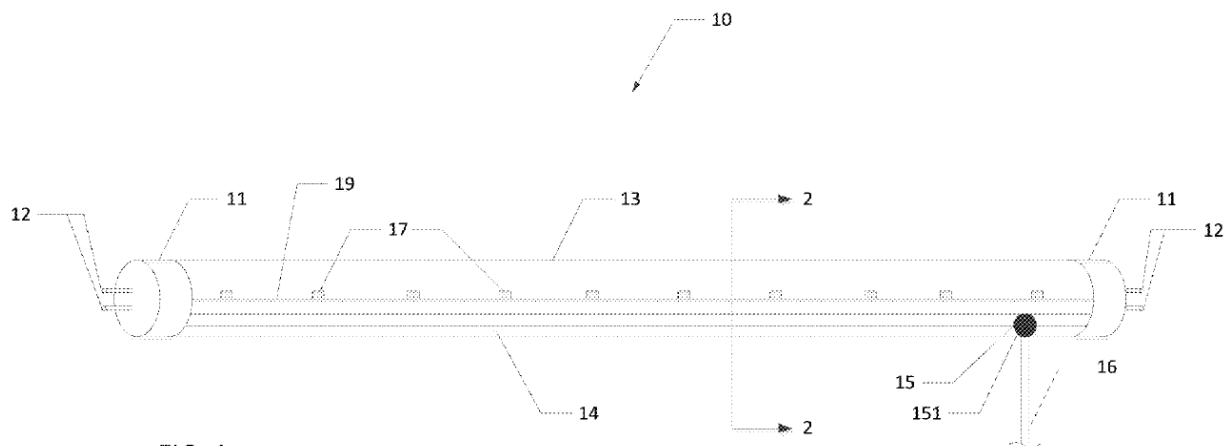


FIG. 1

EX1008, FIG. 1.

(b) Limitation 1[a]

167. My opinion is that this limitation is rendered obvious by Jing-Halliwell. Jing-Halliwell teaches a glass tube lamp with an inner surface covered by a rough surface with a roughness higher than the outer surface. *See* my discussion of Jing at Limitation 1[a], above, in Ground 1.

(c) Limitation 1[b]

168. My opinion is that this limitation is rendered obvious by Jing-Halliwell. Jing-Halliwell teaches two end caps coupled to the ends of the glass lamp tube. *See* my discussion of Jing at Limitation 1[b], above, in Ground 1. Halliwell likewise teaches “the LED lamp tube 10 may further comprise an end cap 11 disposed on each end the body of the LED lamp tube 10.” EX1008, 8:10-12; FIGS. 1, 6-12, 16-18.

(d) Limitation 1[c]

169. My opinion is that this limitation is rendered obvious by Jing-Halliwell. Jing-Halliwell teaches an LED light strip with a plurality of LED light sources disposed on an inner surface of the tube. *See* my discussion of Jing at Limitation 1[c], above, in Ground 1. Halliwell further teaches that “[t]he LEDs are mounted on reflective back plate 19 by any of various methods generally known and understood in art.” EX1008, 11:48-54 (emphasis added). As shown in FIG. 2, “reflective back

plate 19 may be disposed along a diameter of the cross section of LED lamp tube 10.” *Id.* (emphasis added); FIG. 2.

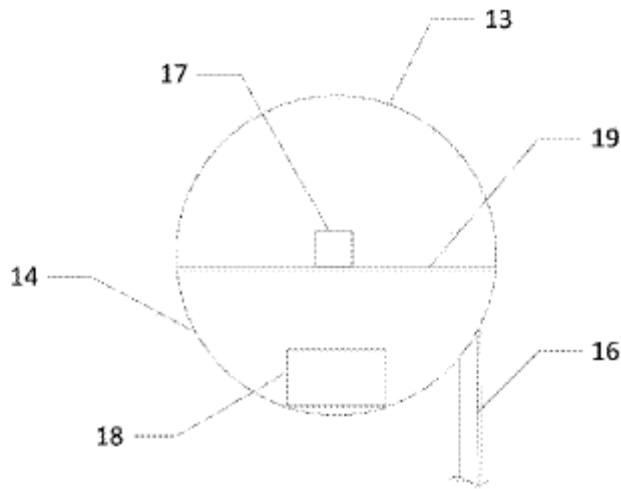


FIG. 2

(e) Limitation 1[d]

170. My opinion is that this limitation is rendered obvious by Jing-Halliwell. Jing-Halliwell teaches a power supply disposed at one end of the tube and electrically connected to the LED light sources. See my discussion of Jing above at Limitation 1[d] in Ground 1. Halliwell further teaches that “driver circuitry 18 may comprise a circuit portion configured to convert the input alternating current (AC) line voltage to a direct current (DC) voltage.” EX1008, 12:12-15, 12:15-29, 12:59-66. “The output of the driver circuitry 18 is fed to one or more LEDs 17 which may be connected in series or in parallel. The LEDs 17 the use [sic] the electrical power to emit light.” *Id.*, 13:25-33 (emphasis added). Halliwell describes that “the driver

circuitry may be mounted in an end cap 11 disposed on an end of LED tube lamp 10.” *Id.*, 12:30-37.

(f) Limitation 1[e]

171. My opinion is that this limitation is rendered obvious by Jing-Halliwell. Jing-Halliwell teaches a reflective film disposed on a portion of the inner surface of the tube. See my discussion of Jing at Limitation 1[e] in Ground 1, above.

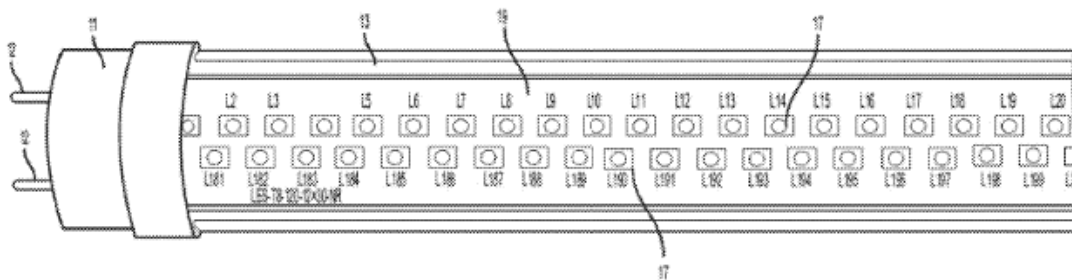
(g) Limitation 1[f]

172. My opinion is that this limitation is rendered obvious by Jing-Halliwell. Jing-Halliwell teaches a tube with a main body region coupled to two rear end regions and the end caps coupled to the rear end regions. See my discussion of Jing at Limitation 1[f] in Ground 1, above. Halliwell teaches that “the LED lamp tube comprises: a substantially elongate member comprising a first end surface, a second end surface, and an intermediate surface substantially between the first and second end surfaces.” EX1008, 2:14-19, 2:26-3:57. “The first and second end surfaces may likewise comprise the at least one end cap 11.” *Id.*, 5:10-15. “[T]he LED lamp tube 10 may further comprise an end cap 11 disposed on each end the body of the LED lamp tube 10.” EX1008, 8:10-12; FIGS. 1, 6-12, 16-18. A POSA would understand that ends of LED lamp tube 10 covered by the end caps 11 are “two rear end regions” and that the portion of LED lamp tube 10 between the ends are a “main body region” of LED lamp tube 10.

(h) Limitation 1[g]

173. My opinion is that this limitation is rendered obvious by Jing-Halliwell. Jing-Halliwell teaches the length of the light strip is longer than the main body region of the tube. As explained in my discussion at §VIII.B.3(g), above, a POSA would understand that LED lamp tube 10 of Halliwell includes two rear end regions and a main body region. For example, a POSA would understand that the “first and second end surfaces” covered by the end caps 11 of Halliwell disclose the claimed two rear end regions and that the “intermediate surface substantially between the first and second end surfaces” discloses the claimed main body region. EX1008, 5:10-15; 2:14-19, 2:26-3:57.

174. As shown in FIGS. 7-9, 16, and 17, Halliwell teaches that reflective back plate 19 extends into the portion of LED tube lamp 10 covered by end caps 11 (the rear end region):

**FIG. 7**

EX1008, FIG. 7.

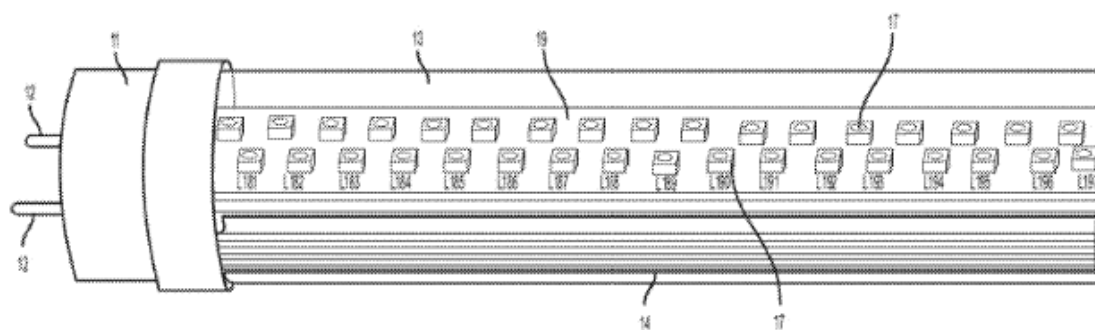


FIG. 8

EX1008, FIG. 8.

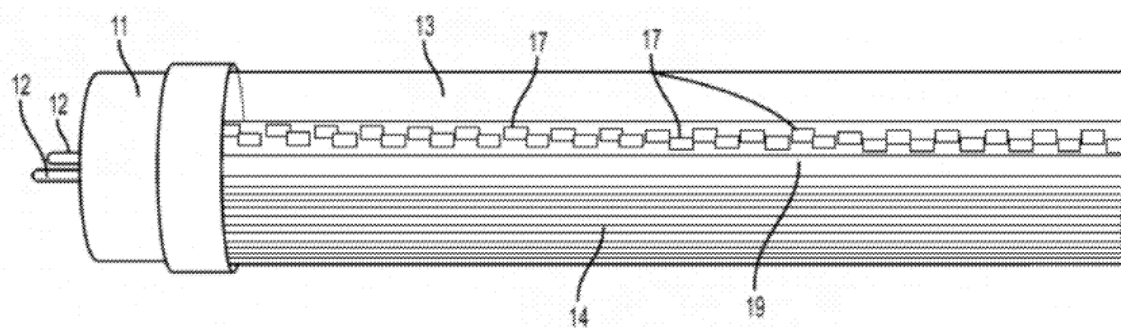


FIG. 9

EX1008, FIG. 9.

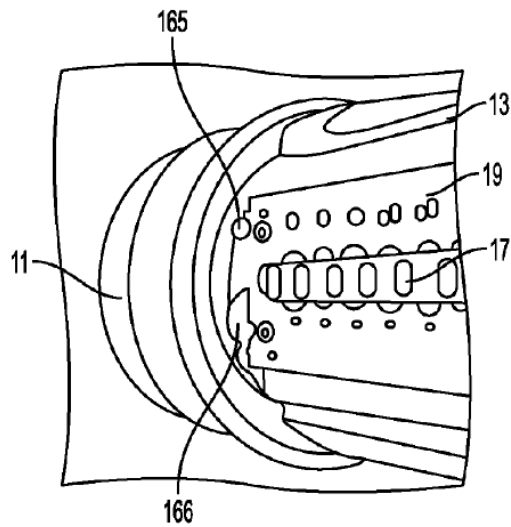


FIG. 16

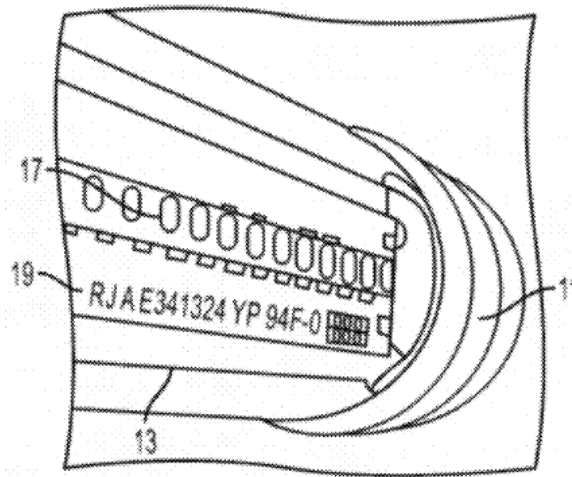


FIG. 17

EX1008, FIGS. 16, 17.

175. A POSA would have understood that reflective back plate 19 with mounted LEDs 17 disclose an LED light strip. A POSA would also have understood that because reflective back plate 19 extends into the region of LED tube lamp 10 covered by end caps 11, reflective back plate 19 is longer than a main body region of LED tube lamp 10.

(i) Claims 2, 3, 8, 9, 14, and 15

176. My opinion is that Claims 2, 3, 8, 9, 14, and 15 are rendered obvious by Jing-Halliwell based on the following:

Claim/ Limitation	Disclosure in Jing-Halliwell
2	See Claim 2, Ground 1, §VIII.A.3(i)
3	See Claim 3, Ground 1, §VIII.A.3(j)
8[p]	See Limitation 1[p], Ground 2, §VIII.B.3(a)

Claim/ Limitation	Disclosure in Jing-Halliwell
8[a]	<i>See</i> Limitation 1[a], Ground 2, §VIII.B.3(b)
8[b]	<i>See</i> Limitation 8[b], Ground 1, §VIII.A.3(m)
8[c]	<i>See</i> Limitation 1[c], Ground 2, §VIII.B.3(d)
8[d]	<i>See</i> Limitation 1[e], Ground 2, §VIII.B.3(f)
8[e]	<i>See</i> Limitation 1[b], Ground 2, §VIII.B.3(c)
8[f]	<i>See</i> Limitation 1[d], Ground 2, §VIII.B.3(e)
8[g]	<i>See</i> Limitation 8[g], Ground 1, §VIII.A.3(r)
8[h]	<i>See</i> Limitation 8[h], Ground 1, §VIII.A.3(s)
8[i]	<i>See</i> Limitation 1[f], Ground 2, §VIII.B.3(g)
8[j]	<i>See</i> Limitation 1[g], Ground 2, §VIII.B.3(h)
9	<i>See</i> Claim 2, Ground 1, §VIII.A.3(i)
14[p]	<i>See</i> Limitation 1[p], Ground 2, §VIII.B.3(a)
14[a]	<i>See</i> Limitation 1[a], Ground 2, §VIII.B.3(b)
14[b]	<i>See</i> Limitation 1[c], Ground 2, §VIII.B.3(d)
14[c]	<i>See</i> Limitation 1[b], Ground 2, §VIII.B.3(c)
14[d]	<i>See</i> Limitation 1[d], Ground 2, §VIII.B.3(e)
14[e]	<i>See</i> Limitation 14[e], Ground 1, §VIII.A.3(bb)
14[f]	<i>See</i> Limitation 1[f], Ground 1, §VIII.A.3(g)
14[g]	<i>See</i> Limitation 1[f], Ground 2, §VIII.B.3(g)
15	<i>See</i> Claim 2, Ground 1, §VIII.A.3(i)

C. Grounds 3 and 4 – Claim 4 Is Obvious Further in View of Foo

1. Motivation to combine

177. For the reasons discussed in Ground 1, a POSA would have been motivated to combine the LED fluorescent lamp of Jing with the circuit board length taught by Huang. For the reasons discussed in Ground 2, a POSA would have been motivated to combine the LED fluorescent lamp of Jing with the circuit board length taught by Halliwell. In my opinion, a POSA would also have been motivated to combine Jing-Huang (Ground 3) or Jing-Halliwell (Ground 4) with the surface

roughness taught by Foo with a reasonable expectation of success for several reasons.

178. Jing discloses that the inner wall of lamp tube 1 can be covered partially or entirely with a “rough surface treatment (the rough surface treated inner wall is called sanding layer 12).” EX1002, ¶[0027] (emphasis added). Jing’s “rough surface treatment refers to the treatment of sanding or spraying the inner wall of the lamp tube to make the light emitted by the lamp tube diffuse evenly and softly.” *Id* (emphasis added). However, Jing does not specify a particular value or degree of that surface roughness. *Id*. A POSA therefore would have been motivated to look elsewhere for specifics.

179. 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.” EX1005, 3:17-22 (emphasis added). Foo also teaches that “advantageously the material is constructed to have a surface roughness smaller than 0.8μm” *Id*.

180. Incorporating Foo’s material with specific roughness characteristics would have been a known use of existing technology to provide capability for LED lamps. A POSA 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. Thus, when a POSA selected a material to provide a rough surface on the interior surface of the LED lamp, the POSA would have had a reasonable expectation that such an implementation would be successful. Therefore, a POSA would have been motivated to use the surface roughness disclosed by Foo in an LED lamp as taught by Jing and Huang.

2. *Modification with Foo*

181. Combining the LED fluorescent lamp of Jing with the circuit board length taught by Huang or Halliwell and the surface roughness of Foo, would produce an LED lamp tube (e.g., the LED fluorescent lamp of Jing) that includes at least a light strip (e.g., board 2 of Jing) and a glass lamp tube (e.g., lamp tube 1 of Jing). EX1002, FIG. 4. The light strip would be longer than a main body region of the glass lamp tube, as disclosed by Huang and Halliwell. EX1003, FIG. 3. A portion of an inner surface of the glass lamp 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) Claim 4

182. Jing-Huang-Foo (Ground 3) and Jing-Halliwell-Foo (Ground 4) teach a roughness of the rough surface that ranges from 0.1 to 40 μm . Foo describes an LED light tube 100 that includes casing 10, a plurality of LED light sources, and two end caps 50. EX1005, 6:10-22. “The inner surface of the casing 10 may be

constructed to have a surface roughness of smaller than 0.8 μ m to enhance the reflectance and reflux of the light.” EX1005, 10:18-20 (emphasis added). Foo discloses that “the casing has an inner surface with a surface roughness smaller than 0.8 μ m.” EX1005, claim 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 μ m, e.g. 6 μ m or 7 μ m” (*sic*). EX1005, 3:17-22.

D. Grounds 5 and 6 – Claims 10 and 16 Are Obvious Further in View of Zhao

1. Motivation to combine

183. For the reasons discussed in Ground 1, it would have been obvious to combine Jing with Huang.

184. For the reasons discussed in Ground 2, it would have been obvious to combine Jing with Halliwell.

185. In my opinion, a POSA would have also been motivated to combine Zhao with Jing-Huang (Ground 5) or Jing-Halliwell (Ground 6) with a reasonable expectation of success for several reasons.

186. A POSA would have understood the importance of securing components within an LED lamp in order to create a reliable and operational product. Further, a POSA would have known that a gel can be used to secure such

components to realize known benefits. For example, Huang teaches that components can be secured using a glue 4 (e.g., silica gel) and that components can be secured to the glass tube using glue 4. EX1003, 1:29-31, 2:29-32, 3:64-4:21, 6:18-23 (emphasis added). In addition to maintaining relative positions of components, Huang teaches that glue 4 provides further benefits, such as force dispersion and heat dissipation. EX1003, 4:4-12, 7:8-18.

187. A POSA would also have understood the need to secure end caps to an LED lamp because the end caps perform several important functions for an LED lamp. For example, the end caps may provide stability for the glass tube, may house or support LED components, may provide a fastening mechanism for securing the LED lamp to a fixture, and may provide electrical connections to the LEDs. A POSA would therefore have been motivated to find a solution for securing the end caps to the glass tube in order to avoid loosening of the end caps from the LED lamp, which could cause undesired effects or poor performance, such as reduced stability for the glass tube, reduced support for LED components, loosening of the LED lamp from a fixture, inability to secure the LED lamp to a fixture, a poor electrical connection to the LEDs, or damage to the LED lamp.

188. However, Jing, Huang, and Halliwell do not disclose using an adhesive to secure the end caps to the glass tube. A POSA therefore would have been motivated to look elsewhere for a solution.

189. A POSA would have been motivated to use an adhesive to secure the end caps to the glass tube, such as by using the adhesive taught by Zhao. Zhao teaches that “end caps 110A and 110B of the LED drive power supply 10 enclose both ends of the tube body 30. In the present embodiment, inner surfaces of the end caps 110A and 110B and the outer surface of the tube body 30 can be adhered together by using adhesives (e.g., light mud), and meanwhile, the base plate can be also fixed to inside the end caps.” EX1007, 8:42-50. A POSA would also understand that adhesives (such as the adhesive of Zhao) may be provided as gels and that such an adhesive would secure the end caps to the glass tube without substantially increasing cost of fabricating the LED lamp.

190. A POSA would have been familiar with the use of adhesives and gels secure components of LED lamps. A POSA would have recognized that Zhao’s adhesive would secure the end caps to the glass tube and would have been motivated to improve the LED lamp of Jing-Huang or Jing-Halliwell by securing the end caps of the LED lamp to the glass tube using the adhesive of Zhao. A POSA would have recognized that Zhao’s adhesive would provide a mechanism for securing the end caps of the LED lamp to the glass tube of the LED lamp. A POSA would have understood that an LED lamp could easily be modified to include such an adhesive because adhesives were well known and such a modification would have been a straight-forward implementation of known technology. It would have been obvious

to a POSA to try adhesive of Zhao with an LED lamp because in doing so, a POSA would have expected this implementation to be successful based on the stability of the technology.

191. Further, a POSA would have been motivated to implement Zhao's adhesive in an LED lamp to improve the cost efficiency of the lamp. A POSA would have known that adhesives are relatively inexpensive and are generally simpler to implement as compared to other fastening mechanisms, such as a screw. Further, some fastening mechanisms (such as a screw) may subject the glass tube to force (potentially causing breakage) and could also potentially short or puncture electrical components of the LED lamp. This modification would have yielded a predictable result because a POSA would have known that the adhesive of Zhao can be added to the LED lamp of Jing-Huang or Jing-Halliwell without degrading the performance of the LED lamp.

2. *Modification with Zhao*

192. Combining the LED fluorescent lamp of Jing with the circuit board length taught by Huang or Halliwell with the adhesive of Zhao would produce an LED lamp tube (e.g., the LED fluorescent lamp of Jing) that includes at least a light strip (e.g., board 2 of Jing) and a glass lamp tube (e.g., lamp tube 1 of Jing). EX1002, FIG. 4. The light strip would be longer than a main body region of the glass lamp

tube, as disclosed by Huang and Halliwell. EX1003, FIG. 3. The glass lamp tube would be secured to end caps via a gel, such as the adhesive taught by Zhao.

3. *Element-by-Element Analysis*

(a) Claim 10

193. Jing-Huang-Zhao (Ground 5) and Jing-Halliwell-Zhao (Ground 6) teach the two end caps secured to the tube by a gel disposed between the inner surface of the end caps and outer surface of the tube. Zhao discloses “enclosing both ends of the incandescent lamp tube body by the end cap 110 with the aid of adhesives such as light mud.” EX1007, 6:36-42 (emphasis added). “When the assembly of LED incandescent lamp 1 is completed, the end caps 110A and 110B of the LED drive power supply 10 enclose both ends of the tube body 30. In the present embodiment, inner surfaces of the end caps 110A and 110B and the outer surface of the tube body 30 can be adhered together by using adhesives (e.g., light mud), and meanwhile, the base plate can be also fixed to inside the end caps.” *Id.*, 8:42-50 (emphasis added). A POSA would understand that Zhao’s description that “inner surfaces of the end caps 110A and 110B and the outer surface of the tube body 30 can be adhered together by using adhesives (e.g., light mud)” discloses the claimed gel is disposed between an inner surface of each of the two end caps and an outer surface of each of the two rear end regions.

(b) Claim 16

194. In my opinion, this claim is rendered obvious by Jing-Huang-Zhao (Ground 5) or Jing-Halliwell-Zhao (Ground 6). See my discussion of Claim 10, above, at VIII.D.3(a).

E. Grounds 7-10 – Claims 5, 6, 11, 12, 17, and 18 Are Obvious Further in View of Deng**1. Motivation to combine**

195. For the reasons discussed in Grounds 1 and 3, it would have been obvious to combine Jing with Huang and Jing-Huang with Foo. For the reasons discussed in Grounds 2 and 4, it would have been obvious to combine Jing with Halliwell and Jing-Halliwell with Foo. For the reasons discussed in Grounds 5 and 6, it would have been obvious to combine Jing-Huang with Zhao and Jing-Halliwell with Zhao. A POSA would have also been motivated to combine Deng with Jing-Huang-Foo (Ground 7), Jing-Halliwell-Foo (Ground 8), Jing-Huang-Zhao (Ground 9), Jing-Halliwell-Zhao (Ground 10) and with a reasonable expectation of success for several reasons.

196. A POSA would have understood the importance of heat dissipation within an LED lamp. Heat is generated inside an LED lamp as the LEDs within the lamp operate. *Id.* Jing provides one such example by disclosing that heat resistance is a problem that can exist in an LED lamp, resulting in poor heat dissipation for the LED lamp. EX1002, ¶[0005]. If the heat is allowed to continue to build, the excess

heat could damage the lamp. Thus, a POSA would have been motivated to look to other solutions for preventing the LED lamp from suffering from a build-up of heat inside the tube lamp. *Id.*

197. Deng describes multiple “air vents 12” in each end cap. EX1006, ¶[0037]. A POSA would have been motivated to look to Deng, which teaches that “[i]n order to dissipate heat of the LED tube 1, air vents 12 for heat dissipation are opened on the end faces of the end covers 10.” EX1006, ¶[0037]. A POSA would additionally understand that the use of a larger single hole or multiple small holes would have the same beneficial effect in reducing the heat inside the tube lamp.

198. A POSA would have been familiar with the use of vents to provide air flow through an LED lamp to dissipate heat. A POSA would have recognized that Deng’s air vents 12 would provide air flow through the LED lamp and would have been motivated to improve an LED lamp with at least an air vent to improve air flow in the LED lamp. A POSA would have understood that an LED lamp could easily be modified to include air vents in the end cap described by Deng because venting for improved air flow was well known and such a modification would have been a straight-forward implementation of known technology. It would have been obvious to a POSA to try the air vents described in Deng with an LED lamp because in doing so, a POSA would have expected this implementation to be successful based on the stability of the technology.

199. Further, Deng also describes the end caps of an LED light being made of an insulating material: “end covers 10 are also made of an insulating material.” EX1006, ¶¶ [0036], [0015]. A POSA would have been motivated to implement Deng’s insulating end covers in the LED lamp to improve the cost efficiency of the lamp. Specifically, Deng teaches that forming the end covers from an insulating material improves “overall resistance of the LED tube 1 to electric leakage” and results in safer “installation and use processes.” EX1006, ¶ [0036]. Such a combination would have been a simple substitution Jing’s end caps for Deng’s end caps. This substitution would have yielded a predictable result because a POSA would have known that the end caps are physical components that can be substituted for one another without degrading the performance of the LED lamp.

2. *Modification with Deng*

200. Combining the LED fluorescent lamp of Jing with the circuit board length taught by Huang or Halliwell, the air vents of Deng, and/or the adhesive of Zhao, and/or the surface roughness of Foo would produce an LED lamp tube (e.g., the LED fluorescent lamp of Jing) that includes at least a light strip (e.g., board 2 of Jing) and a glass lamp tube (e.g., lamp tube 1 of Jing). EX1002, FIG. 4. The light strip would be longer than a main body region of the glass lamp tube, as disclosed by Huang. EX1003, FIG. 3. End caps of the LED lamp tube of Jing would be

replaced with end covers 10 of Deng, which would each include an insulating end wall, two conductive pins, and at least one opening in the form of air vents 12.

3. *Element-by-Element Analysis*

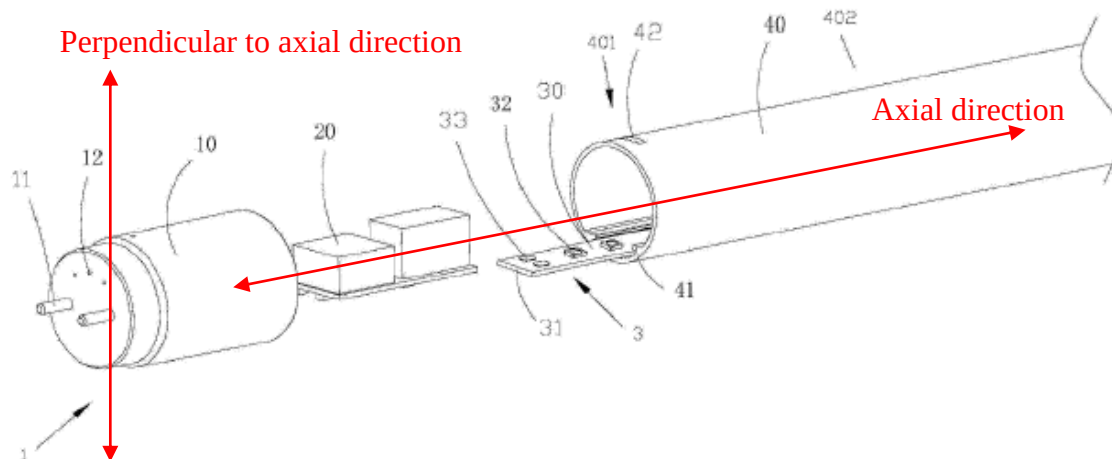
(a) Claim 5

201. Jing-Huang-Foo-Deng (Ground 7) and Jing-Halliwell-Foo-Deng (Ground 8) teach two end caps with insulating end walls, which are perpendicular to an axial direction of the tube, and that have two conductive pins and openings. Deng discloses that “end covers 10 are also made of an insulating material, and copper pins 11 for power-on are arranged on the end faces of the end covers 10. Each of the copper pins 11 runs through the end face of the corresponding end cover 10, one end of the copper pin 11 is connected to the driver power supply unit 20 in the tube body 40, and the other end is for connecting an external power supply.” EX1006, ¶[0036]. A POSA would understand that the insulating material of end covers 10 of Deng discloses the claimed insulating end wall, and that copper pins 11 of Deng disclose the claimed two conductive pins.

202. Deng discloses that “air vents 12 for heat dissipation are opened on the end faces of the end covers 10. Air 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.” EX1006, ¶[0037]. Deng further describes that “air vents for heat dissipation are opened on the end faces of the end covers.” *Id.*, claim 10. A

POSA would understand that air vents 12 of Deng disclose the claimed at least one opening. A POSA would also understand that such openings and the benefits of such openings were known in the art. See my discussion at §VI.D, above (*citing* EX1008, 8:61-94, FIG. 18).

203. As shown in annotated FIG. 1, below, Deng discloses that the “end faces” of the end covers 10 (the claimed insulating end wall) are substantially perpendicular to an axial direction of hollow tube body 40, and that pins 11 and air vents 12 are arranged on the end faces of end covers 10. EX1006, ¶[0037], FIG. 1.



EX1006, FIG. 1; *see also id.*, FIG. 3.

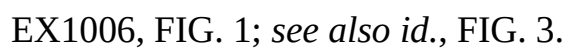
204. Although FIG. 1 of Deng illustrates one cover 10 at the left side of the LED 1, and the right side of LED 1 is not shown, the description of Deng makes clear that LED 1 includes “end covers 10,” and that “end covers 10 connect[] the ends of the tube body 40.” EX1006, ¶[0024] (emphasis added); *see also id.*, ¶¶[0027], [0029], [0036], [0037]. A POSA would understand that both the left side

and right side of LED 1 include a cover 10 having the claimed insulating end wall, two conductive pins and at least one opening, the insulating end wall substantially perpendicular to an axial direction of the glass lamp tube, and the two conductive pins and the opening arranged on the insulating end wall.

(b) Claim 6

205. Jing-Huang-Foo-Deng (Ground 7) and Jing-Halliwell-Foo-Deng (Ground 8) teach two end caps sleeves with a respective rear end region, and an outer diameter of each end cap is substantially the same as the outer diameter of the main body region. Deng discloses “end covers 10 connecting the ends of the tube body 40” and “covering the ends of the tube body.” EX1006, ¶[0007], [0024] (emphasis added). A POSA would understand that each end cover 10 (the claimed two end caps) “sleeves with” a respective rear end region of tube body 40.

206. “As shown in Fig. 1 and Fig. 2, the cross section of the tube body 40 is round, an end cover 10 is connected to each of the two ends of the tube body 40, the cross sections of the end covers 10 match the cross section of the tube body 40 in shape, and the inner diameters of the end covers 10 are slightly close to the outer diameter of the tube body 40.” EX1006, ¶[0027] (emphasis added). A POSA would understand that an outer diameter of each end cover 10 is “substantially the same as” (to the extent that term is understood) the outer diameter of tube body 40.



207. My opinion is that this claim is rendered obvious by Jing-Huang-Zhao-Deng (Ground 9) or Jing-Halliwell-Zhao-Deng (Ground 10). See my discussion of Claim 5, at §VIII.E.3(a).

208. My opinion is that this claim is rendered obvious by Jing-Huang-Zhao-Deng (Ground 9) or Jing-Halliwell-Zhao-Deng (Ground 10). See my discission of Claim 6, at §VIII.E.3(b).

209. My opinion is that this claim is rendered obvious by Jing-Huang-Zhao-Deng (Ground 9) or Jing-Halliwell-Zhao-Deng (Ground 10). See my discussion of Claim 5, at §VIII.E.3(a).

(f) Claim 18

210. My opinion is that this claim is rendered obvious by Jing-Huang-Zhao-Deng (Ground 9) or Jing-Halliwell-Zhao-Deng (Ground 10). See my discussion of Claim 6, at §VIII.E.3(b).

IX. CONCLUSION

211. 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.

Wednesday, December 14, 2022

Date



Michael Lebby, Ph.D.