

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

INTER PARTES Review No. IPR2023-00675
Patent 10,897,801

DECLARATION OF DONALD E. ACKLEY, Ph.D

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I. INTRODUCTION

1. My name is Donald E. Ackley, Ph.D. 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 have a Ph.D. from Brown University in Electrical Sciences. I wrote my dissertation on my research into picosecond relaxations in amorphous semiconductors. I received my Bachelor of Science in Electrical Engineering and my Master of Science in Electrical Sciences, both also from Brown University.

3. I have extensive experience in the design and development of LEDs, LED lamps, and LED displays. For example, I managed programs for development of LEDs at Epitaxx Inc. before the company was sold to Nippon Sheet Glass. Additionally, while I was at Siemens Corporate Research, I developed tunable LED devices. Additionally, when I worked for Lytel Inc., I managed and built an engineering team and research facilities with the goal of developing novel optoelectronic materials and components including LEDs.

4. From 1990 to 1996, I worked at Motorola Photonics Technology Center, first as a manager and then as a Chief Scientist. During this time, I worked on programs related to LED chips and OLEDs.

5. Next, from 1996 to 1999, I worked as an Executive Director of Microelectronics at Nanogen, Inc. I was responsible for directing a team of engineers, biologists, and chemists to further develop the company's DNA chip and microfluidics technology.

6. I was the Vice President of Engineering at Redeon, Inc., from 1999 to 2001 and was responsible for the engineering development of MEMS microneedle technology for transdermal drug delivery and continuous glucose monitoring. Part of this technology involved application of printed circuit board technology to create microneedle arrays.

7. I next served as President and CEO of VSK Photonics Inc. from 2001 to 2004. The company produced 10 and 40 Gb/s optical components. During my time at the company, I led the transition to LED-based TOSA modules.

8. After my time at VSK Photonics, from 2001 to 2004, I served as founder, CEO, CTO, and/or a Board Member of three different companies—Nanotrope Inc., Newton Sensors Inc., and Jaco Electronics. Since then, I have been a consultant providing technical support for various technologies including superluminescent LEDs as amplifiers for LIDAR and remote sensing, single frequency optical devices, organic TFT and photodetector arrays, and biosensors.

9. I have also held academic appointments, including as an adjunct professor at the University of Illinois Department of Electrical Engineering. During

this appointment, I researched high-power InGaAs diode lasers. I also worked as a visiting scientist at Rutgers University in the Department of Materials Science and Engineering. During this time, I researched sol gel waveguide chemical sensors.

10. I am an inventor on over 75 issued and pending U.S. Patents. In particular, U.S. Patent Nos. 5,324,964; 5,563,900; 5,710,441; and 8,970,948 relate to my work in LED technology.

11. I have also written over fifty articles for scientific journals and authored chapters for two books.

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

13. Because of my background, training, and experience, I am qualified as an expert to explain the background of the technology encompassed by the '801 Patent as well as to opine on the validity of the claims of the '801 Patent in view of the prior art references discussed herein.

III. COMPENSATION

14. 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. LEGAL CONSIDERATIONS

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

A. Obviousness

16. I understand that a claimed invention is obvious and, therefore, not patentable if the subject matter claimed would have been obvious to a person of ordinary skill in the art at the time that the patent was filed (a “POSITA”), which I have been asked to treat as of September 25, 2015. I understand that there must be some articulated reasoning with some rational underpinning to support a conclusion of obviousness. I further understand that rationales that may support a conclusion of obviousness include:

- a) simply arranging old elements in a way in which each element performs the same function it was known to perform, and the arrangement yields expected results;
- b) merely substituting one known element for another known element in the field, and the substitution yields no more than a predictable result;
- c) combining elements in a way that was “obvious to try” because of a design need or market pressure, where there was a finite number of identified, predictable solutions;

- d) whether design incentives or other market forces in a field prompted variations in a work that were predictable to a POSITA;
- e) that some teaching, suggestion, or motivation would have led a POSITA to modify the prior art or to combine prior art references to arrive at the claimed invention, among other rationales.

B. Claim Interpretation

17. I understand that a claim term is given the meaning that the term would have to a POSITA at the time the patent is filed, which generally is the ordinary and customary meaning of the term. I further understand that the ordinary and customary meaning of a term may be evidenced by a variety of sources, including the words of the claims themselves, the specification, the prosecution history, and extrinsic evidence concerning relevant scientific principles, the meaning of technical terms, and the state of the art.

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

V. OVERVIEW OF TASK & BASIS FOR OPINIONS

19. I have been asked to review the '801 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 September 25, 2015, 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 VI below.

20. 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 '801 Patent being invalid.

21. 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.

22. 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.

VI. LEVEL OF SKILL IN THE RELEVANT ART

23. I have been asked to provide my opinions regarding the knowledge and understanding of a POSITA at the time that the '801 Patent was filed. 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 to which the claimed subject matter pertains would have the capability of understanding the scientific and engineering principles applicable to the pertinent art.

24. 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. I understand that a POSITA is not a specific real individual, but rather a hypothetical individual having qualities based on the factors above. This hypothetical person has knowledge of all prior art in the relevant field. I also understand that a POSITA is a person of ordinary creativity, not an automaton. Therefore, a POSITA has and applies common sense to modify or combine references in the prior art, and can also find any teaching, suggestion, or motivation, whether to modify or combine, whether explicit or implicit.

25. A POSITA as of September 25, 2015—the '801 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 two to four years of experience (either in academia or industry) in design, development and/or testing of lighting designs, including knowledge of LEDs and related technology for driving LEDs, or

the equivalent, with additional education substituting for experience and vice versa. Such a POSITA would have been familiar with the concepts and types of LED lighting technology described below.

VII. OVERVIEW OF THE TECHNICAL FIELD & PRIOR ART

26. The '801 Patent describes “[a]n LED tube lamp includes a tube having two ends, two end caps respectively at the ends of the tube, a power supply in one or both of the end caps, an LED light strip in the tube; and a plurality of LED light sources on the LED light strip.” EX1001, Abstract; *see also* EX1001, 1:59-62 (“The present disclosure relates to illumination devices, and more particularly to an LED tube lamp and its components including the light sources, electronic components, and end caps.”). As acknowledged by the '801 Patent, “LED lighting technology is rapidly developing to replace traditional incandescent and fluorescent lightings.” EX1001, 1:66-67. It was well-known that LED lamps were often not compatible with traditional power systems used for fluorescent lamps. EX1001, 2:57-67 (“[T]he driving of an LED uses a DC driving signal. The driving signal for a fluorescent lamp is a low-frequency and low-voltage AC signal as provided by an AC powerline, a high-frequency and high-voltage AC signal provided by a ballast, or even a DC signal provided by a battery for emergency lighting applications. Since the voltages and frequency spectrums of these types of signals differ significantly, simply performing a rectification to produce the required DC driving signal in an LED tube

lamp is not competent at achieving the LED tube lamp's compatibility with traditional driving systems of a fluorescent lamp.”). The '801 Patent purports to provide a novel LED lamp that provides more compatibility with such power systems. EX1001, 3:42-43.

A. Fluorescent lamps

27. Fluorescent lamps were in common use at the time of the '801 Patent. EX1001, 1:66-2:8. “A fluorescent lamp consists of a glass tube filled with an inert gas (usually argon) at low pressure. On each side of the glass tube is an electrode. Electricity is passed through the gas, causing an arc of illumination.” EX1007, 1:22-25. “Historically, fluorescent lamps use AC power, effectively meaning that the electrode that functions as the cathode switches back and forth.” EX1007, 2:1-3.

28. “As electrical current forms an arc through the lamp, it ionizes a higher percentage of the tube's contained gas molecules. The more molecules that are ionized, the lower the resistance of the gas. If too many gas molecules are ionized, the resistance will drop to the point that an electrical short would occur.” EX1007, 2:13-18. “Therefore, the ballast [included in the fluorescent lamp] also contains electronic components that control the current, preventing the current through the lamp from rising to the point that the lamp would burn out.” EX1007, 2:18-21. “An electrical ballast is a device that intended to limit the amount of current in an electric circuit.” EX1007, 1:45-47. “The ballast is typically physically located in a box

mounted near its lamp or lamps.” EX1007, 1:63-65. The electrical ballast “contains electronic components that control the current, preventing the current through the lamp from rising to the point that the lamp would burn out. Electronic ballasts use semiconductors to limit power to a fluorescent lamp.” EX1007, 2:18-22.

29. Some fluorescent lamps used magnetic ballasts instead of electronic ballast. EX1008, 1:24-29. A magnetic ballast can be as simple as a series inductor as shown in EX1008, Fig. 15a, or can further comprise a glow starter as depicted in EX1008, Fig. 15a and described in EX1008, 1:51-55. Alternatively, magnetic ballasts can be a rapid-start type. EX1008, FIG. 15b, 1:56-59. A rapid-start magnetic ballast includes a transformer and additional resistors and capacitors such that the LED lamp lights simultaneously with the filament pre-heat functionality.

B. Pre-heat process

30. “Fluorescent lamps often require that their filaments (electrodes) be preheated prior to lamp ignition.” EX1011, 1:12-13. “In lamps that require preheating, it is difficult to start a lamp when the filaments have not been sufficiently preheated.” EX1011, 1:38-40. “Preheating is often controlled by an automatic switch commonly referred to as a starter.” EX1011, 1:13-15. During preheating, “[c]urrent [] flows through the [starter’s] electrodes and lamp filaments heating the latter.” EX1011, 1:25-26. “Once the filaments have been preheated, one or more

large voltage pulses, generated by an ignitor, are applied to the fluorescent lamp filaments.” EX1011, 1:15-17.

31. “[A] rapid start ballast is used for fluorescent lamps having a filament (two electrode pin lamp) that is used for pre-heating before the lamp is started. A rapid start ballast applies voltage and heats the two electrode pins (the cathodes) simultaneously.” EX1007, 2:41-45. “A programmed-start ballast is a more advanced version of the rapid start ballast. . . . [P]rogrammed-start [] provides precise heating of lamp filaments and controls the pre-heat time before the startup voltage is applied, thereby reducing filament stress. The programmed-start ballast applies power to the filaments first, which allows the cathodes to preheat and then applies voltage to the lamps to strike an arc.” EX1007, 2:51-58. In contrast, “[a]n instant start ballast does not preheat the electrodes, instead using a relatively high voltage (~600 V) to initiate the discharge arc.” EX1007, 2:30-32.

C. The Rise of LED Lamps and Issues with replacing fluorescent lamps with LED lamps

32. “[T]here has been over the past decade an enormous commercial move toward replacing both incandescent and fluorescent light fixtures with light-emitting diode (LED) lighting.” EX1007, 4:13-16. “LEDs have advantages over those prior light sources: lower energy consumption, longer life, improved robustness, smaller size, and the ability to be switched on and off faster.” EX1007, 4:20-22.

33. LEDs for use in tube lamps were typically mounted in arrays on LED light strips made of various materials, including traditional printed circuit boards (PCBs) and flexible circuit boards or strips. For example, Shimasaki discloses that “[t]he substrate 61 is formed in a rectangular shape from an insulating material, for example, a tabular material such as a glass composite substrate (CEM-3) or a glass epoxy substrate (FR-4).” EX1009, 4:40-44. 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 using an adhesive or mounted on an intermediate structure like a heat dissipating element. As an example of the former, Li describes that “the substrate 310 can be fixed to the inner surface of the inner tube 11 at ends by means of a silicone-like adhesive, for example.” EX1005, [0097]. Alternatively, Ono describes that “[t]he light source unit 23 includes a plurality of light emitting elements 33 such as LED elements or EL elements, a board 34 with a mounting surface on which the plurality of light emitting elements 33 have been mounted, and a heat dissipator 35 bonded to the opposite side of the board 34 from the mounting surface.” EX1006, [0016], FIG. 1. The benefit of this structure is that heat from the LED light strip could be thermally conducted away from the LED light strip. From reviewing these references, a POSITA would have understood that there were many known ways of disposing an LED strip within and on the inner surface of a lamp tube, each supporting and securing the LED strip in place. A POSITA would have

also been familiar with methods of manufacturing LED strips. For example, Shimasaki describes how to couple multiple circuit boards such that power is provided to each LED. EX1009, Abstract, 5:45-6:40. As another example, Kawabata describes using solder pads to connect LED light strips to a power supply using solder pads. *See, e.g.*, EX1018, 11:6-61, FIGS. 7-9.

34. “Most LED fixtures drawing from AC wall receptacle power must have a driver circuitry that includes a power converter with at least a current-limiting resistor.” EX1007, 5:12-15. Therefore, replacing a traditional fluorescent lamp with an LED lamp required a different driving circuit because “[a] small change in voltage causes a large change in current. If the supplied voltage exceeds the LED’s forward voltage drop by a small amount, the current rating may be exceeded by a large amount, potentially damaging or destroying the LED. A solution is to use constant-current power supplies to keep the current below the LED’s maximum current rating.” EX1007, 5:7-12. Because “a fluorescent tube lamp requires a means to limit current flow to prevent a self-destroying positive feedback loop[,] . . . ballasted fluorescent fixtures are ubiquitous in the lighting industry.” EX1007, 5:27-31. “Replacing either an instant-start, shunted socket fluorescent lamp or a rapid-start non-shunted socket fluorescent lamp with a replacement LED tube and driver has previously required the ballast to be electrically detached or physically removed from the system, and the standard AC power wires to be attached directly to the

driver's circuitry." EX1007, 5:16-22. "Detachment can be expensive, typically requiring the services of a licensed electrician. Removal can also be time-consuming, requiring access to the ballast itself, which is often behind lamp fixture or ceiling panels." EX1007, 5:22-26. Solutions existed allowing consumers to "plug an LED tube lamp into any size compatible fluorescent fixture (with or without ballast or shunt) and have the internal circuitry utilize the supplied energy to power the LED array." EX1007, 5:37-40. These solutions included "using direct line voltage to power a secondary LED power supply while bypassing ballasted input power or physically removing the ballast altogether," "us[ing] back up battery power to supply the LED array," and creating a "self-ballasted lamp." EX1007, 5:40-45, 5:65-6:3.

35. It was known that operation of an LED lamp generates heat, which, if not dissipated, can reduce performance and damage components of an LED lighting device. EX1010, 167/367, 201/367, 203/367. It was also known that the components of the driver circuits, especially the electrolytic capacitors, were an important, if not the most important, factor in determining the reliability of LED lighting systems, and that elevated temperatures reduced the reliability of those components. Thus, a POSITA would have been interested in managing the temperature of the driver components and circuit boards. In my opinion, a POSITA was well aware of the importance of managing heat in a LED lamp. Additionally, it

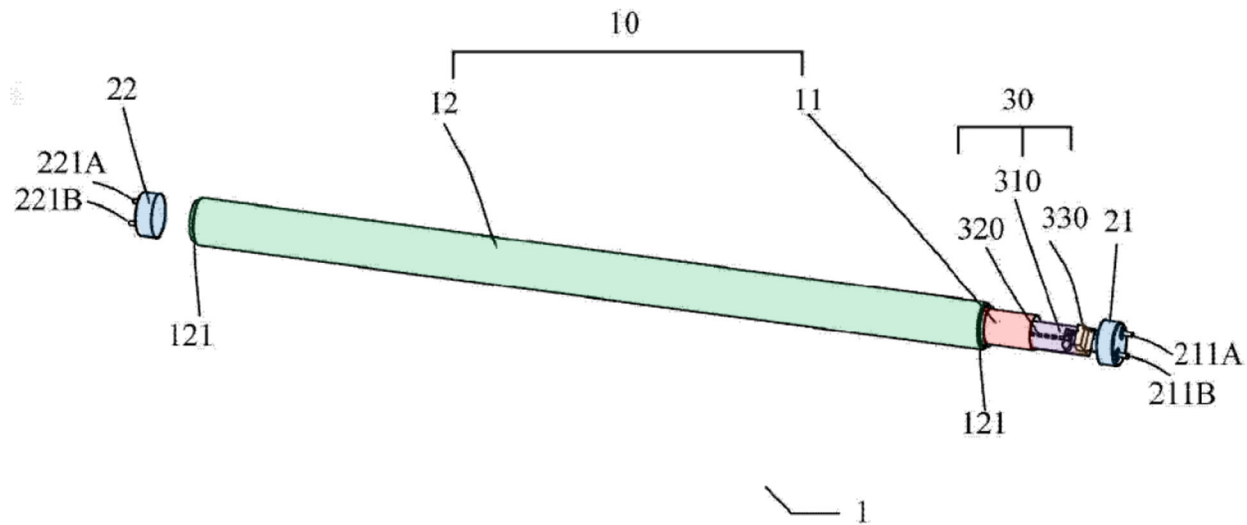
was also known to include openings in the end caps, such as to reduce pressure or heat within the tube. *See, e.g.*, EX1012, [0037], FIGS. 1, 3.

D. Li (EX1005)

36. Li is titled “LED Fluorescent Lamp and Installation Method Thereof.”

Li was published on July 2, 2014. I understand that Li qualifies as prior art to the ’801 Patent.

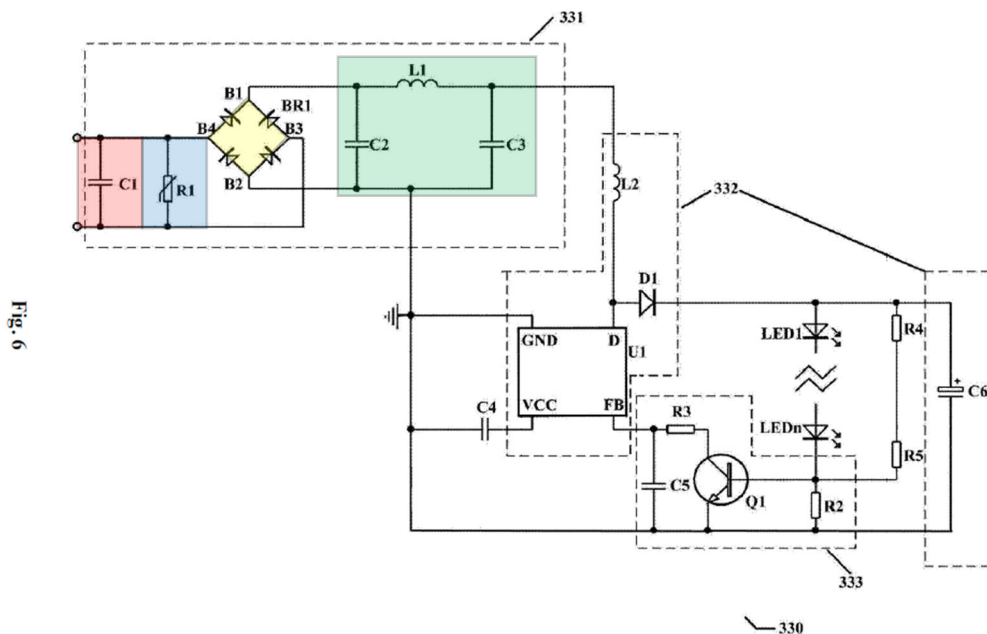
37. Li describes “[a]n LED fluorescent lamp according to an embodiment of the invention comprises: a [red] glass inner tube; a [green] glass outer tube sleeved outside the glass inner tube; [blue] end covers enclosing two ends of the glass inner tube and provided with plugs adaptable to fluorescent lamp holders; and an [orange] LED driver power supply, comprising a strip substrate fixed inside the glass inner tube, a plurality of LED units arranged on the [purple] strip substrate, and a drive circuit module, which is arranged at one or two ends of the strip substrate and electrically connected to the LED units and the plugs.” EX1005, Abstract; *see also* EX1005, [0088-0090], [0092], [0095], [0100-0101], [0108].

**Fig. 1**EX1005, FIG. 1.¹

38. Li describes the drive circuit module as making the LED lamp compatible with conventional lighting fixtures. EX1005, [0092], [0113]. “The drive circuit module 330 shown in Fig. 6 comprises a bridge rectifier filter unit 331, a DC-DC boost conversion unit 332 and a feedback unit 333.” EX1005, [0112]. This includes “a [yellow] full-bridge rectifier BR1” and [green] “filter capacitors C2 & C3 and the inductor L1 form[ing] a π -shaped filter loop.” EX1005, [0113], [0115]. “[T]he [red] filter capacitor C1 and the [blue] varistor R1 are connected in parallel between the AC input terminals B3 and B4 of the full-bridge rectifier BR1.” EX1005, [0115]. Li describes both resistors and varistors and in Figure 6, R1 is

¹ All colorized figures herein are annotated.

illustrated as a variable resistor or “varistor.” A varistor is a term of art that refers to a voltage dependent resistor where the resistance of a varistor depends on the voltage applied. *See* EX1007, 10:26-30 (“A varistor is an electronic component with diode-like but nonlinear current-voltage characteristics. At low voltage it has high resistance to current, and at high voltage it changes and becomes low resistance to current. The varistor is thus a voltage-dependent variable resistor.”).



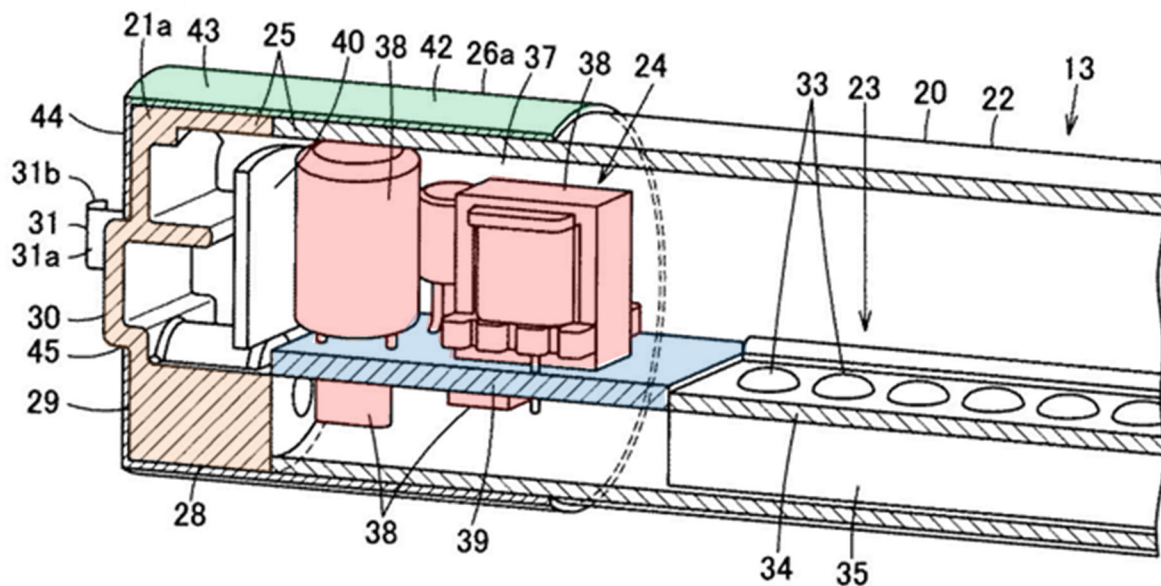
EX1005, FIG. 6.

E. Ono (EX1006)

39. Ono is titled “Straight Tube Lamp and Lighting Device.” Ono was published on June 5, 2014. I understand that Ono qualifies as prior art to the ’801 Patent.

40. “The straight tube lamp 13 includes a light source unit 23 having light emitting elements 33, a lighting circuit 24 for lighting the light emitting elements 33, and a lamp unit 22 housing the light source unit 23 and the lighting circuit 24. The lamp unit 22 includes a straight tube 20 that is at least partially translucent, and a cap 21a disposed on one end of the tube 20. The lighting circuit 24 is covered with an [orange] insulator 25, and the lighting circuit 24 is covered with a [green] non-combustible cover 26a via the insulator 25.” EX1006, [Solution].

[Fig. 1]



EX1006, FIG. 1.

41. “The lighting circuit 24 receives commercial alternating current power from the cap 21a on one end, converts the alternating current power into direct current power for lighting the light emitting elements 33, and supplies the direct

current power to the light emitting elements 33.” EX1006, [0017]. “The lighting circuit 24 is housed inside the tube 20 on one end in a lighting circuit housing portion 37 between the light source unit 23 housed inside the tube 20 and the cap 21a attached to one end of the tube 20. The lighting circuit 24 has a [blue] circuit board 39 on which a plurality of [red] electronic components 38 have been mounted. Lead components such as capacitors and inductors are mounted on the mounting surface of the circuit board 39, and surface mounted components such as resistors and switching elements are mounted on the wiring pattern surface.” EX1006.

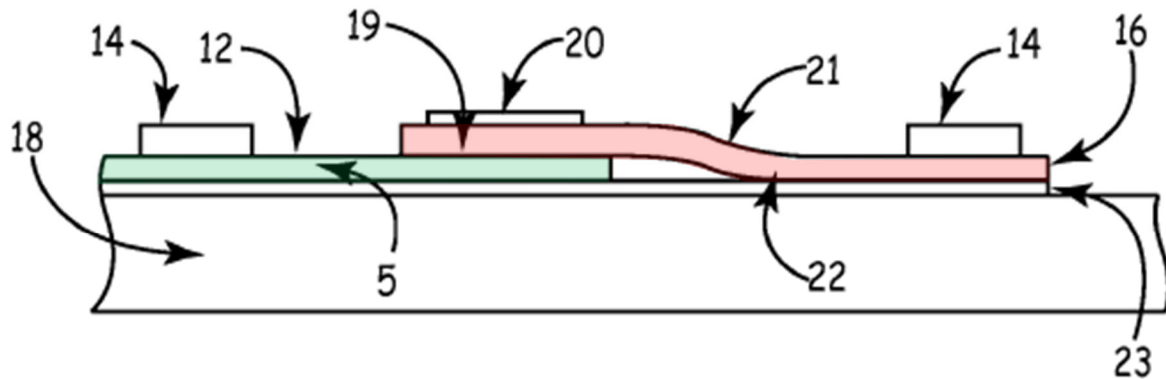
F. Holec (EX1020)

42. Holec is titled “Circuit Boards Interconnected By Overlapping Plated Through Holes Portions.” Holec was filed on March 18, 2009, and issued on August 30, 2011. I understand that Holec qualifies as prior art to the ’801 Patent.

43. Holec is directed to “the design and method of interconnecting printed circuit boards. Particularly, embodiments of the present invention disclose a method for making long or continuous circuit strips, grids, matrices or links structures using the same. More particularly, embodiments of the present invention disclose the construction of layered, semi-flexible interconnected circuits for use with high powered LEDs in Solid-State Lighting (SSL) applications.” EX1020, 1:26-34. Specifically, Holec acknowledges that “[i]n various applications, such as production of high power solid-state (LED) lighting strips it is advantageous to have

interconnections between circuit boards which are highly reliable, carry significant levels of current or voltage without loss, are protected from mechanical damage and shorting, allow various shapes and geometries of connection and are easy and efficient to apply.” EX1020, 2:35-41.

44. Holec describes “[t]he circuit boards can be overlapped for interconnection (see FIG. 4B, FIG. 5). This is very useful if the connector board contains active circuitry and it is beneficial to connect multiple boards, such as in the fabrication of arrays of boards (see FIG. 10). The overlapping connections are highly advantageous to the assembly of strips having multiple circuit boards (see FIG. 13C). In a practical application, they are used to make long circuit board strips or arrays of solid-state lighting circuits (e.g., high power LED emitters used as the individual light sources).” EX1020, 9:25-34. Specifically, Holec discloses “a connection 19 is made by either welding or soldering the conductive pads 7 from the top board 16 to the bottom board conductive pads 8 on the bottom board 12. The size of pads 7, 8 factors into both the quality of the connection and the mechanical stress the connection can sustain. Also, by embedding or closely connecting through holes 2 to pads 7, 8 the mechanical performance is improved.” EX1020, 9:47-54.

**FIG. 5**

EX1020, FIG. 5.

45. Holec's Figures 2b and 3 illustrate the conductive pads on each board where Figure 2b shows a bottom view of the top circuit board and [yellow] conductive pads 7 and Figure 3 shows a top view of the bottom circuit boards with [blue] conductive pads 8 that "are designed to match the geometry and locations of the bottom side connection pads 7." EX1020, 8:63-65, 9:3-6. Holec additionally claims "a distal end having a first electrically conductive pad located on top of the circuit board." EX1020, Claim 1, 14:32-33.

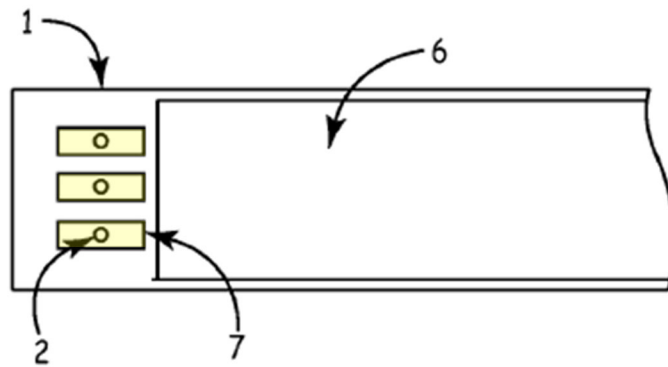


FIG. 2b

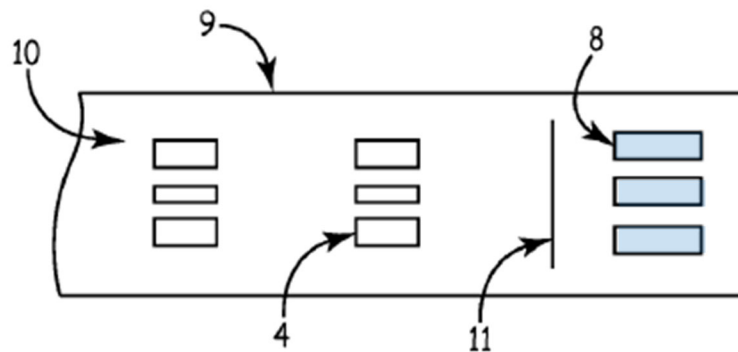


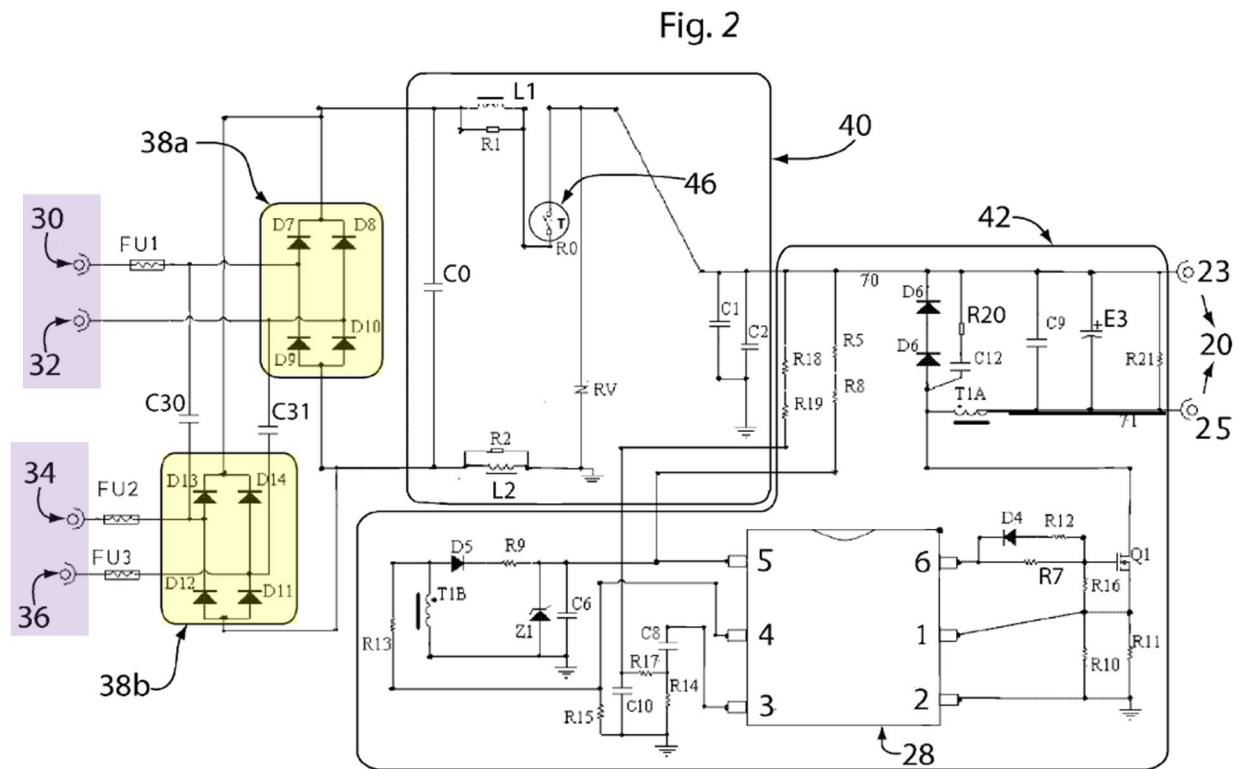
FIG. 3

Id., FIGs. 2b, 3.

G. Guang (EX1007)

46. Guang is titled “LED Tube Driver Circuitry for Ballast and Non-Ballast Fluorescent Tube Replacement.” Guang was filed on September 17, 2014. I understand that Guang qualifies as prior art to the ’801 Patent.

47. Guang discloses “[a]n LED lamp tube and driver circuit that is direct replacement for fluorescent tubes with or without ballasts, that works with standard AC high voltage current input, with high frequency pulse current input, or with lower voltage input.” EX1007, Abstract. “FIG. 2 is an electronic schematic of the power management circuitry of the Fluorescent Compatible LED Tube Lamp 10 of FIGS. 1 and 2, showing how power can be supplied through either or both pairs of [purple] electrode pins, 30, 32, or 34, 36. Incoming AC power is rectified by [yellow] parallel DC converter 38a and 38b, which then filtered by a filter circuit 40, and finally managed by a step-down constant current control circuit 40.” EX1007, 8:67-63; *see also* EX1007, 9:2-8 (“[P]ower would be supplied from external fluorescent fixtures to the first pair of electrode pins 30 and 32, to the second pair of electrode pins 34 and 36, or to a combination of pins of both pairs. The power, whether arriving at the electrodes as AC or DC is passed through the respective first rectifier circuit 38a and/or second rectifier circuit 38b.”). “Each of the first and second rectifier circuits 38a and 38b has four diodes, which each pass electrical current in only one direction.” EX1007, 9:28-30.



EX1007, FIG. 2.

H. Esaki (EX1014)

48. Esaki is titled “Lighting Apparatus and Illuminating Fixture With The Same.” Esaki was filed on December 3, 2012, published on June 6, 2013, and issued on September 16, 2014. I understand that Esaki qualifies as prior art to the ’801 Patent.

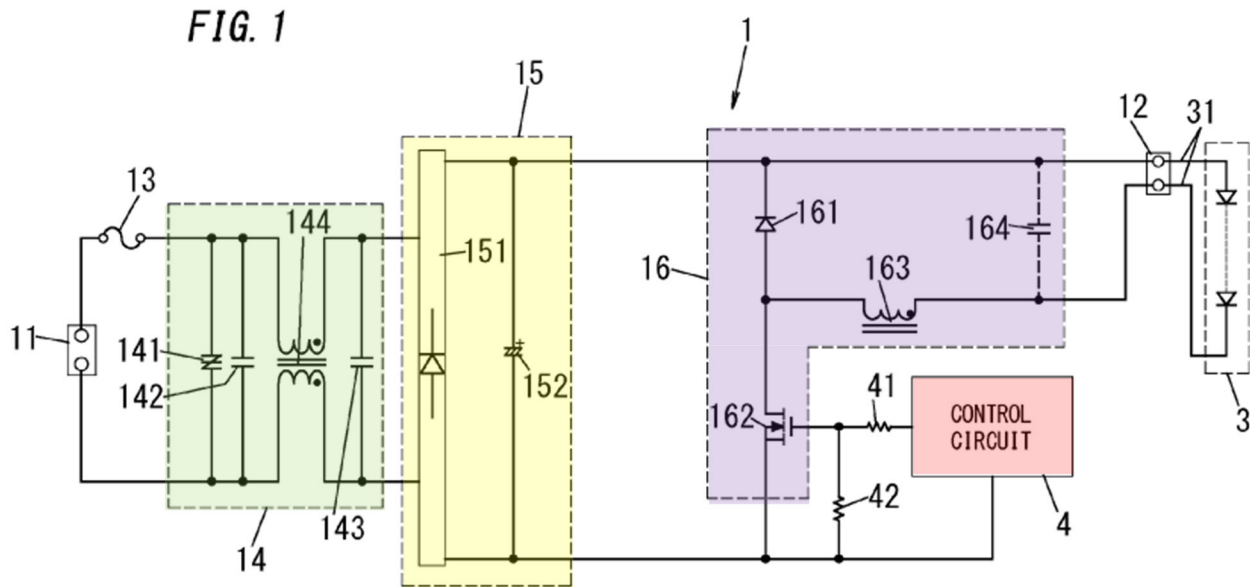
49. Esaki relates “to a lighting apparatus capable of dimming a semiconductor light emitting element and an illuminating fixture with the same.” EX1014, 1:6-10. To accomplish the disclosed dimming functionality, Esaki discloses a power supply for an LED light with “a switching regulator including a

switching element; and a control circuit configured to adjust a switching frequency and on-duration of the switching element in accordance with a dimming ratio.”

EX1014, Abstract. The power supply includes a [green] filter circuit 14, a [yellow] DC power supply circuit including a rectifier 151 a smoothing capacitor 152.

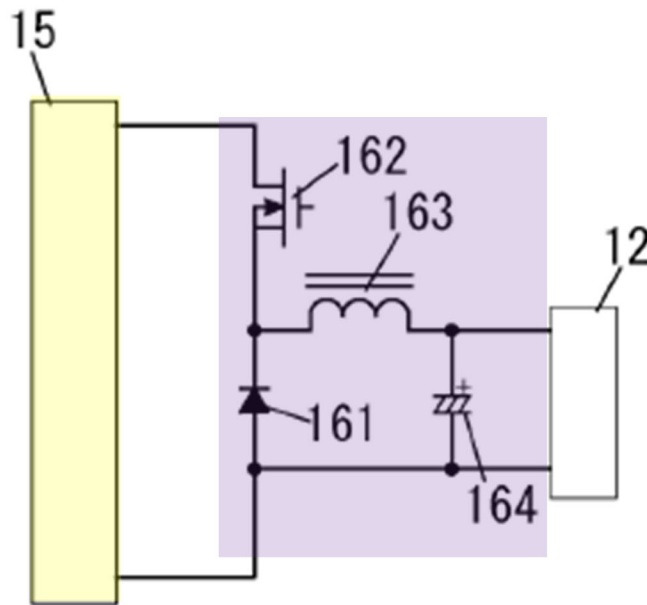
EX1014, 4:66-5:4, 5:17-19. The power supply further includes a [purple] step-down chopper (a buck converter) circuit 16 including a diode 161, a switching element 162, an inductor 163, and an output capacitor 164. EX1014, 5:35-41, 5:50-54.

Finally, the power supply includes the [red] control circuit 4 that controls the step-down chopper circuit 16. EX1014, 5:59-62. The power supply is electrically connected to the [blue] light source load 3, “comprising a semiconducting light emitting element (LED)” EX1014, 4:54-56. Further, “[t]he light source load 3 may be an LED module formed of a plurality (for example, thirty) light emitting diodes connected in series, in parallel, or in series and parallel.” EX1014, 4:58-61.



EX1014, FIG. 1.

50. Esaki describes different configurations for step-down chopper circuit 16. EX1014, 4:35-42. In one configuration, the step-down chopper circuit is arranged such that the anode of the diode 161 is connected to the output of power supply circuit 15, the switching element 162 and the inductor 163 are connected to the cathode of the diode 161, and the inductor 163 is further connected to the output connector 12, which is further connected to the light source module 3. EX1014, 25:64-26:6, FIG. 16.

FIG. 16

EX1014, FIG. 16.

VIII. THE '801 PATENT

51. The '801 Patent describes “[a]n LED tube lamp includes a [blue] tube having two ends, two [orange] end caps respectively at the ends of the tube, a [green] power supply in one or both of the end caps, an [red] LED light strip in the tube; and a [yellow] plurality of LED light sources on the LED light strip.” EX1001, Abstract; *see also* EX1001, 98:59-99:13.

52. “The part of the end wall 320 which is connected to the hollow conductive pins 301 is made by an insulating material, and the other part of the end wall 320 is made by aluminum.” EX1001, 106:22-25. “Each of the end caps 300

comprises a [purple] pair of hollow conductive pins 301 utilized for being connected to an outer electrical power source.” EX1001, 99:34-36.

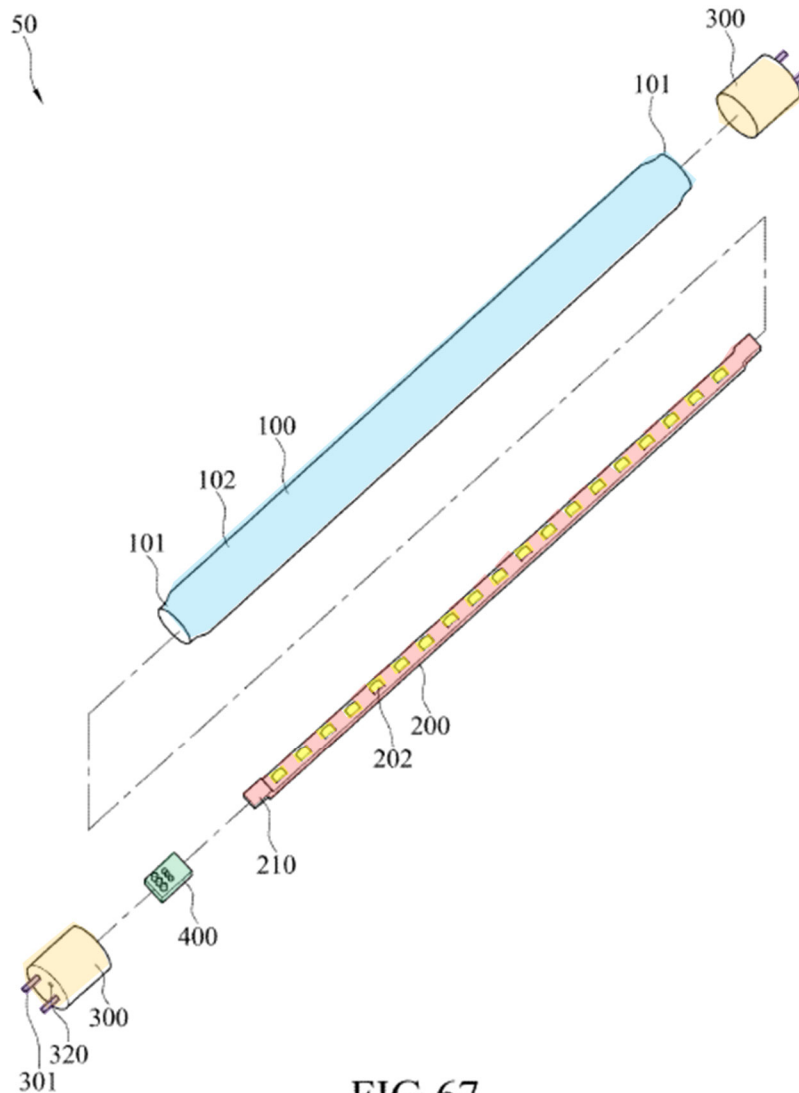


FIG. 67

EX1001, FIG. 67.

53. “The [blue] power supply 400 can be a module, e.g., an integrated power module. The power supply 400 may be in the form of a single integrated unit

(e.g., with all components of the power supply 400 are within a body) disposed in an end cap 300 at one end of the tube 100.” EX1001, 101:62-66.

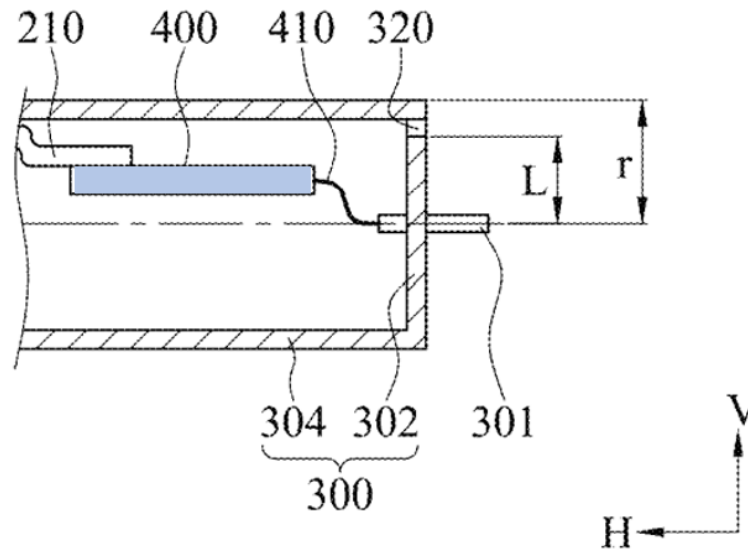


FIG. 69

EX1001, FIG. 69.

54. “The power supply 400 shown in FIG. 83 comprises a [blue] printed circuit board 420, one or more [red] electronic components 430, and a heat-dissipating element or driving module 440.” EX1001, 107:46-49. The electronic components include components such as rectifying circuits, filtering circuits, resistors, capacitors, inductors, and integrated circuits. EX1001, 3:66-7, 5:13-15.

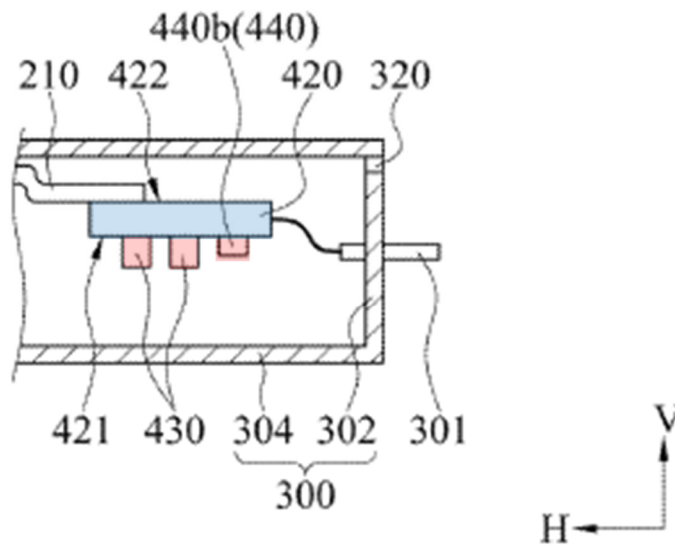


FIG. 83

EX1001, FIG. 83.

55. The '801 Patent describes prior art LED lamps and associated drawbacks. EX1001, 1:66-3:20. Specifically, “existing LED tube lamps have certain drawbacks. For example, the electrical components and fuses in the LED tube lamps may not perform properly due to increasing temperature inside the LED tube lamps during the use of the LED tube lamps. Specifically, the fuses very likely incorrectly cause open circuit in responsive to high environment temperature inside the LED tube lamps instead of high electrical current flow. The electrical components operate in unexpected ways which are different from circuit design.” EX1001, 2:18-27. Additionally, heat dissipation can also be a problem. EX1001, 2:53-56. Further, “the driving of an LED uses a DC driving signal. The driving

signal for a fluorescent lamp is a low-frequency and low-voltage AC signal as provided by an AC powerline, a high-frequency and high-voltage AC signal provided by a ballast, or even a DC signal provided by a battery for emergency lighting applications. Since the voltages and frequency spectrums of these types of signals differ significantly, simply performing a rectification to produce the required DC driving signal in an LED tube lamp is not competent at achieving the LED tube lamp's compatibility with traditional driving systems of a fluorescent lamp.”

EX1001, 2:57-67. “[A]n LED is a nonlinear component with significantly different characteristics from a fluorescent lamp. Therefore, using an LED tube lamp with an electrical ballast impacts the resonant circuit design of the electrical ballast, causing a compatibility problem. Generally, a program-start ballast will detect the presence of a filament in a fluorescent lamp, but traditional LED driving circuits cannot support the detection and may cause a failure of the filament detection and thus failure of the starting of the LED tube lamp. Further, electrical ballast is in effect a current source, and when it acts as a power supply of a DC-to-DC converter circuit in an LED tube lamp, problems of overvoltage and overcurrent or undervoltage and undercurrent are likely to occur, resulting in damaging of electronic components in the LED tube lamp or unstable provision of lighting by the LED tube lamp.”

EX1001, 3:5-20.

56. To overcome the purported shortcomings, the '801 Patent proposes an LED tube lamp having a power supply including electronic components where “[a]t least some of the electronic components comprise a rectifying circuit having at least two input terminals and configured to rectify signal receiving from the input terminals. At least one of the electronic components comprises a filtering circuit electrically connecting to the rectifying circuit.” EX1001, 3:66-4:4. The rectifying circuit is configured to rectify the external driving signal to produce a rectified signal. EX1001, 43:35-37. The filtering circuit is connected to the rectifying circuit and configured to produce a filtered signal. EX1001, 41:50-52. As I explained above in Section VII, it was well-known before the '801 Patent to perform such rectifying and filtering.

A. Challenged Claims

57. I understand that claims 13-25 of the '801 Patent are challenged claims. Claim 13 is independent. Claims 14-25 depend from independent claim 13.

58. '801 Claim 13 reads:

13[p] An LED tube lamp, comprising:

13[a] a glass tube having two ends;

13[b] an LED light strip attached to an inner circumferential surface of the glass tube;

13[c] a plurality of LED light sources mounted on the LED light strip;

13[d] a power supply module electrically connecting to the LED light strip and configured to drive the plurality of LED light sources; and

13[e1] a first end cap and a second end cap respectively attached at the two ends of the glass tube, each of the first and second end caps comprising a lateral wall and an end wall, the lateral wall substantially being coaxial with the glass tube and connecting to the glass tube, the end wall substantially being perpendicular to an axial direction of the lateral wall and connecting to an end of the lateral wall away from the glass tube,

13[e2] wherein the end wall comprises an insulating portion made of an insulating material and at least one opening being on the end wall,

13[f] wherein the power supply module comprises a printed circuit board and a plurality of electronic components mounted on the printed circuit board, the printed circuit board comprises a first surface and a second surface opposite to and substantially parallel to the first surface, and the first surface and the second surface of the printed circuit board are substantially parallel with the axial direction of the lateral wall;

13[g1] wherein at least some of the plurality of electronic components comprise a rectifying circuit having at least two input terminals and configured to rectify signal receiving from the at least two input terminals,

13[g2] at least one of the plurality of electronic components comprises a filtering circuit electrically connecting to the rectifying circuit;

13[h] wherein the plurality of electronic components comprise a resistor which is positioned close to the end wall of the first end cap and connecting to one of the input terminals of the rectifying circuit.

59. '801 Claim 14 reads:

The LED tube lamp according to claim 13, wherein the LED light strip comprises two first soldering pads arranged at one end of the LED light strip and the two first soldering pads respectively electrically connect to two second soldering pads on the printed circuit board.

60. '801 Claim 15 reads:

The LED tube lamp according to claim 14, wherein the printed circuit board is disposed on an end of the LED light strip.

61. '801 Claim 16 reads:

The LED tube lamp according to claim 15, wherein the two first soldering pads are arranged on the end of the LED light strip on which the printed circuit board is disposed.

62. '801 Claim 17 reads:

The LED tube lamp according to claim 15, wherein each of the end caps comprises two conductive pins connected to the insulating portion thereof, and the resistor is electrically connected between one of the two conductive pins and one of the input terminals of the rectifying circuit or between the two conductive pins.

63. '801 Claim 18 reads:

18[a] The LED tube lamp according to claim 17, wherein the rectifying circuit comprises: a first full-wave bridge rectifying circuit, having two input terminals electrically connected to the two conductive pins of one of the end caps, respectively, and having a positive output terminal and a negative output terminal; and

18[b] a second full-wave bridge rectifying circuit, having two input terminals electrically connected to the two conductive pins of the other one of the end caps, respectively, and having a positive output terminal and a negative output terminal,

18[c] wherein the positive output terminals of the first and the second full-wave bridge rectifying circuits are electrically connected to each other, and the negative output terminals of the first and the second full-wave bridge rectifying circuits are electrically connected to each other.

64. '801 Claim 19 reads:

19[a] The LED tube lamp according to claim 18, wherein the filtering circuit comprises: an inductor, having an end electrically connected to the positive output terminals of the first and the second full-wave bridge rectifying circuits, and the other end regarding as one of the filtering output terminals;

19[b] a first capacitor, having an end electrically connected to the end of the inductor, and the other end electrically connected to the negative output terminals of the first and the second full-wave bridge rectifying circuits; and

19[c] a second capacitor, having an end electrically connected to the other end of the inductor, and the other end regarding as the other one of the filtering output terminals.

65. '801 Claim 20 reads:

20[a] The LED tube lamp according to claim 17, wherein the rectifying circuit comprises: a full-wave bridge rectifying circuit, having two input terminals electrically connected to the two conductive pins of one of the end caps, respectively, and having a positive output terminal and a negative output terminal; and

20[b] a half-wave bridge rectifying circuit, having an input terminal electrically connected to one of the two conductive pins of the other one of the end caps, and having a positive output terminal and a negative output terminal,

20[c] wherein the positive output terminals of the full-wave bridge rectifying circuit and the half-wave bridge rectifying circuit are electrically connected to each other, and the negative output terminals of the full-wave bridge rectifying circuit and the half-wave bridge rectifying circuit are electrically connected to each other.

66. '801 Claim 21 reads:

The LED tube lamp according to claim 20, wherein the filtering circuit comprises: a first capacitor, having an end electrically connected to the positive output terminals of the full-wave bridge rectifying circuit and the half-wave bridge rectifying circuit, and the other end electrically connected to the negative output terminals of the first and the second full-wave bridge rectifying circuits.

67. '801 Claim 22 reads:

22[a] The LED tube lamp according to claim 21, wherein the filtering circuit further comprises: an inductor, having an end electrically connected to the end of the first capacitor, and the other end regarding as one of the filtering output terminals; and

22[b] a second capacitor, having an end electrically connected to the other end of the inductor, and the other end regarding as the other one of the filtering output terminals.

68. '801 Claim 23 reads:

The LED tube lamp according to claim 21, wherein the filtering circuit further comprises: an EMI-reducing capacitor, coupled between the two conductive pins of one of the end caps.

69. '801 Claim 24 reads:

24[a] The LED tube lamp according to claim 17, wherein at least some of the electronic components form a driving circuit electrically connected to the filtering output terminals of the filtering circuit and have two driving output terminals electrically connected to the LED light strip; and further wherein the driving circuit comprise: a controller;

24[b] a diode, having an anode electrically connected to one of the filtering output terminals and one of the driving output terminals;

24[c] a switch, having a first terminal coupled to the other one of the filtering output terminals, a second terminal electrically connected to a cathode of the diode, and a control terminal coupled to the controller, wherein the switch is turned on or off in response to a signal received from the controller; and

24[d] an inductor, having an end electrically connected to the second terminal of the switch, and another end electrically connected to the LED light strip via the other one of the driving output terminals.

70. '801 Claim 25 reads:

The LED tube lamp according to claim 24, wherein the electronic components forming the driving circuit further comprise: a capacitor, electrically connected between the driving output terminals.

B. Prosecution History

71. I have reviewed the prosecution history of the '801 Patent. The '801 Patent issued from an application filed on January 15, 2020, U.S. Patent Application No. 16/743,526.

72. The first non-final office action, issued by the Examiner on June 15, 2020, included rejections of claims 1 and 13 based on non-statutory double patenting

over U.S. Patent No. 10,560,989, a parent patent to the '801 Patent. EX1002, 341/675. The Applicant filed a terminal disclaimer to advance prosecution, despite disputing the double-patenting rejection. EX1002, 297-300/675. Additionally, the Applicant added new claims 30-41. EX1002, 290-292/675.

73. The Examiner issued a Notice of Allowance. In the Notice, the Examiner indicated that “the prior arts of record fail to disclose or suggest wherein the end wall comprises an insulation portion made of an insulating material and at least one opening being on the end wall, as required by claims 1 and 13.” EX1002, 44/675.

C. Claim Construction

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

1. “electrically connected” / “electrically connecting”

75. It is my opinion that the term “electrically connected” should be construed as “connected through wires or other intervening electrical components.” “Electrically connected” is found in claims 17-25. A POSITA would have understood that to be “electrically connected,” components do not require a direct connection, *i.e.*, with no intervening electrical components or modules.

76. The '801 Patent distinguishes between “electrically connected” and “directly electrically connected”:

As used herein, items described as being “electrically connected” are configured such that an electrical signal can be passed from one item to the other. . . . Moreover, items that are “directly electrically connected,” to each other are electrically connected through one or more passive elements, such as, for example, wires, pads, internal electrical lines, resistors, etc. As such, directly electrically connected components do not include components electrically connected through active elements, such as transistors or diodes.

EX1001, 16:13-28. Therefore, the '801 Patent itself confirms my opinion that the construction is correct.

2. *“attached to an inner circumferential surface of the glass tube”*

77. In my opinion, “attached to an inner circumferential surface of the lamp tube” means either directly attached, with no intervening components, or indirectly attached, with at least one intermediate component. My opinion is informed by the '801 Patent. The '801 Patent describes the LED light strip as being fixed to the inner surface of the glass tube by an adhesive sheet. EX1001, 30:46-56. Additionally, the '801 Patent describes embodiments where the LED light strip is “directly bonded” to the inner circumferential surface of the glass tube. EX1001, 33:8-12. Therefore, the patent describes both directly attached, with no intervening components, or indirectly attached, with at least one intermediate component.

3. “coupled”

78. In my opinion, the term “coupled,” as used in the ’801 Patent has the same meaning as “connected.” The ’801 Patent equates the terms “coupled” and “connected” and uses the terms interchangeably throughout the specification. *See, e.g.,* EX1001, 15:13-25 (“It will be understood that when an element is referred to as being ‘connected’ or ‘coupled’ to or ‘on’ another element, it can be directly connected or coupled to or on the other element or intervening elements may be present. In contrast, when an element is referred to as being ‘directly connected’ or ‘directly coupled’ to another element, there are no intervening elements present. Other words used to describe the relationship between elements should be interpreted in a like fashion (e.g., ‘between’ versus ‘directly between,’ ‘adjacent’ versus ‘directly adjacent,’ etc.). However, the term ‘contact,’ as used herein refers to direct contact (i.e., touching) unless the context indicates otherwise.”).

IX. COMPARISON OF PRIOR ART TO ’801 PATENT’S CHALLENGED CLAIMS

A. Ground 1 - Claims 13-17 are Obvious over Li in view of Ono and Holec

1. *Motivation to Combine Li, Ono, and Holec*

79. Li discloses an LED lamp including a drive circuit that makes the lamp compatible with standard fluorescent light fixtures. EX1005, [0092], [0113]. The drive circuit is “connected between an alternating current (AC) or direct current

(DC) power supply outside the lighting device and the light emitting diode as a light source, and is used to provide the required current or voltage (e.g., constant current, constant voltage or constant power) to the light emitting diode.” EX1005, [0082]. “[T]he components of the drive circuit module 330 are arranged at two ends of the substrate 310.” EX1005, [0101], *see also* EX1005, Abstract, [0108]. Li teaches that “the driver power supply can be achieved in a modular structure” and “comprises a printed circuit board and one or more components mounted on the printed circuit board and electrically connected together by means of wiring.” EX1005, [0082]; *see also* EX1005, Abstract, [0100], [0108]. “Examples of these components include but are not limited to LED drive controller chips, rectifier chips, resistors, capacitors and coils.” EX1005, [0082]. However, Li does not explicitly describe how the PCB would be arranged to create that modular structure.

80. To understand how to implement Li’s drive circuit at the end of substrate 310 within the LED tube and on a circuit board that fits into an end cap of the LED lamp, in my opinion, a POSITA would have been motivated to look for the details Li lacks in a reference like Ono for an example of installing capacitors, resistors, and other electronic components on a printed circuit board (“PCB”) and positioning that PCB in the end cap. Specifically, Ono describes a “lighting circuit 24 [that] has a circuit board 39 on which a plurality of electronic components 38 have been mounted. Lead components such as capacitors and inductors are mounted

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

EX1006, [0017]. “The lighting circuit 24 is housed inside the tube 20 on one end in a lighting circuit housing portion 37 between the light source unit 23 housed inside the tube 20 and the cap 21a attached to one end of the tube 20.” EX1006, [0017].

There are many reasons a POSITA would have been motivated to configure the ends of Li’s lamp, including the physical format of its circuit on a PCB, with the insulator end caps within a non-combustible cover of Ono.

81. Li also does not describe how a POSITA would manufacture Li’s drive circuit in an LED lamp. Therefore, a POSITA would have been motivated to look to other references to determine how to manufacture a drive circuit, mounted on a PCB, in an LED lamp. Such a reference would need to describe how to connect the drive circuit to the light strip such that power would be provided to the LEDs on the light strip. Holec is an example of a reference a POSITA would have identified as describing manufacturing techniques for LED lamps. Holec describes how to connect PCB substrates in circuitry for LED lamps. EX1020, Abstract, 1:26-34. Specifically, Holec is directed to “the design and method of interconnecting printed circuit boards. Particularly, embodiments of the present invention disclose a method for making long or continuous circuit strips, grids, matrices or links structures using the same. More particularly, embodiments of the present invention disclose the

construction of layered, semi-flexible interconnected circuits for use with high powered LEDs in Solid-State Lighting (SSL) applications.” EX1020, 1:26-34. Specifically, Holec acknowledges that “[i]n various applications, such as production of high power solid-state (LED) lighting strips it is advantageous to have interconnections between circuit boards which are highly reliable, carry significant levels of current or voltage without loss, are protected from mechanical damage and shorting, allow various shapes and geometries of connection and are easy and efficient to apply.” EX1020, 2:35-41.

82. For example, in my opinion, a POSITA would have implemented Li’s drive circuit on a PCB as described by Ono. Specifically, a POSITA would have been motivated to use Ono’s drive circuit configuration in the lamp end as taught by Li. EX1005, Abstract, [0082], [0100], [0108]. For example, Ono describes that arranging electronic components on different sides on a PCB provides certain advantages. Specifically, “by forming the insulator 25 from the end portion of the tube 20 and the cap 21a, a separate insulating member is not required, the number of parts can be reduced, and assembly is more efficient” and “[w]hen the lighting circuit 24 has electronic components 38 arranged only on one side of the circuit board 39, the other side of the circuit board 39 does not have to be covered with the non-combustible cover 26a. In this case, the side of the circuit board 39 on which the electronic components 38 have been arranged faces the side opposite to the mounting

surface of the board 34 on which the light emitting elements 33 have been mounted, that is, the side opposite the direction in which the light from the light emitting elements 33 is emitted. In this way, a non-combustible cover 26a does not have to be arranged on the light emitting side, and light is not blocked by the non-combustible cover 26a. This improves illumination efficiency.” EX1006, [0030], [0046]. Further, Ono describes improved reliability and efficiency: “because [its] non-combustible cover 26a has a lighting circuit covering portion 42 that covers the periphery of the lighting circuit 24, . . . covering the periphery of the lighting circuit 24, which is susceptible to heat damage, with the non-combustible cover 26a creates a reliable non-combustible structure.” EX1006, [0031]. Thus, a POSITA would have been motivated to implement Ono’s lamp-end structure (the physical format Li’s circuit on Ono’s dual-sided circuit board and Ono’s insulator end caps) to reduce the number of parts and improve the efficiency of assembly, as well as to improve safety due to the inclusion of a reliable non-combustible structure surrounding the power circuit.

83. It would have been obvious to a POSITA to try the PCB implementation described in Ono with Li’s drive circuit to because there were a finite number of possible solutions that would have been identifiable and predictable to a POSITA. For example, Li teaches that the “the strip substrate is an aluminum substrate or double-sided printed circuit board.” EX1005, [0021]. Li further

describes that “[t]he driver power supply module 330 can adopt circuits with various topological structures,” and “comprises a printed circuit board and one or more components mounted on the printed circuit board and electrically connected together by means of wiring.” EX1005, [0082], [0109]. Ono likewise describes a “circuit board 39 on which a plurality of electronic components 38 have been mounted,” such as capacitors and inductors mounted on one surface, and resistors and switches mounted on another surface. EX1006, [0017]. A POSITA would have recognized a design need for implementing Li’s not fully described drive circuit and would have looked to Ono’s PCB structure that also taught a double-sided PCB but with a particular arrangement of components. In doing so, a POSITA would have expected this implementation to be successful and yield predictable results based on the stability of the technology and straight-forward implementation of the technology.

84. Further, a POSITA would have found it obvious to try implementing Ono’s insulating material for end caps within a non-combustible cover with Li’s end covers because there were a finite number of identified, predictable solutions a POSITA would have pursued. For example, Li describes that an objective of the invention is “a simple manufacturing process.” EX1005, [0006]. Ono explains that “by forming the insulator 25 from the end portion of the tube 20 and the cap 21a, a *separate insulating member is not required*, the number of parts can be reduced, and assembly is *more efficient*.” EX1006, [0030] (emphasis added). Thus, a

POSITA would have been motivated to implement Ono's known end cap structure to reduce the number of parts and improve the efficiency of assembly with a reasonable expectation of success.

85. Using the manufacturing process described in Holec would have also contributed to achieving Li's goal of improving manufacturing techniques and reliability because Holec discloses techniques that improve the reliability of the LED lamp. EX1020, 4:64-5:7 ("The inventors of embodiments of the present invention have developed an alternative interconnection design and method of connection replacing or augmenting the use of rigid connectors, wires, cables or flex circuits. This connection design works effectively with a variety of printed circuit boards, shapes and sizes. This method of interconnect uses thin substrate printed circuit boards specially designed for surface mount and manual soldering to join circuit boards. The connection design is desirable for several reasons, not only for ease of assembly, but also for the structure, appearance and reliability of the connection.").

86. A POSITA would have understood that the substitution of Ono's known PCB structure for Li's drive circuit and Ono's insulating end-caps for Li's end covers would have predictable results. Li describes that its drive circuit uses a double-sided PCB (EX1005, [0021]) and Ono describes lighting circuit 24 as a double-sided PCB with a specific configuration of well-known components (EX1006, [0017]). Both Li's drive circuit and Ono's lighting circuit 24 serve the

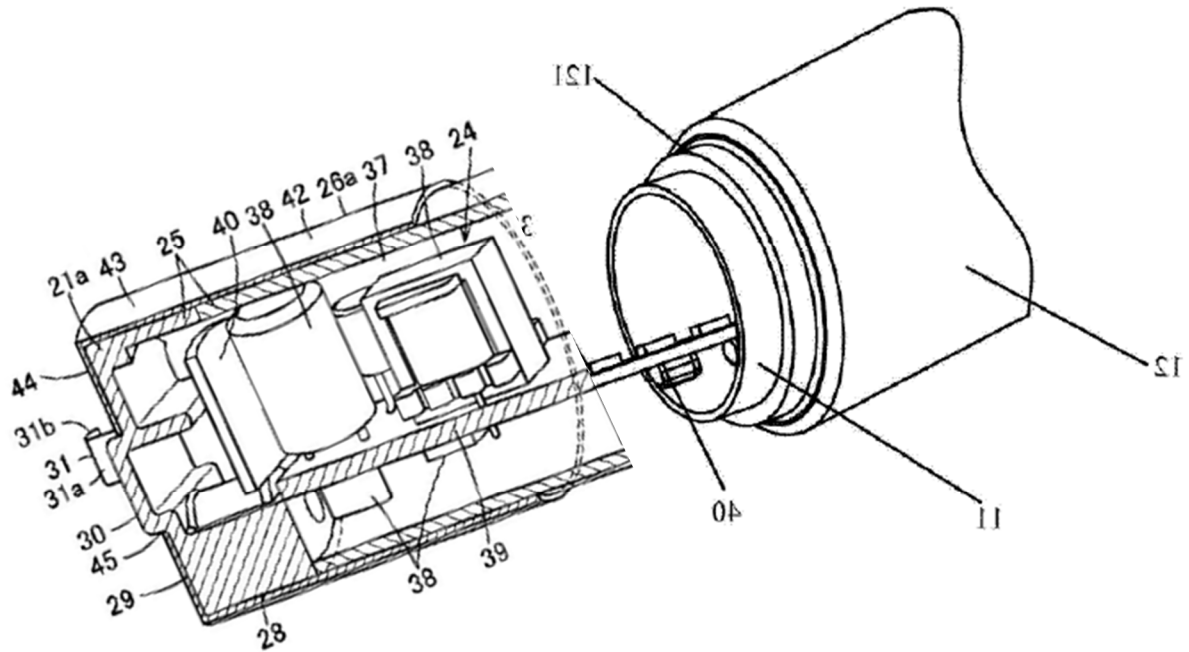
same purpose: providing power to LED lamps. EX1006, [0017]; EX1005, [0082]. Therefore, a POSITA would have understood that Ono's teachings of mounting components on a double-sided PCB would be used to implement Li's drive circuit on a double-sided PCB. Similarly, both Li and Ono describe end caps to enclose the end of a glass tube and provide external electrical connection. EX1006, [0013]; EX1005, Abstract. Thus, a POSITA would have understood that the simple substitution of Ono's PCB structure and end caps for Li's drive circuit and end covers would have predictable results.

87. A POSITA would have also understood that implementing Holec's method of joining circuit boards in an LED lamp would have been an obvious solution to try because circuit board joining techniques, like soldering, were well developed and stable. A POSITA would have expected to be able to solder Li's drive circuit to Li's LED light strip substrate using Holec's soldering method (EX1020, Abstract) because it disclosed using joining techniques that would have been straight-forward to implement in Li using techniques that a POSITA would have expected to work. Further, a POSITA would have expected that Holec's circuit board joining techniques could be used to join circuit boards in any LED lamp, not just Holec's. A POSITA would have understood that Holec's techniques could be substituted in any implementation that required joining two circuit boards and providing a way to electrically couple components on each circuit board.

88. Further, a POSITA would have expected the implementation on Ono's lamp-end configuration in the ends of Li's LED lamp to be successful. Ono itself successfully implements its lamp-end configuration in LED tube lamps used to replace conventional fluorescent bulbs. This is an identical application as Li. Ono's dual-sided PCB structure is also consistent with Li's teaching that "[p]referably, . . . the strip substrate is an aluminum substrate or double-sided printed circuited board [PCB]." EX1005, [0021]. Thus, a POSITA would have understood that Ono's lamp-end configuration could easily be incorporated into Li's LED lamp because the technology for installing electronic components on a PCB was well developed and the installation would have been straight-forward for a POSITA to implement using known technology. A POSITA would have expected the combination to be successful.

2. Modification of Li in view of Ono and Holec

89. A POSITA would have been motivated to modify the Li LED lamp with Ono's lighting circuit PCB and insulated end caps to create the Li-Ono lamp, as shown below.



Li FIG. 3
(Modified per Li-Ono-Holec)

EX1005, FIG. 3; EX1006, FIG. 1.

90. A POSITA would have been motivated to use Holec's method of soldering two circuit boards together to connect Ono's PCB to Li's LED light strip substrate.

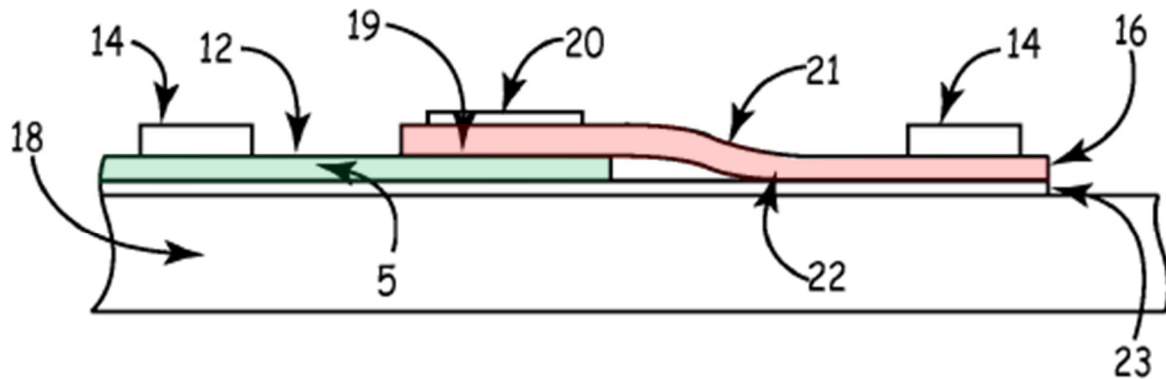


FIG. 5

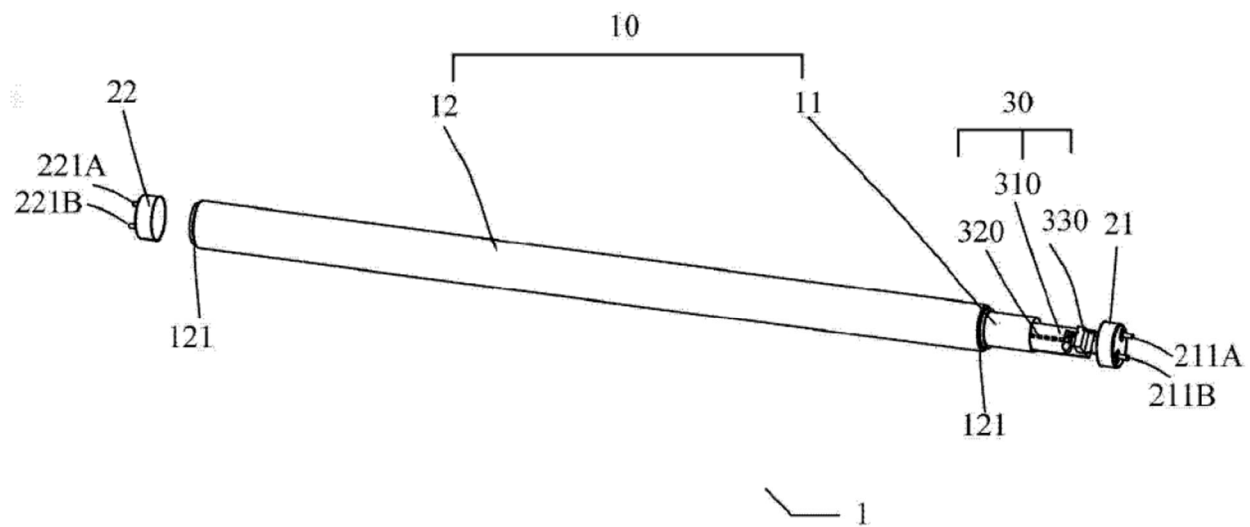
EX1020, FIG. 5.

3. *Element-by-Element Analysis*

Limitation 13[p]: “An LED tube lamp, comprising:”

91. It is my opinion that the combination of Li, Ono, and Holec renders obvious an LED tube lamp. Li describes an “LED fluorescent lamp 1 shown in Fig. 1 comprises a tube body 10, a pair of end covers 21 & 22 located at two ends of the tube body 10, and an LED driver power supply 30 located inside the tube body 10.”

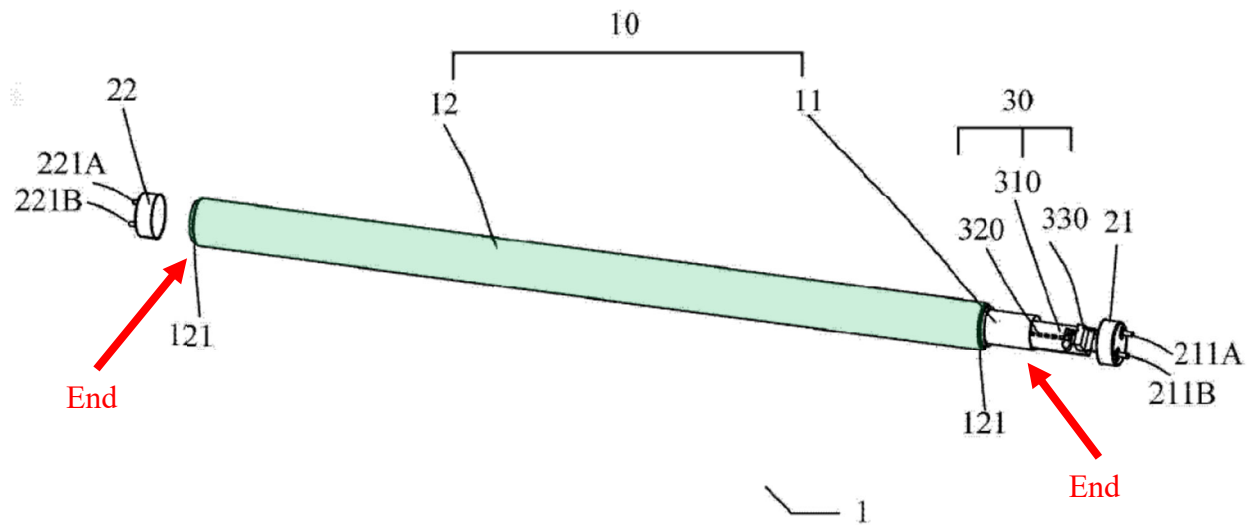
EX1005, [0088]. Li's tube lamp is shown in Figure 1:

**Fig. 1**

EX1005, [0088]; FIG. 1.

Limitation 13[a]: “a glass tube having two ends;”

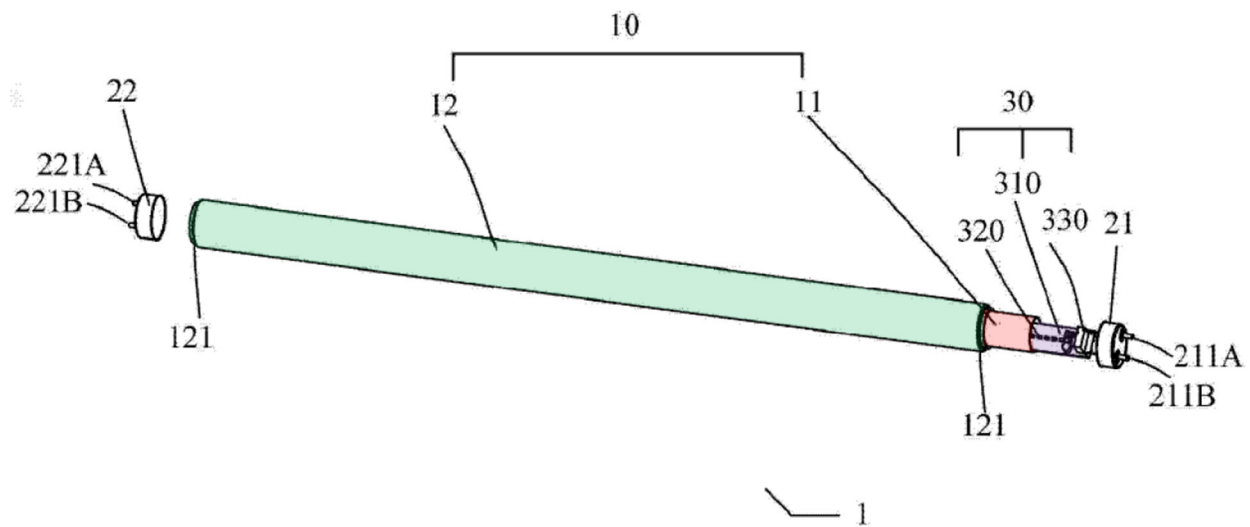
92. It is my opinion that the combination of Li, Ono, and Holec renders obvious a glass tube with two ends. The LED lamp tube body “comprises an [red] inner tube 11 and an [green] outer tube 12 sleeved outside the inner tube 11 and they may be made of a glass material.” EX1005, [0089]. Li’s Figure 1 shows that both the inner and outer tubes have ends.

**Fig. 1**

EX1005, [0089], FIG. 1.

Limitation 13[b]: “an LED light strip attached to an inner circumferential surface of the glass tube;”

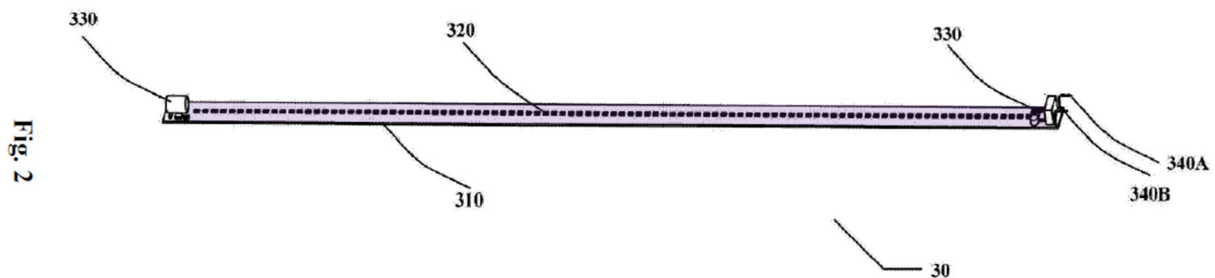
93. It is my opinion that the combination of Li, Ono, and Holec renders obvious an LED light strip inside the tube. Li teaches that inside the [red] inner glass tube is “a plurality of LED units 320 [that] are arranged longitudinally along the [purple] substrate 310.” EX1005, [0098]. “The substrate 310 of the LED power supply 30 is fixed to the inside of the inner tube 11 at ends by means of a silicone-like adhesive, for example.” EX1005, [0097].

**Fig. 1**

EX1005, FIG. 1.

Limitation 13[c]: “a plurality of LED light sources mounted on the LED light strip;”

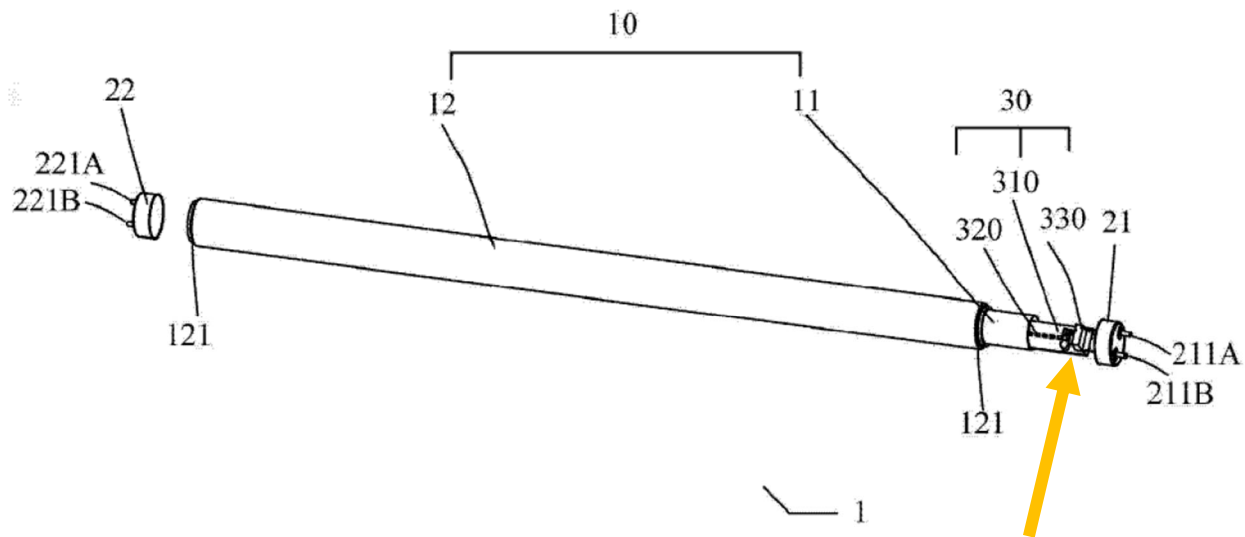
94. It is my opinion that the combination of Li, Ono, and Holec renders obvious multiple LED light sources mounted on the LED light strip. Li discloses a ceramic or composite substrate that includes “a plurality of LED units 320 [] arranged longitudinally along the [purple] substrate 310.”



EX1005, [0096], [0098], FIG. 2.

Limitation 13[d]: “a power supply module electrically connecting to the LED light strip and configured to drive the plurality of LED light sources; and”

95. It is my opinion that the combination of Li, Ono, and Holec renders obvious a power supply connected and providing power to the LED light sources. Li discloses “a[n] [orange] drive circuit module” in the LED light. EX1005, Abstract. The “drive circuit module, which is arranged at one or two ends of the strip substrate and electrically connected to the LED units and the plugs.” EX1005, Abstract.

**Fig. 1**

EX1005, FIG. 1.

96. The drive circuit module is “connected between an alternating current (AC) or direct current (DC) power supply outside the lighting device and the light emitting diode as a light source, and is used to provide the required current or voltage (e.g., constant current, constant voltage or constant power) to the light emitting diode.” EX1005, [0082]. Therefore, the drive circuit module provides power to drive the LED light sources attached to the substrate.

Limitation 13[e1]: “a first end cap and a second end cap respectively attached at the two ends of the glass tube, each of the first and second end caps comprising a lateral wall and an end wall, the lateral wall substantially being coaxial with the glass tube and connecting to the glass tube, the end wall

substantially being perpendicular to an axial direction of the lateral wall and connecting to an end of the lateral wall away from the glass tube,”

97. It is my opinion that the combination of Li, Ono, and Holec renders obvious end caps attached to each end of the tube, each having lateral and end walls. Li's LED light includes “[blue] end covers 21 and 22 [that] enclose the two ends of the inner tube 11.” EX1005, [0092]. As shown in Figure 1, the end caps have a cylindrical structure. The sides of the cylinder (“a lateral wall”) are parallel (e.g., coaxial) with the length of the tube. The end of the cylinder (“an end wall”) is perpendicular to the side of the cylinder.

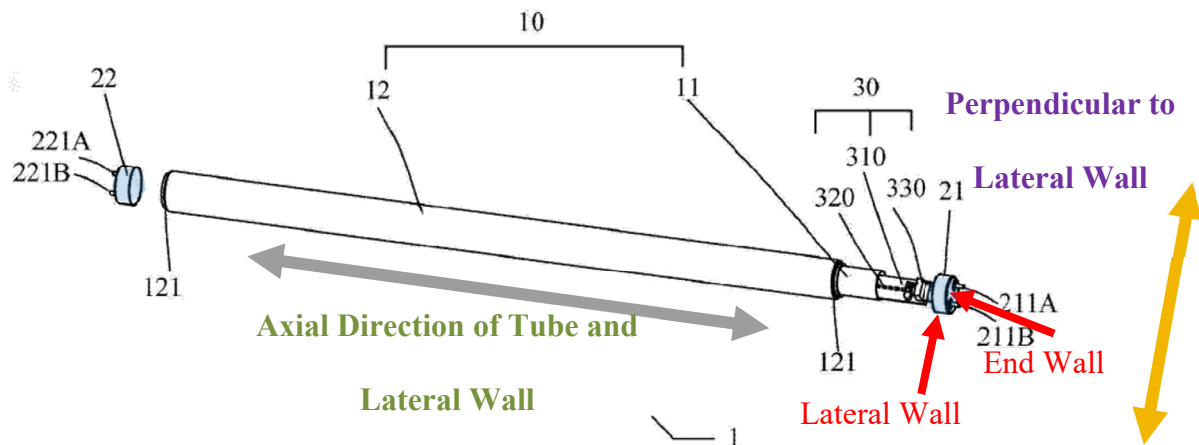


Fig. 1

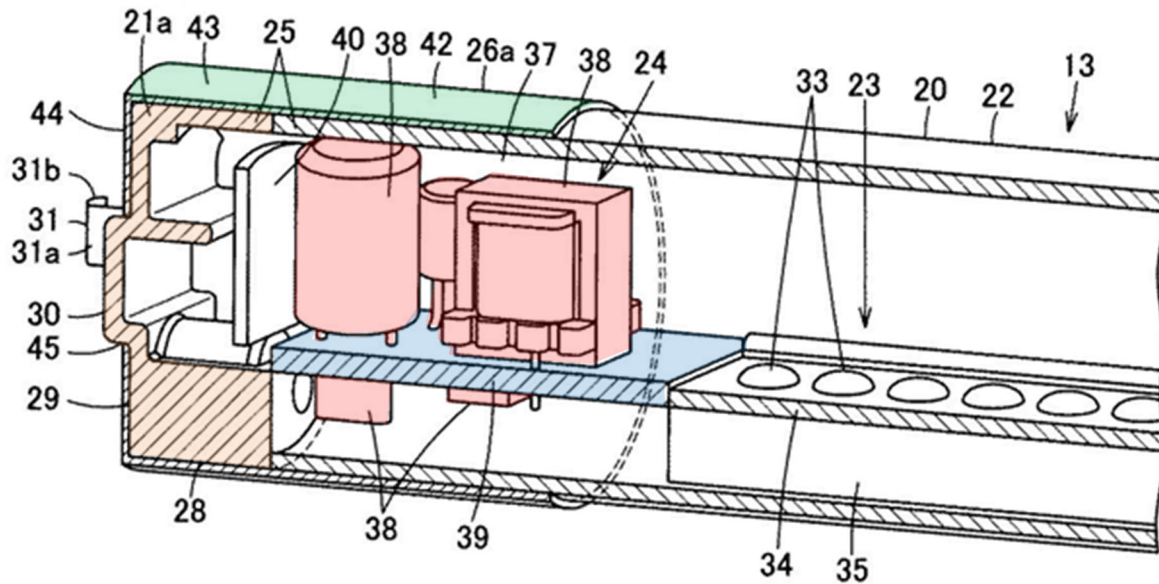
EX1005, Abstract, FIGs. 1-2.

98. Ono describes an “insulator 25 [that] is composed of a tube 20 and a cap 21a, both made of a resin material, and the lighting circuit 24 is covered by the tube 20 and the cap 21a.” EX1006, [0018]; *see also* EX1006, [0030], [0041-0044],

FIGs. 1, 7. “The lighting circuit 24 is covered with an insulator 25, and the lighting circuit 24 is covered with a non-combustible cover 26a via the insulator 25.”

EX1006, [Solution].

[Fig. 1]



EX1006, FIG. 1.

Limitation 13[e2]: “wherein the end wall comprises an insulating portion made of an insulating material and at least one opening being on the end wall,”

99. It is my opinion that the combination of Li, Ono, and Holec renders obvious a portion of the end wall made of an insulating material. Because Li is silent on the material that forms end caps 21 and 22, as I explained above, it is my opinion that a POSITA would have been motivated to look to other LED lighting references, such as Ono, to determine the materials that could be used as end caps. Ono

describes that a cap 21a is an insulator made of a resin material. EX1006, [0018]; *see also* EX1006, [0030], [0041]-[0044], FIGS. 1, 7.

Limitation 13[f]: “wherein the power supply module comprises a printed circuit board and a plurality of electronic components mounted on the printed circuit board, the printed circuit board comprises a first surface and a second surface opposite to and substantially parallel to the first surface, and the first surface and the second surface of the printed circuit board are substantially parallel with the axial direction of the lateral wall;”

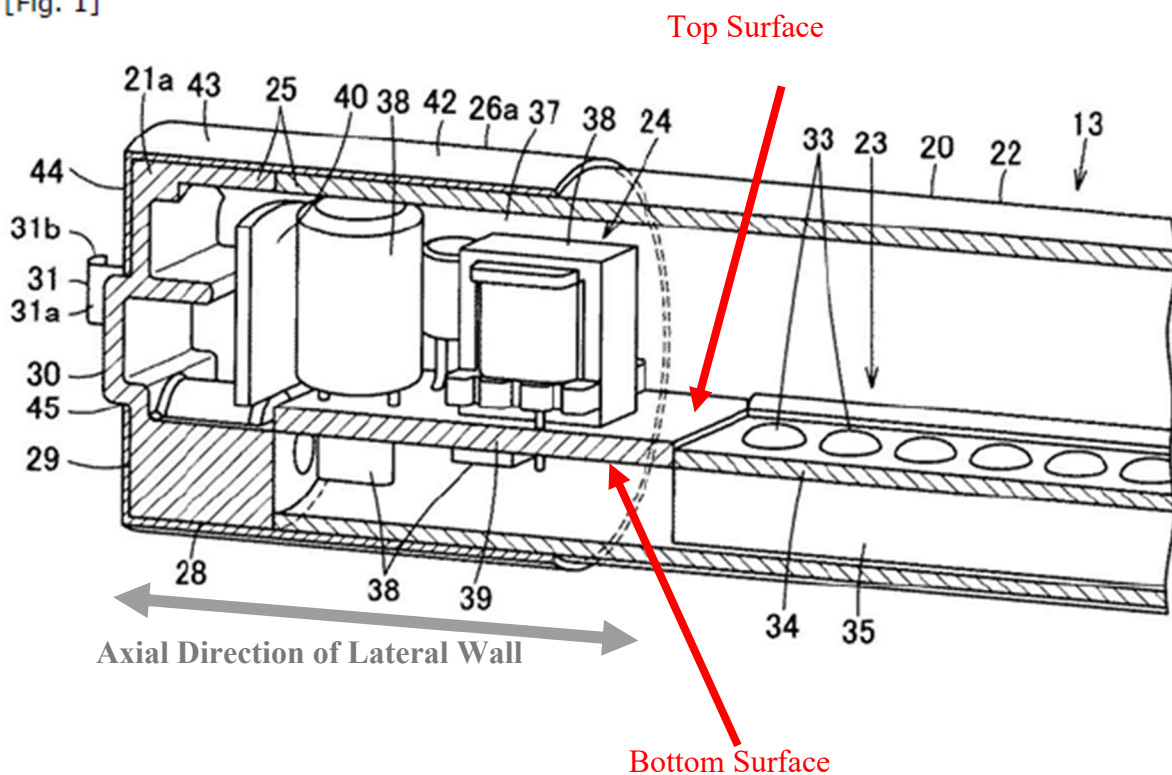
100. It is my opinion that the combination of Li, Ono, and Holec renders obvious a power supply formed of a PCB having two parallel surfaces on which electronic components are mounted and positioned parallel with the axial direction of the lateral wall of the end cap. Li discloses the LED drive circuit module 330 but does not describe the physical structure of the drive circuit beyond disclosing that “the driver power supply can be achieved in a modular structure. For example, it comprises a printed circuit board and one or more components mounted on the printed circuit board and electrically connected together by means of wiring. Examples of these components include but are not limited to LED drive controller chips, rectifier chips, resistors, capacitors and coils.” EX1005, [0082].

101. As I explained above, a POSITA would have been motivated to look to Ono to understand the physical implementation of the circuits described in Li.

Specifically, Ono describes that “[t]he lighting circuit 24 has a circuit board 39 on which a plurality of electronic components 38 have been mounted. Lead components such as capacitors and inductors are mounted on the mounting surface of the circuit board 39, and surface mounted components such as resistors and switching elements are mounted on the wiring pattern surface.” EX1006, [0017].

102. As shown in Figure 1, Ono’s PCBs have top and bottom surfaces parallel to each other. EX1006, FIG. 1. The PCB is arranged in the end cap such that the PCB is substantially parallel with the axial direction of the lateral wall of the end cap. EX1006, FIG. 1.

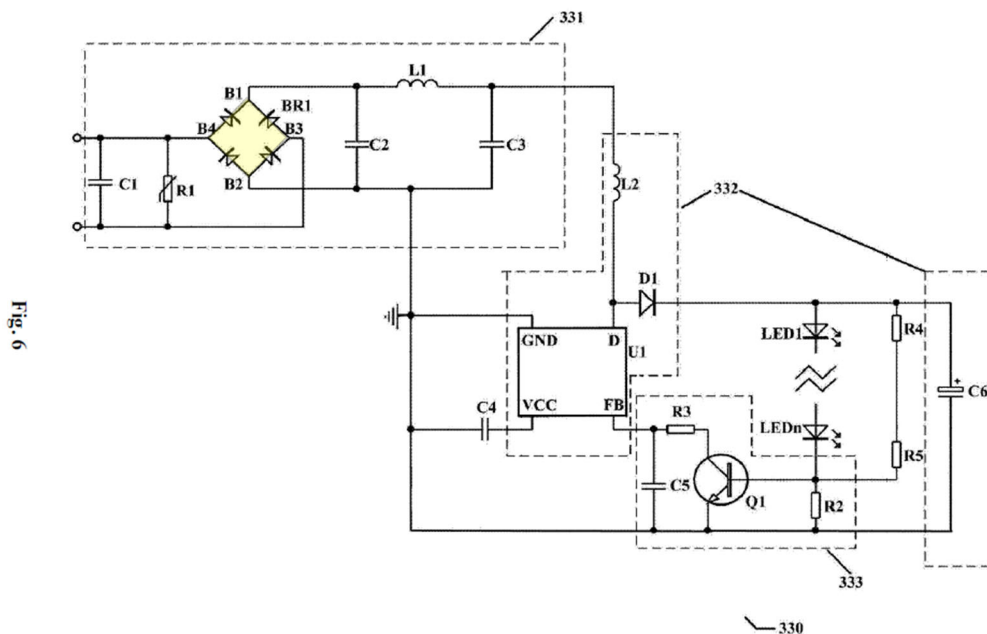
[Fig. 1]



EX1006, FIG. 1.

Limitation 13[g1]: “wherein at least some of the plurality of electronic components comprise a rectifying circuit having at least two input terminals and configured to rectify signal receiving from the at least two input terminals,”

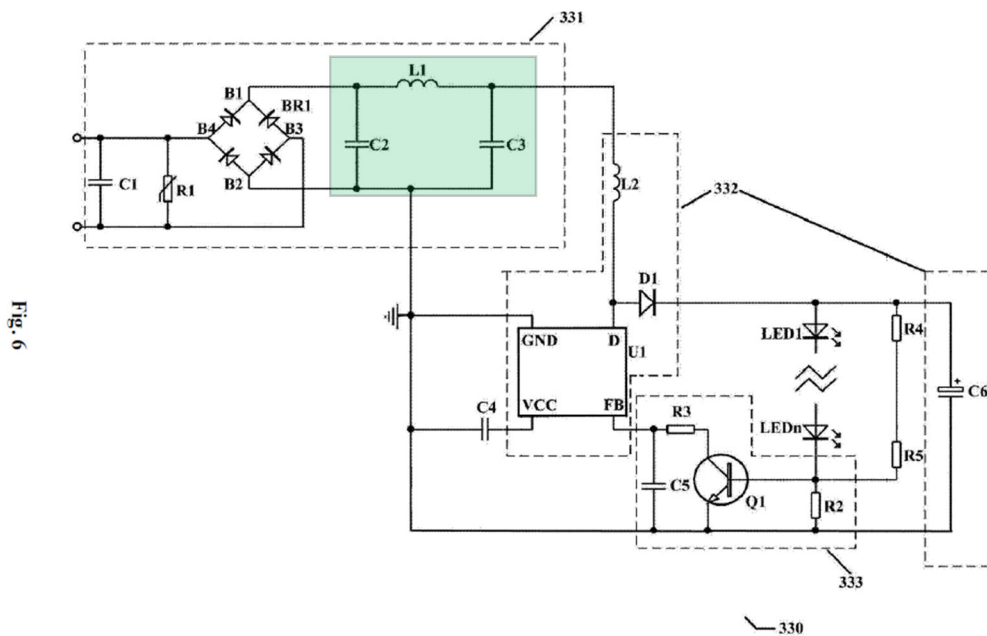
103. It is my opinion that the combination of Li, Ono, and Holec renders obvious a rectifying circuit with two input terminals that is configured to rectify the signal received at the input terminals. Li describes that “[t]he drive circuit module 330 shown in Fig. 6 comprises a bridge rectifier filter unit 331, a DC-DC boost conversion unit 332 and a feedback unit 333.” EX1005, [0112]. “[T]he bridge rectifier filter unit 331 comprises a [yellow] full-bridge rectifier BR1, capacitors C1, C2 & C3, a varistor R1 and an inductor L1.” EX1005, [0113]. A POSITA would have understood that a bridge rectifier converts, or “rectifies,” an alternating current (AC) signal input into the rectifier and outputs a direct current (DC) signal. EX1015, 3:1-15.



EX1005, FIG. 6.

Limitation 13[g2]: “at least one of the plurality of electronic components comprises a filtering circuit electrically connecting to the rectifying circuit,”

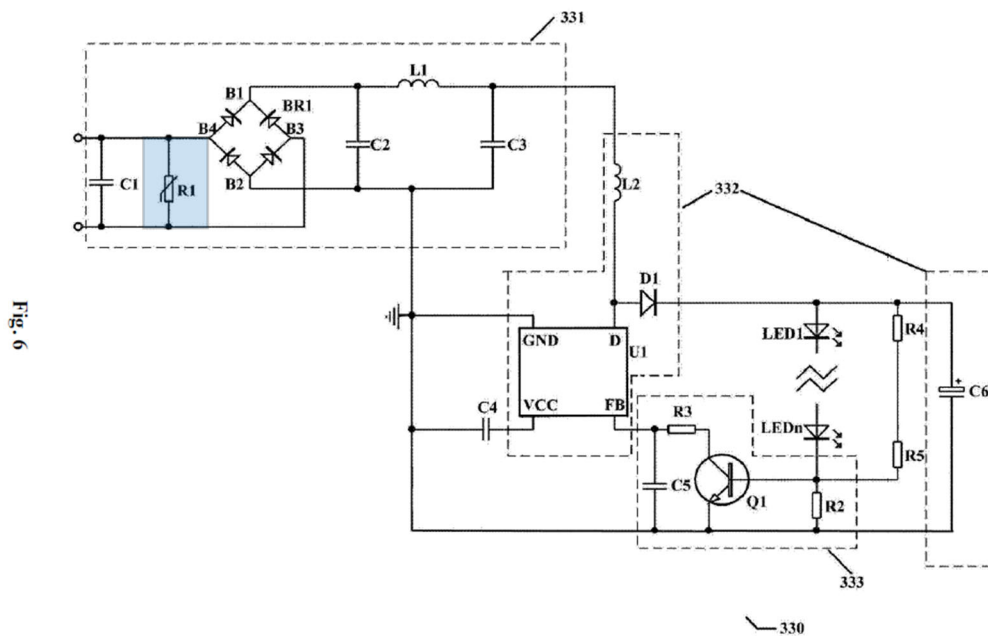
104. It is my opinion that the combination of Li, Ono, and Holec renders obvious a filtering circuit electrically connected to the rectifying circuit. Li describes that “[t]he filter capacitors C2 & C3 and the inductor L1 form a π -shaped filter loop and are electrically connected between the anode terminal B1 and the cathode terminal B2 of the full-bridge rectifier BR1 to low-pass filter the pulsating voltage output from the full-bridge rectifier BR1.” EX1005, [0115]; *see also* EX1005, [0113].



EX1005, FIG. 6.

Limitation 13[h]: “wherein the plurality of electronic components comprise a resistor which is positioned close to the end wall of the first end cap and connecting to one of the input terminals of the rectifying circuit”

105. It is my opinion that the combination of Li, Ono, and Holec renders obvious a resistor located closest to the end wall of an end cap and connected to an input of the rectifying circuit. Li describes that “the filter capacitor C1 and the varistor R1 are connected in parallel between the AC input terminals B3 and B4 of the full-bridge rectifier BR1, wherein the varistor R1 holds the input voltage of the full-bridge rectifier BR1 at a predetermined level by suppressing abnormal overvoltage in the circuit.” EX1005, [0115].



EX1005, [0115], FIG. 6. In my opinion, a POSITA would have understood the AC input of the drive circuit, located on the left side of Figure 6, to be the conductive pins in the end wall at one end of the tube light. EX1005, [0100] (“During operation, one of the pins 340A and 340B is electrically connected to the live line of an external AC power supply (e.g., mains supply) via a corresponding plug on the end cover 21, while the other pin is electrically connected to the neutral line of the external AC power supply via a plug on the end cover 21, thereby causing the external AC power supply to supply power to the drive circuit module 330.”). Therefore, the varistor R1 is close to the end wall. While in Figure 6, the capacitor C1 is illustrated closer to the circuit inputs, because the capacitor C1 and the varistor R1 are connected in parallel, it is my opinion that the locations of the capacitor C1 and the varistor R1

can be reversed without changing the functionality of the circuit disclosed in Li. Therefore, it is my opinion that Li discloses that the varistor R1 is located closest to the end wall of the end cap.

106. My opinion that the location of the varistor R1 is closest to the end wall of the end cap is confirmed by Ono. Ono describes that “[t]he lighting circuit 24 has a circuit board 39 on which a plurality of electronic components 38 have been mounted. Lead components such as capacitors and inductors are mounted on the mounting surface of the circuit board 39, and surface mounted components such as resistors and switching elements are mounted on the wiring pattern surface.” EX1006, [0017]. Ono’s resistors are located on the bottom side (*e.g.*, the wiring pattern surface) of the PCB 39. EX1006, [0017] (“[S]urface mounted components such as resistors and switching elements are mounted on the wiring pattern surface.”). Ono’s capacitors are located on the top of the PCB 39 (*e.g.*, the mounting surface). EX1006, [0017] (“Lead components such as capacitors and inductors are mounted on the mounting surface of the circuit board 39”). Therefore, when Li’s drive circuit is implemented in a PCB as described by Ono, the capacitor C1 is mounted on the top of the PCB and the varistor R1 is mounted on the bottom and a POSITA would have understood that both the capacitor C1 and the varistor R1 are located closest to the end wall of the end cap.

107. Further, a POSITA would have understood that resistors are heat generating circuit elements. *See, e.g.*, EX1019, 1/2. Therefore, it would have been obvious for a POSITA to place the varistor R1 closest to the end cap such that heat would be efficiently dissipated through heat dissipating functions in the end caps, such as ventilating holes. This placement would cool the resistor as well as minimize the effects of the resistor heating up other components on the PCB and improve the lifespan of the LED lamp. As an alternative to, or in addition to ventilation holes, the PCB could be placed in direct contact with the end cap. A POSITA would have understood that heat is transferred to the end cap through this direct connection and would have been conducted out of the LED lamp to the outside environment directly through the end wall or through the conducting pins. Thus, it would have been obvious to a POSITA to locate the (heat generating) varistor R1 closest to the end cap.

Claim 14: “The LED tube lamp according to claim 13, wherein the LED light strip comprises two first soldering pads arranged at one end of the LED light strip and the two first soldering pads respectively electrically connect to two second soldering pads on the printed circuit board.”

108. It is my opinion that the combination of Li, Ono, and Holec renders obvious an LED light strip with two first soldering pads arranged at one end of the LED light strip, the two first soldering pads respectively electrically connect to two

second soldering pads on the printed circuit board. Holec describes “[t]he circuit boards can be overlapped for interconnection (see FIG. 4B, FIG. 5). This is very useful if the connector board contains active circuitry and it is beneficial to connect multiple boards, such as in the fabrication of arrays of boards (see FIG. 10). The overlapping connections are highly advantageous to the assembly of strips having multiple circuit boards (see FIG. 13C). In a practical application, they are used to make long circuit board strips or arrays of solid-state lighting circuits (e.g., high power LED emitters used as the individual light sources).” EX1020, 9:25-34. Specifically, Holec discloses “a connection 19 is made by either welding or soldering the conductive pads 7 from the top board 16 to the bottom board conductive pads 8 on the bottom board 12. The size of pads 7, 8 factors into both the quality of the connection and the mechanical stress the connection can sustain. Also, by embedding or closely connecting through holes 2 to pads 7, 8 the mechanical performance is improved.” EX1020, 9:47-54.

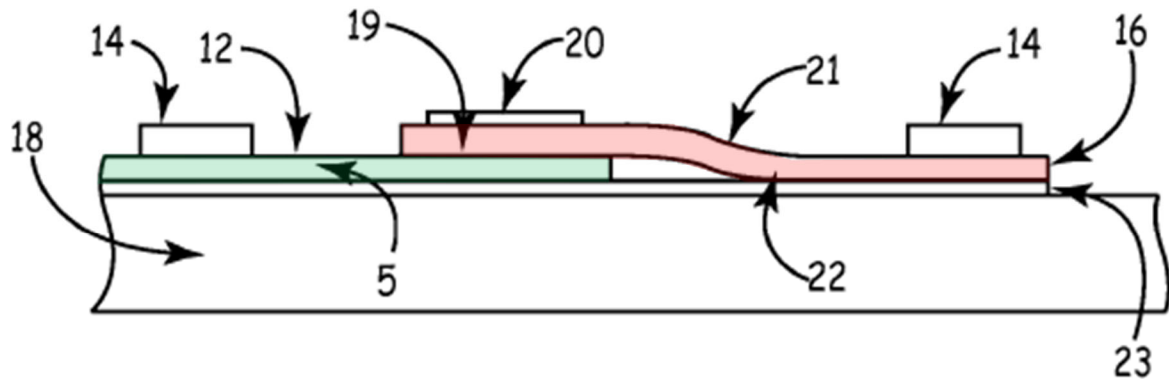


FIG. 5

EX1020, FIG. 5.

109. In the Li-Ono-Holec system, Li's light strip is made of a substrate onto which LED lights are attached. EX1005, [0098] (“[A] plurality of LED units 320 are arranged longitudinally along the substrate 310 to form a uniform luminous zone.”). The power supply is also on a PCB, as I described above when discussing Limitation 13[f]. In order to make an electrical connection between the substrate and PCB, a POSITA would use Holec's conductive pads to ensure that electricity is conducted across the connection.

Claim 15: “The LED tube lamp according to claim 14, wherein the printed circuit board is disposed on an end of the LED light strip.”

110. It is my opinion that the combination of Li, Ono, and Holec renders obvious a power supply PCB disposed on an end of the LED light strip. Li describes

EX1005, FIG. 1. The power supply is also on a PCB, as I described above when discussing Limitation 13[f].

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Claim 16: “The LED tube lamp according to claim 15, wherein the two first soldering pads are arranged on the end of the LED light strip on which the printed circuit board is disposed.”

112. It is my opinion that the combination of Li, Ono, and Holec renders obvious the two first soldering pads being arranged on the end of the LED light strip on which the PCB is disposed. As I discussed above in Claim 14, Li's LED light strip substrate is electrically connected to the PCB forming the power supply using Holec's conductive pads ("soldering pads"). The conductive pads are at the end of both the top and bottom boards 12, 16 so that the ends of the boards overlap slightly to make the connection between the boards when the conductive pads are joined using solder. EX1020, 9:45-12.

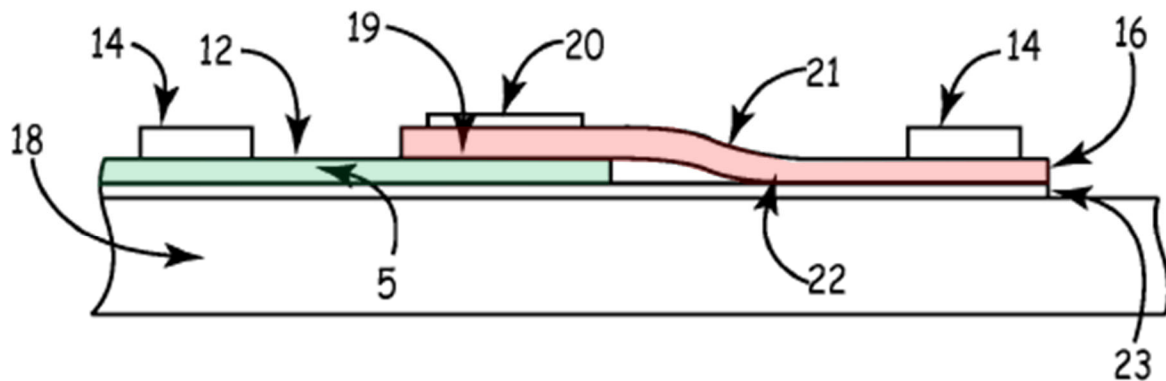


FIG. 5

EX1020, FIG. 5.

113. In the Li-Ono-Holec lamp, the soldering pads are on each end of Li's LED light strip so that the soldering pads are near the power supply PCB to allow the linear conductor to span the space between the soldering pads on the power supply PCB and the soldering pads on the light strip. EX1020, claim 1 ("each circuit board comprising a distal end having a first electrically conductive pad located on a top of the circuit board").

Claim 17: "The LED tube lamp according to claim 15, wherein each of the end caps comprises two conductive pins connected to the insulating portion thereof, and the resistor is electrically connected between one of the two conductive pins and one of the input terminals of the rectifying circuit or between the two conductive pins."

114. It is my opinion that the combination of Li, Ono, and Holec renders obvious each end cap including two conductive pins connected to the insulating portion of the end cap and the resistor electrically connected between one of the two conductive pins and one of the input terminals of the rectifying circuit or between the two conductive pins. Li describes "pins 340A and 340B are arranged at one end of the substrate 310 as a first electrode and a second electrode of the LED drive circuit module 330, respectively (therefore, the pins 340A and 340B are hereinafter also referred to as 'electrode pins'). After assembly, the electrode pins 340A and

340B are electrically connected to the plugs 211A and 211B on the end cover 21.”

EX1005, [0100].

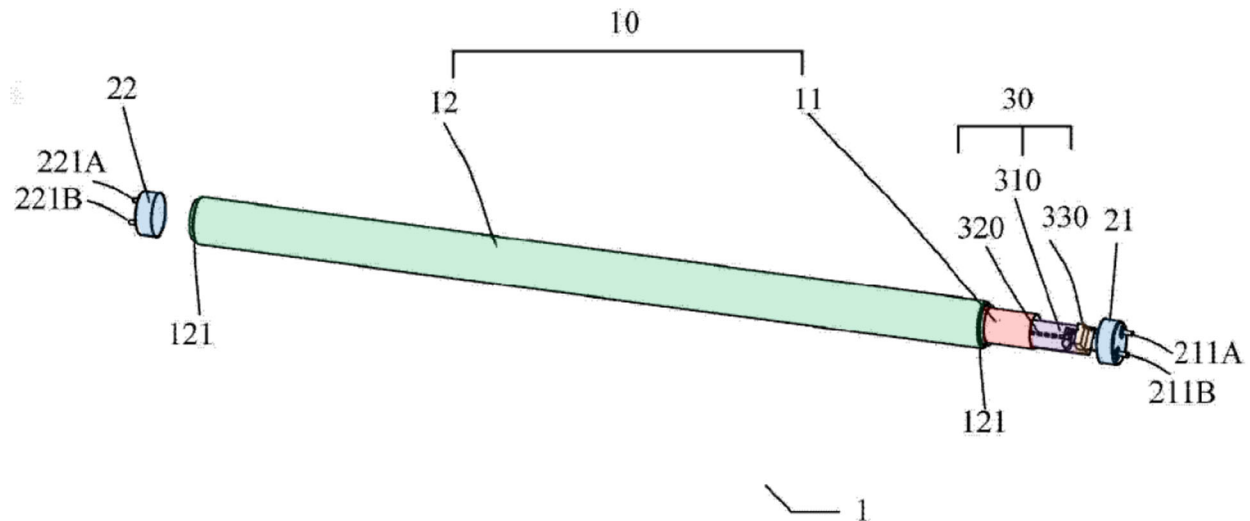


Fig. 1

EX1005, FIG. 1.

115. Li describes that “the filter capacitor C1 and the varistor R1 are connected in parallel between the AC input terminals B3 and B4 of the full-bridge rectifier BR1, wherein the varistor R1 holds the input voltage of the full-bridge rectifier BR1 at a predetermined level by suppressing abnormal overvoltage in the circuit.” EX1005, [0115].



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B. Ground 2 - Claims 18-23 are Obvious over Li, Ono, and Holec in view of Guang

1. Motivation to Combine Li, Ono, Holec, and Guang

116. For the reasons discussed throughout Ground 1, in my opinion, it would have been obvious to a POSITA to combine Li, Ono, and Holec. In my opinion, a POSITA would have also been motivated to combine Guang with Li-Ono-Holec with a reasonable expectation of success for several reasons.

117. Li teaches pins at both ends of the tube lamp: Li teaches “pins 340A and 340B are arranged at one end of the substrate 310 as a first electrode and a second electrode of the LED drive circuit module 330, respectively (therefore, the pins 340A and 340B are hereinafter also referred to as ‘electrode pins’). After assembly, the electrode pins 340A and 340B are electrically connected to the plugs 211A and 211B on the end cover 21.” EX1005, [0100]. Li also teaches “[o]ptionally, as shown in Fig. 3, a pair of pins 350A and 350B electrically connected to the plugs 221A and 221B on the end cover 22, respectively, are arranged on the other end of the substrate 310.” EX1005, [0101]. “[A]rranging a pair of directly connected pins 350A and 350B on an end opposite the end on which the electrode pins 340A and 340B are arranged can greatly facilitate installation of the LED fluorescent lamp.” EX1005, [0102]. Li further describes a drive circuit module on each end of the tube lamp connected to the pins 340A/340B and 350A/350B, respectively. EX1005, [0100-0101]. But Li describes that “when the electrode pins

340A and 340B are electrically connected to the jacks A and B, respectively, and the pins 350A and 350B are electrically connected to the jacks C and D, respectively, the electrode pin 340A is electrically connected to the live line L and meanwhile, as the pins 350A and 350B located at the other end of the substrate 310 are shorted.” EX1005, [0105]. Li further discloses that the drive circuit of Figure 6 illustrates the drive circuit shown in Figure 2, which illustrates the embodiment with pins only on one end of the tube lamp. EX1005, [0111]. Therefore, a POSITA would have been motivated to modify the drive circuit module of Figure 6 such that it works in the embodiment that includes optional pins 350A and 350B.

118. In my opinion, a POSITA would have understood that different types of lamp holders exist and it would have been desirable to have both ends of the LED lamp able to receive power. EX1007, 8:57-67 (referring to Figure 2 “showing how power can be supplied through either or both pairs of electrode pins”). Therefore, a POSITA would have been motivated to include two bridge rectifying circuit, like what is disclosed in Guang, to receive and rectify power from both sets of conductive pins rather than just one. This would provide that the replacement LED lamp would be operable in the lamp holder no matter the orientation of the LED lamp.

119. A POSITA could have recognized the benefits provided by Guang by incorporating aspects of Guang’s power management circuitry into the Li-Ono-Holec lamp. Specifically:

Either end of the Fluorescent Compatible LED Tube Lamp 10 can be plugged into either end of a fluorescent fixture having a tube to be replaced. The driver circuit is versatile in handling a variety of electrical current conditions present among various fluorescent lamp fixtures. It doesn't matter to the driver circuit shown in FIG. 2 whether the socket is shunted or Non-shunted. It also does not matter to the driver circuit shown in FIG. 2 whether any particular one of the various fluorescent lamp fixtures into which the Fluorescent Compatible LED Tube Lamp 10 might be plugged, has a ballast delivering modified AC current to the socket, whether there is bare line voltage (e.g. 110V AC) present at the socket, or whether there is an AC-DC transformer already wired into the fixture for a previous LED conversion. The arrangement of eight diodes D7 to D14 of the rectifier circuits 38a and 38b ensures that when power is input from any two of the electrode pins, four of the eight diodes will operate to pass DC current to the filter circuit 40, whether it is DC or AC power that is input from the electrode pins. The arrangement of eight diodes of the rectifier circuit, as shown in FIG. 2, allows that the electrode pins from which the input power is received can be any two of the tube's four electrode pins, that is, the input power can be from an electrode pin on one end of the tube in conjunction with another pin on the other end of the tube completing the input power circuit, or input power can be from an electrode pin on one end of the tube and with the other pin of the pair on the same end of the tube completing the input power circuit.

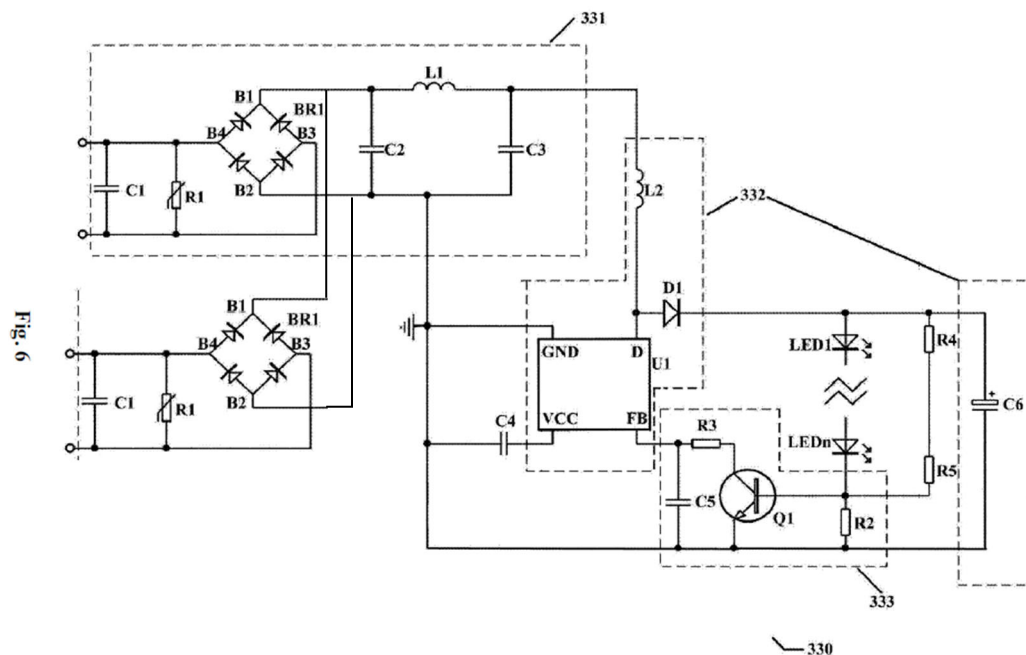
EX1007, 9:51-10:11. A POSITA would have understood that by integrating the diodes from Guang's rectifier circuit into the Li-Ono-Holec lamp by placing a bridge rectifier circuit at each set of conductive pins, the compatibility of the LED lamp with conventional lamp holders would have been increased.

120. Further, because Li already discloses a bridge rectifier circuit, BR1, in the drive power module, a POSITA would have expected that including a second full-wav bridge rectifier circuit at a second set of pins would be successful because to do so was an implementation of known components already existing in the drive

power module in exactly the same way, just at a different location. In fact, Guang himself successfully implemented two bridge rectifier circuits in an LED lamp. EX1007, 9:2-21. No other changes to the circuit would be required as both bridge rectifier circuits are connected to the downstream portions of the drive circuit, *i.e.*, the filtering circuit, DC-DC boost conversion unit 332, and feedback unit 333.

2. *Modification of Li-Ono-Holec in view of Guang*

121. In my opinion, the modification of Li-Ono-Holec to include Guang's two full-wave bridge rectifying circuits would duplicate the single bridge rectifying circuit of Li for both sets of conductive pins located on opposite sides of the LED tube lamp.



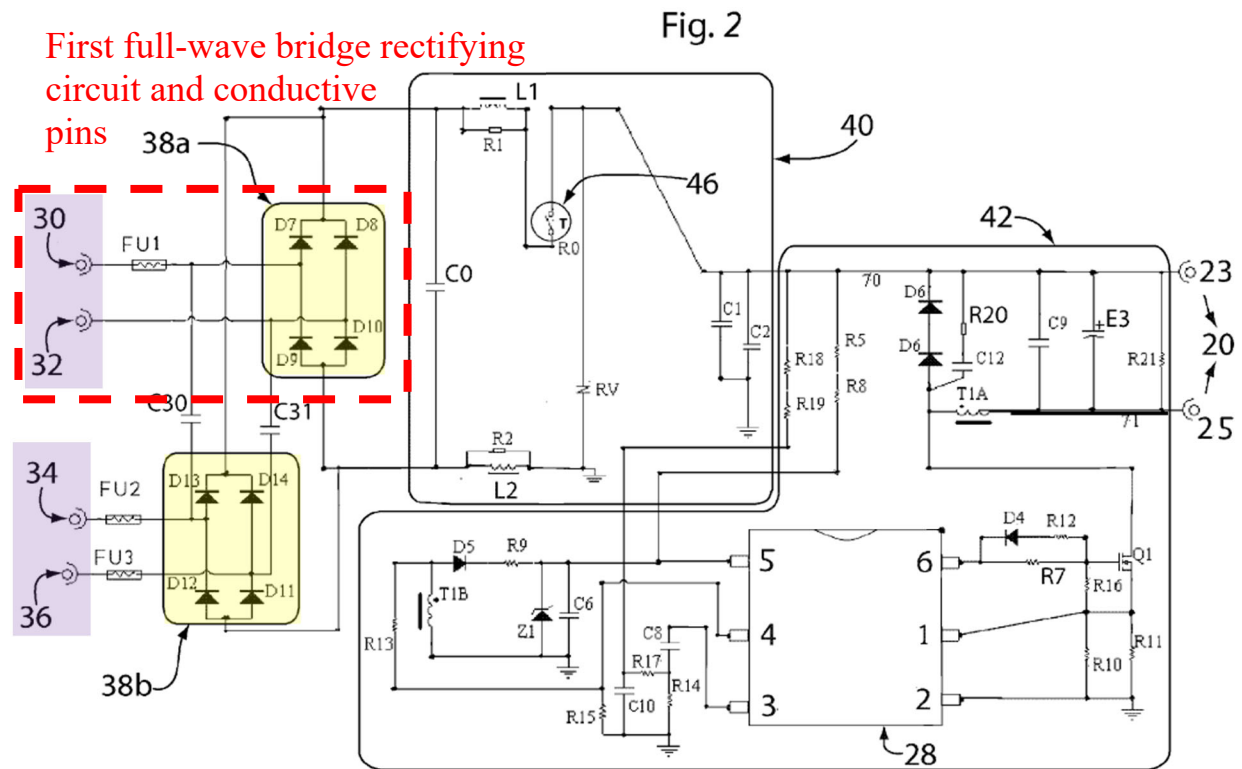
Li FIG. 6
(Modified per Li-Ono-Holec-Guang)

EX1005, FIG. 6; EX1007, FIG. 2.

3. *Element-by-Element Analysis*

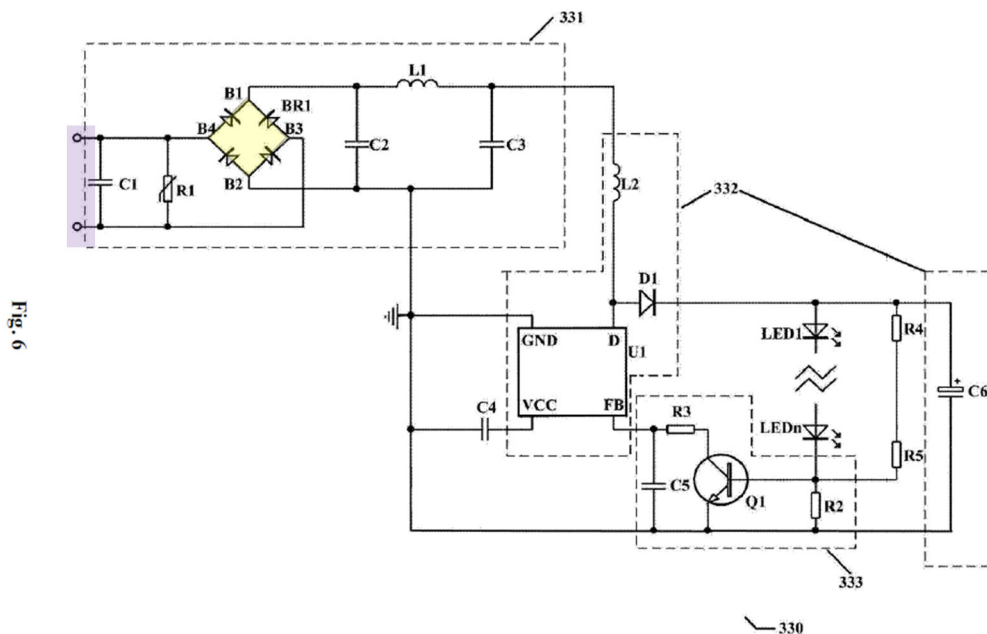
Limitation 18[a]: “The LED tube lamp according to claim 17, wherein the rectifying circuit comprises: a first full-wave bridge rectifying circuit, having two input terminals electrically connected to the two conductive pins of one of the end caps, respectively, and having a positive output terminal and a negative output terminal; and”

122. It is my opinion that the combination of Li, Ono, Holec, and Guang renders obvious a first full-wave bridge rectifying circuit, with positive and negative output terminals, connected to one set of conductive pins. Guang describes “[e]ach of the [yellow] first and second rectifier circuits 38a and 38b has four diodes, which each pass electrical current in only one direction. The first and second rectifier circuits are connected in parallel as shown. Any AC current arriving via [purple] electrode pins 30 and 32 is converted to DC by diodes D7 and D8 alternately. If AC current arrives via [purple] electrode pins 34 and 36 the current is converted to DC by diodes D13 and D14 alternately.” EX1007, 9:28-35.



EX1007, 9:2-8, FIG. 2. Full-wave bridge rectifying circuit 38a has positive and negative output terminals. EX1007, 9:39-50.

123. Li also discloses a [yellow] full-wave bridge rectifying circuit, BR1, connected to a [purple] set of conductive pins, and has output positive terminal B1 and output negative terminal B2. EX1005, [0113].

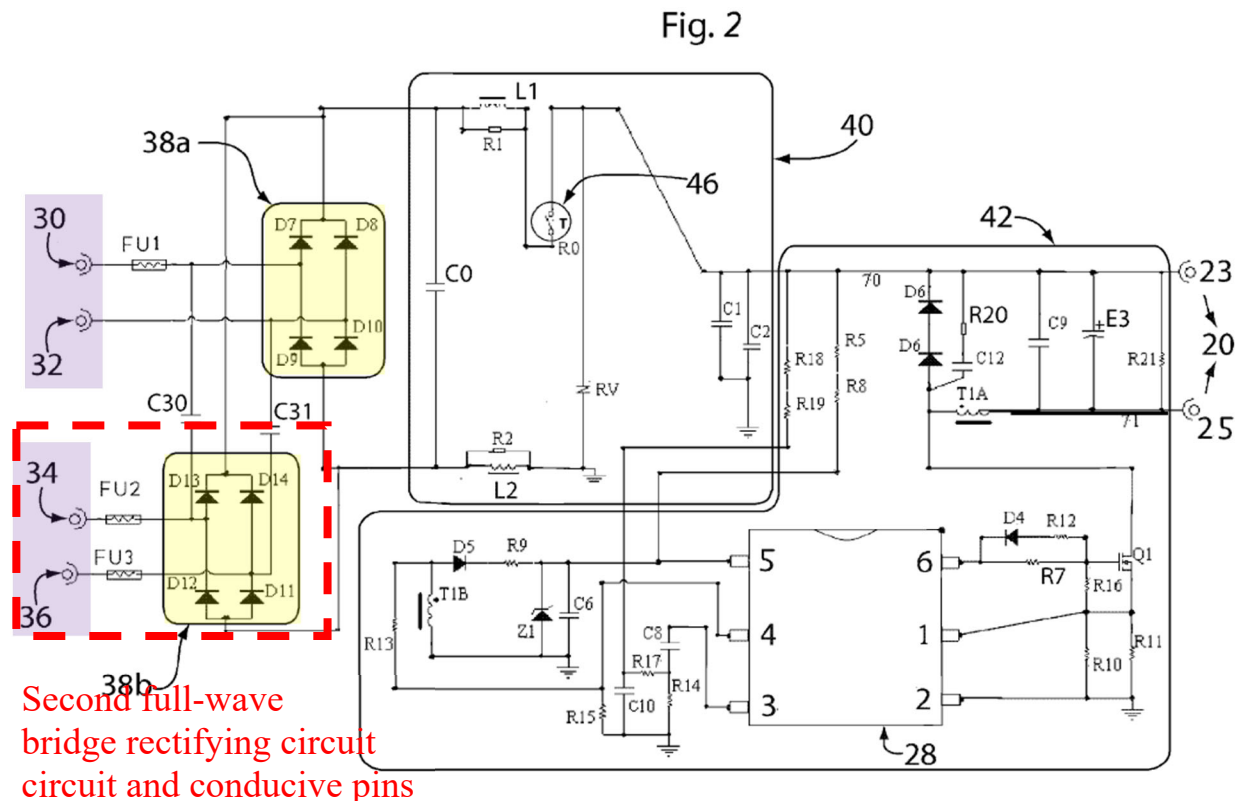


EX1005, FIG. 6.

Limitation 18[b]: “a second full-wave bridge rectifying circuit, having two input terminals electrically connected to the two conductive pins of the other one of the end caps, respectively, and having a positive output terminal and a negative output terminal,”

124. It is my opinion that the combination of Li, Ono, Holec, and Guang renders obvious a second full-wave bridge rectifying circuit, with positive and negative output terminals, connected to the other set of conductive pins. While Li does not disclose a second full-wave bridge rectifying circuit, Li does disclose a second set of conductive pins. EX1005, [0101]. And as I explained above, it would have been obvious to a POSITA to include Guang’s second bridge rectifying circuit connected to Li’s second set of conductive pins. Specifically, Guang describes

“[e]ach of the [yellow] first and second rectifier circuits 38a and 38b has four diodes, which each pass electrical current in only one direction. The first and second rectifier circuits are connected in parallel as shown. Any AC current arriving via [purple] electrode pins 30 and 32 is converted to DC by diodes D7 and D8 alternately. If AC current arrives via [purple] electrode pins 34 and 36 the current is converted to DC by diodes D13 and D14 alternately.” EX1007, 9:28-35.

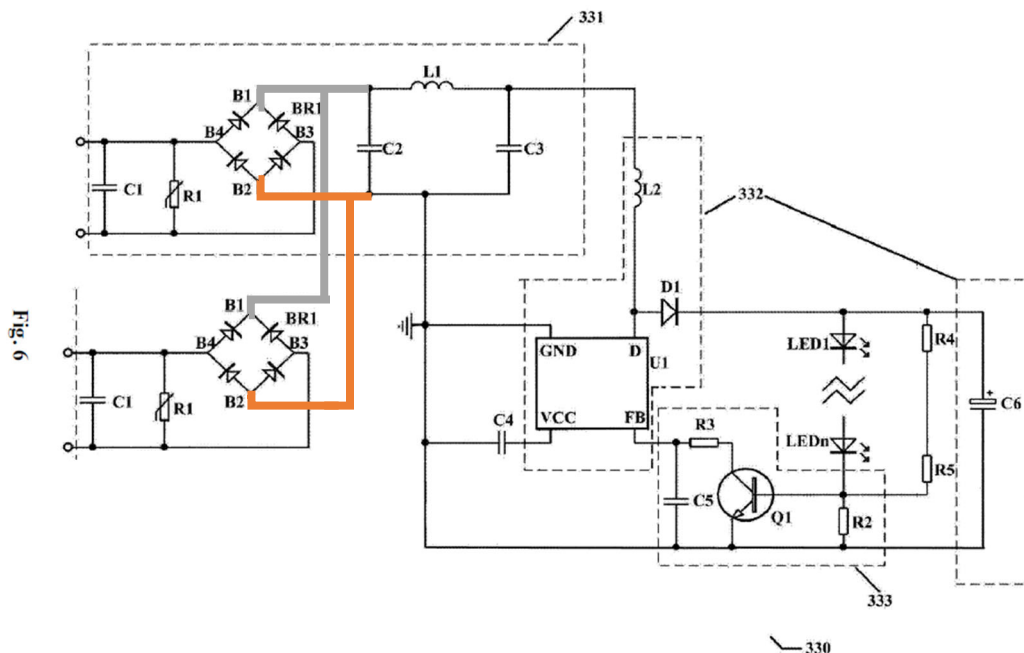


EX1007, 9:2-8, 9:28-30, 9:39-50, FIG. 2.

Limitation 18[c]: “wherein the positive output terminals of the first and the second full-wave bridge rectifying circuits are electrically connected to each

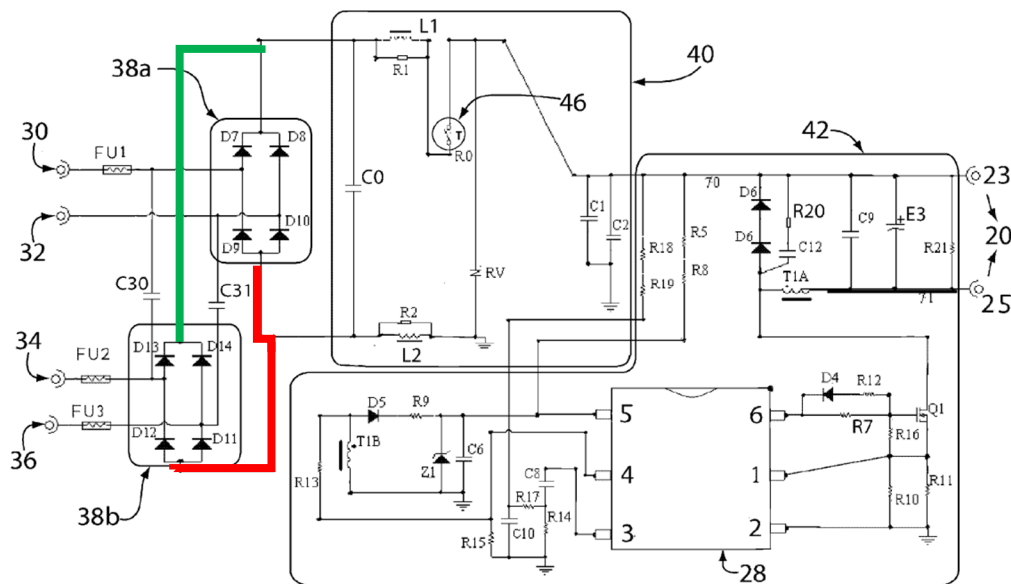
other, and the negative output terminals of the first and the second full-wave bridge rectifying circuits are electrically connected to each other.”

125. It is my opinion that the combination of Li, Ono, Holec, and Guang renders obvious a circuit where the positive output terminals of the two full-wave bridge rectifying circuits are electrically connected and the negative output terminals of the two full-wave bridge rectifying circuits are electrically connected. In the Li-Ono-Holec-Guang system, the [green] positive output terminals of both full-wave bridge rectifying circuits are connected to the part of the circuit near inductor L1 and capacitor C2. The [red] negative output terminals are connected in close proximity to capacitor C2.



EX1005, FIG. 6 (as modified by Guang).

Fig. 2

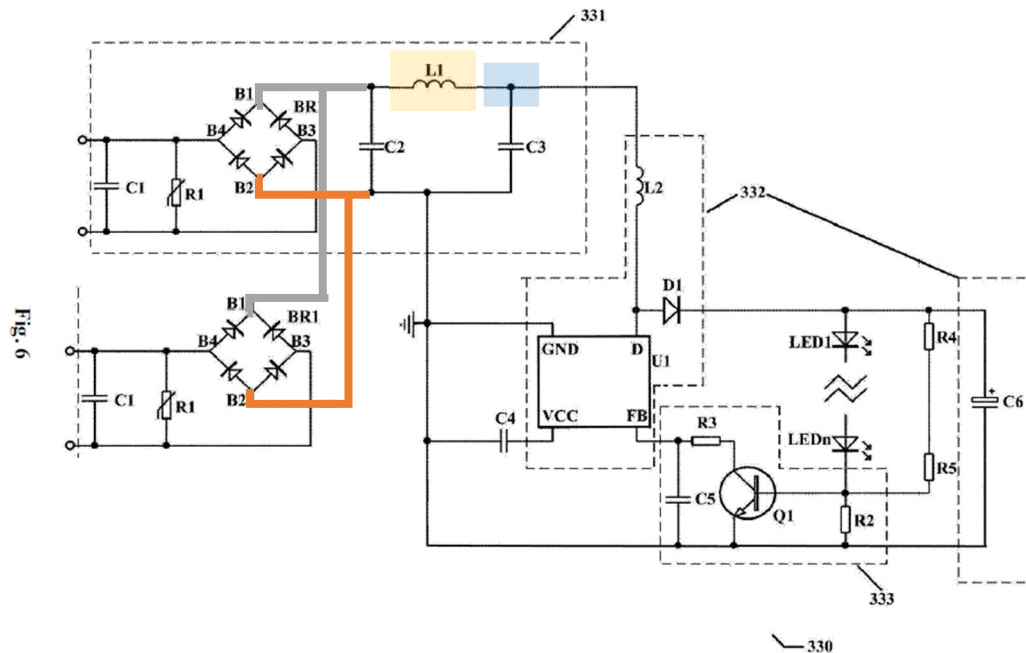


Limitation 19[a]: “The LED tube lamp according to claim 18, wherein the filtering circuit comprises: an inductor, having an end electrically connected to the positive output terminals of the first and the second full-wave

bridge rectifying circuits, and the other end regarding as one of the filtering output terminals;”

127. It is my opinion that the combination of Li, Ono, Holec, and Guang renders obvious an inductor having an end electrically connected to the positive output terminals of the first and the second full-wave bridge rectifying circuits, and the other end is one of the filtering output terminals. As I described above in Limitations 18[a] and 18[b], Li-Ono-Holec-Guang contains two full-wave bridge rectifying circuits.

128. Additionally, Li discloses that “the bridge rectifier filter unit 331 comprises a full-bridge rectifier BR1, capacitors C1, C2 & C3, a varistor R1 and an [orange] inductor L1. After being rectified by the full-bridge rectifier BR1, AC (e.g., mains supply) outputs a full-wave pulsating voltage at the anode terminal 1. The filter capacitors C1, C2 & C3, the varistor R1 and the inductor L1 constitute an EMI filter circuit, which on the one hand, suppresses the impact of high-frequency interference in the AC grid on the drive circuit and on the other hand, suppresses the electromagnetic interference of the drive circuit to the AC grid.” EX1005, [0113]. Additionally, “[t]he filter capacitors C2 & C3 and the inductor L1 form a π -shaped filter loop and are electrically connected between the anode terminal B1 and the cathode terminal B2 of the full-bridge rectifier BR1 to low-pass filter the pulsating voltage output from the full-bridge rectifier BR1.” EX1005, [0115].



EX1005, FIG. 6 (as modified by Guang). A POSITA would have understood that the inductor L1 is part of the filtering circuit, connected to the outputs of the full-wave bridge rectifying circuits because L1 describes it as connected to the anode and cathode terminals of the rectifying circuits. Further, a POSITA would have understood that the inductor L1 is regarded as an output of the filtering circuit because it is connected to the [blue] node constituting the output of the bridge rectifier filter unit 331.

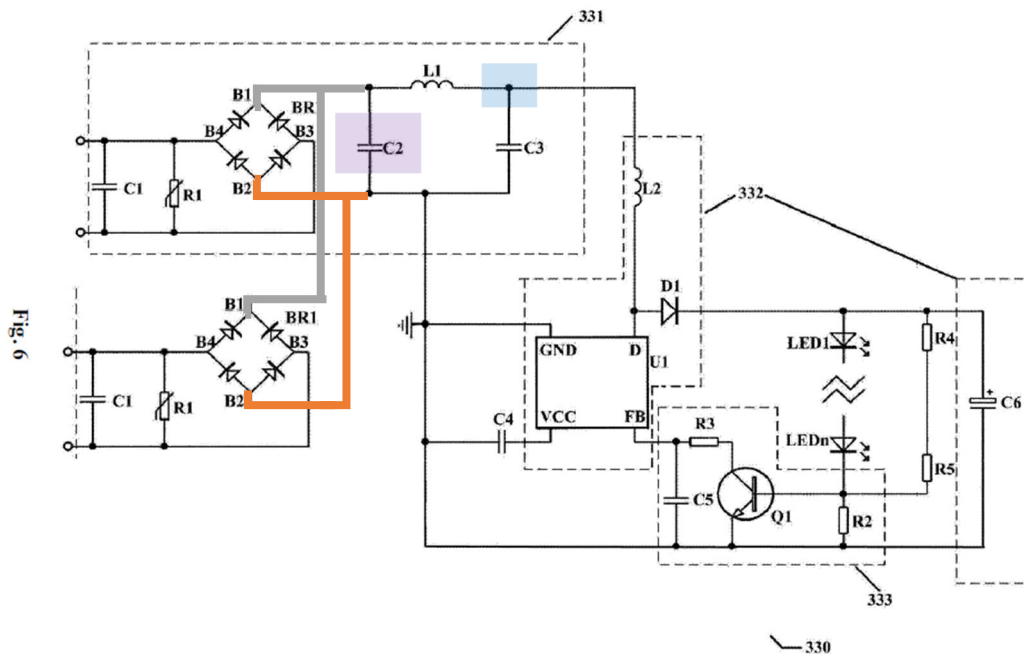
Limitation 19[b]: “a first capacitor, having an end electrically connected to the end of the inductor, and the other end electrically connected to the

negative output terminals of the first and the second full-wave bridge rectifying circuits; and”

129. It is my opinion that the combination of Li, Ono, Holec, and Guang renders obvious a first capacitor having an end electrically connected to the end of the inductor, and the other end electrically connected to the negative output terminals of the first and the second full-wave bridge rectifying circuits. As I described above in Limitations 18[a] and 18[b], Li-Ono-Holec-Guang contains two full-wave bridge rectifying circuits.

130. Additionally, Li discloses that “the bridge rectifier filter unit 331 comprises a full-bridge rectifier BR1, capacitors C1, C2 & C3, a varistor R1 and an inductor L1. After being rectified by the full-bridge rectifier BR1, AC (e.g., mains supply) outputs a full-wave pulsating voltage at the anode terminal 1. The filter capacitors C1, C2 & C3, the varistor R1 and the inductor L1 constitute an EMI filter circuit, which on the one hand, suppresses the impact of high-frequency interference in the AC grid on the drive circuit and on the other hand, suppresses the electromagnetic interference of the drive circuit to the AC grid.” EX1005, [0113]. Additionally, “[t]he filter capacitors C2 & C3 and the inductor L1 form a π -shaped filter loop and are electrically connected between the anode terminal B1 and the cathode terminal B2 of the full-bridge rectifier BR1 to low-pass filter the pulsating voltage output from the full-bridge rectifier BR1.” EX1005, [0115].

131. A POSITA would have understood that the [purple] capacitor C2 is part of the filtering circuit, connected to one end of the inductor L1 because Li describes it as forming part of a π -shaped filter loop. Further, a POSITA would have understood that the capacitor C2 is also connected to the [gray] anode (negative) terminal B1 of the full-wave bridge rectifying circuits.



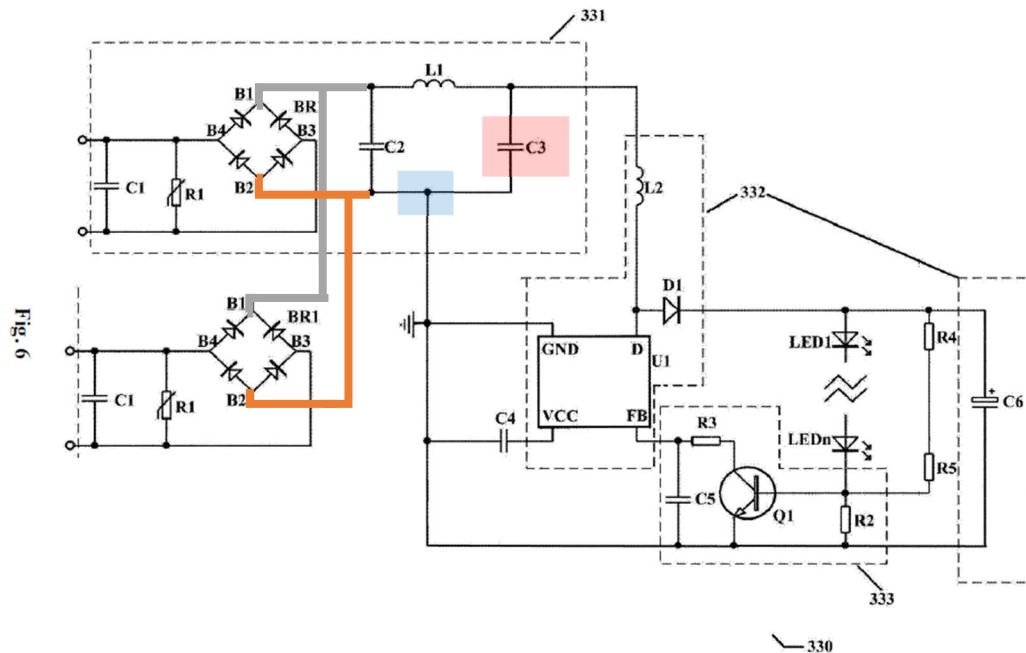
EX1005, FIG. 6 (as modified by Guang).

Limitation 19[c]: “a second capacitor, having an end electrically connected to the other end of the inductor, and the other end regarding as the other one of the filtering output terminals.”

132. It is my opinion that the combination of Li, Ono, Holec, and Guang renders obvious a second capacitor having an end electrically connected to the other

end of the inductor, and the other end is the other filtering output terminal. Li discloses that “the bridge rectifier filter unit 331 comprises a full-bridge rectifier BR1, capacitors C1, C2 & C3, a varistor R1 and an inductor L1. After being rectified by the full-bridge rectifier BR1, AC (e.g., mains supply) outputs a full-wave pulsating voltage at the anode terminal 1. The filter capacitors C1, C2 & C3, the varistor R1 and the inductor L1 constitute an EMI filter circuit, which on the one hand, suppresses the impact of high-frequency interference in the AC grid on the drive circuit and on the other hand, suppresses the electromagnetic interference of the drive circuit to the AC grid.” EX1005, [0113]. Additionally, “[t]he filter capacitors C2 & C3 and the inductor L1 form a π -shaped filter loop and are electrically connected between the anode terminal B1 and the cathode terminal B2 of the full-bridge rectifier BR1 to low-pass filter the pulsating voltage output from the full-bridge rectifier BR1.” EX1005, [0115].

133. A POSITA would have understood that the [red] capacitor C3 is part of the filtering circuit, connected to one end of the inductor L1 because Li describes it as forming part of a π -shaped filter loop. Further, a POSITA would have understood that the capacitor C3 is also connected to an output of the filtering circuit because it is connected to the [blue] node constituting the output of the bridge rectifier filter unit 331.



EX1005, FIG. 6 (as modified by Guang).

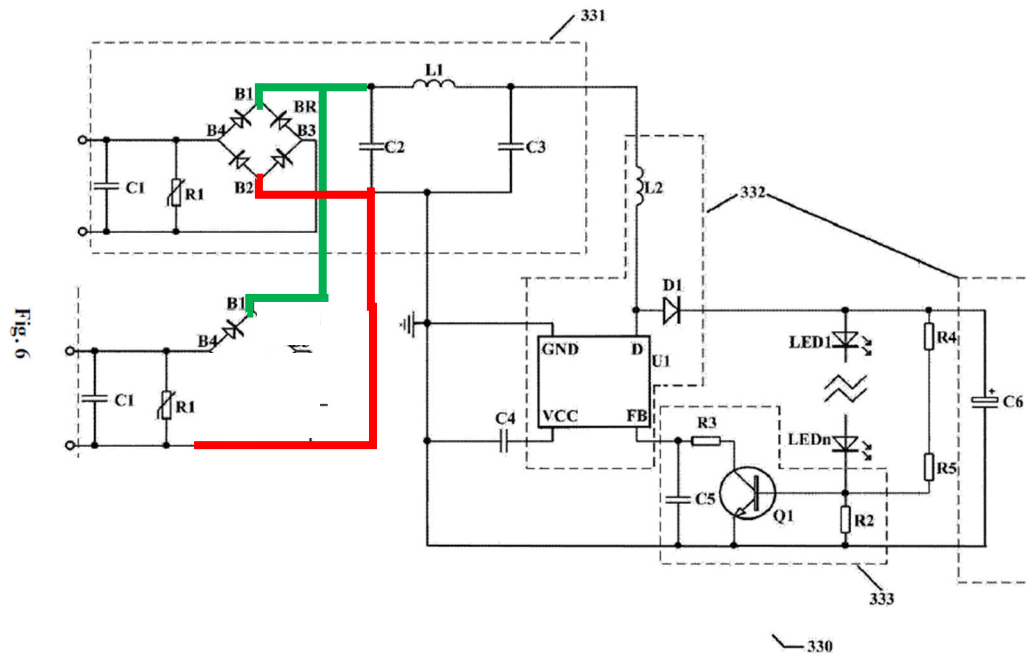
Limitation 20[a]: “The LED tube lamp according to claim 17, wherein the rectifying circuit comprises: a full-wave bridge rectifying circuit, having two input terminals electrically connected to the two conductive pins of one of the end caps, respectively, and having a positive output terminal and a negative output terminal; and”

134. It is my opinion that the combination of Li, Ono, Holec, and Guang describes a full-wave bridge rectifying circuit having two input terminals electrically connected to the two conductive pins of one of the end caps, respectively, and having a positive output terminal and a negative output terminal. *See* Limitation 18[a]. And as described above in Ground 1, Li-Ono-Holec discloses all limitations of Claim 17.

Limitation 20[b]: “a half-wave bridge rectifying circuit, having an input terminal electrically connected to one of the two conductive pins of the other one of the end caps, and having a positive output terminal and a negative output terminal,”

135. It is my opinion that the combination of Li, Ono, Holec, and Guang renders obvious a half-wave bridge rectifying circuit having an input terminal electrically connected to one of the two conductive pins of the other one of the end caps, and having a positive output terminal and a negative output terminal. As I discussed with respect to Limitation 18[b], Li-Ono-Holec-Guang includes a second full-wave bridge rectifying circuit. However, Li teaches that “although full-wave rectification is shown here, half-wave rectification is also usable.” EX1005, [0114]. Therefore, a POSITA would have understood with either (or both) of the full-wave bridge rectifying circuits BR1 could be replaced with a half-wave bridge rectifying circuit.

136. When one of the full-wave bridge rectifying circuits is replaced with a half-wave bridge rectifying circuits, the Li-Ono-Holec-Guang system becomes:

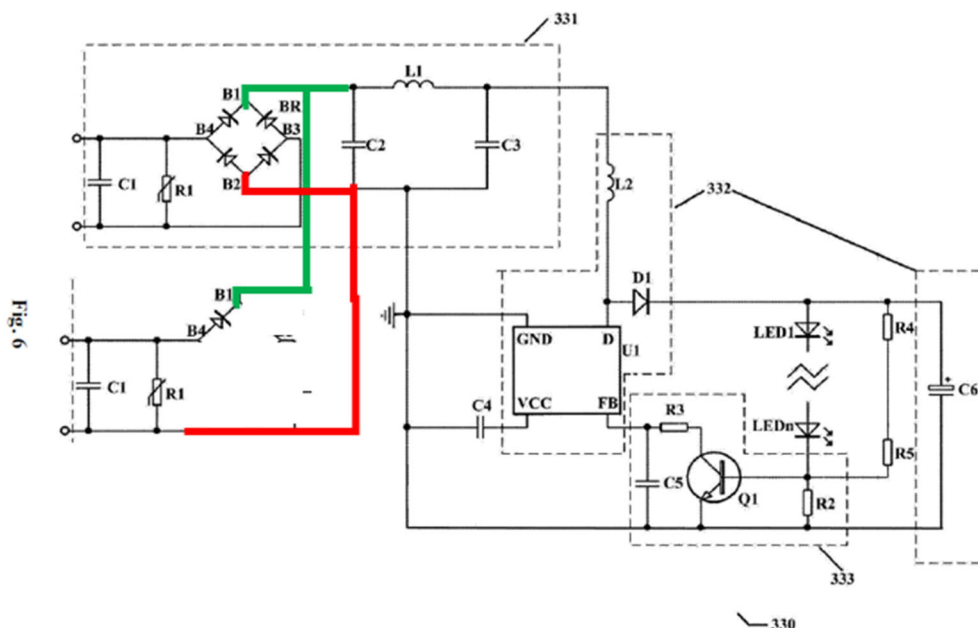


EX1005, FIG. 6 (as modified by Guang).

Limitation 20[c]: “wherein the positive output terminals of the full-wave bridge rectifying circuit and the half-wave bridge rectifying circuit are electrically connected to each other, and the negative output terminals of the full-wave bridge rectifying circuit and the half-wave bridge rectifying circuit are electrically connected to each other.”

137. It is my opinion that the combination of Li, Ono, Holec, and Guang renders obvious a circuit where the positive output terminals of the full-wave bridge rectifying circuit and the half-wave bridge rectifying circuit are electrically connected to each other, and the negative output terminals of the full-wave bridge rectifying circuit and the half-wave bridge rectifying circuit are electrically

connected to each other. The green positive output terminals of the full-wave bridge rectifying circuit and half-wave bridge rectifying circuit of Li-Ono-Holec-Guang are connected to the part of the filtering circuit near the inductor L1 and the capacitor C2. Additionally, the red negative output terminals of the full-wave bridge rectifying circuit and half-wave bridge rectifying circuit of Li-Ono-Holec-Guang are connected near the capacitor C2. Therefore, a POSITA would understand that the two rectifying circuits are electrically connected as each are part of the same circuit.



EX1005, FIG. 6 (as modified by Guang).

Claim 21: “The LED tube lamp according to claim 20, wherein the filtering circuit comprises: a first capacitor, having an end electrically connected to the positive output terminals of the full-wave bridge rectifying

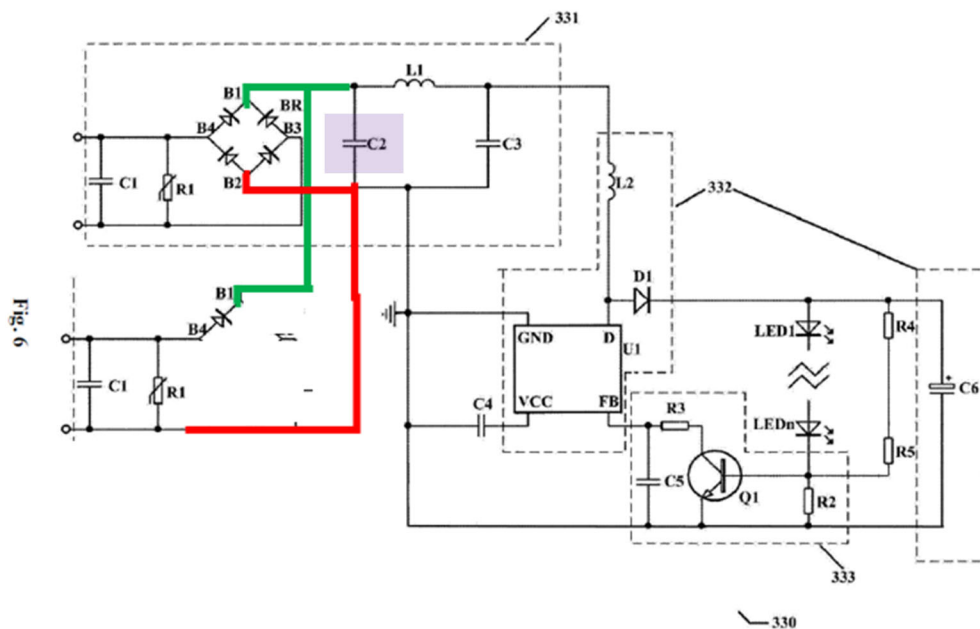
circuit and the half-wave bridge rectifying circuit, and the other end electrically connected to the negative output terminals of the first and the second full-wave bridge rectifying circuits.”

138. It is my opinion that the combination of Li, Ono, Holec, and Guang renders obvious that the filtering circuit includes a first capacitor having an end electrically connected to the positive output terminals of the full-wave bridge rectifying circuit and the half-wave bridge rectifying circuit, and the other end electrically connected to the negative output terminals of the first and the second full-wave bridge rectifying circuits.

139. Li discloses that “the bridge rectifier filter unit 331 comprises a full-bridge rectifier BR1, capacitors C1, C2 & C3, a varistor R1 and an inductor L1. After being rectified by the full-bridge rectifier BR1, AC (e.g., mains supply) outputs a full-wave pulsating voltage at the anode terminal 1. The filter capacitors C1, C2 & C3, the varistor R1 and the inductor L1 constitute an EMI filter circuit, which on the one hand, suppresses the impact of high-frequency interference in the AC grid on the drive circuit and on the other hand, suppresses the electromagnetic interference of the drive circuit to the AC grid.” EX1005, [0113]. Additionally, “[t]he filter capacitors C2 & C3 and the inductor L1 form a π -shaped filter loop and are electrically connected between the anode terminal B1 and the cathode terminal B2

of the full-bridge rectifier BR1 to low-pass filter the pulsating voltage output from the full-bridge rectifier BR1.” EX1005, [0115].

140. A POSITA would have understood that the [purple] capacitor C2, part of the filtering circuit, connected to one end of the inductor L1 because Li describes it as forming part of a π -shaped filter loop. Further, a POSITA would have understood that the capacitor C2 is also connected to the [red] anode (negative) terminal B1 of the full-wave bridge rectifying circuit and half-wave bridge rectifying circuit.



EX1005, FIG. 6 (as modified by Guang).

Limitation 22[a]: “The LED tube lamp according to claim 21, wherein the filtering circuit further comprises: an inductor, having an end electrically

connected to the end of the first capacitor, and the other end regarding as one of the filtering output terminals; and”

141. It is my opinion that the combination of Li, Ono, Holec, and Guang describes an inductor having an end electrically connected to the end of the first capacitor, and the other end is one of the filtering output terminals. *See* Limitation 19[a]. And as described above in Ground 1, Li-Ono-Holec discloses all limitations of Claim 17.

Limitation 22[b]: “a second capacitor, having an end electrically connected to the other end of the inductor, and the other end regarding as the other one of the filtering output terminals.”

142. It is my opinion that the combination of Li, Ono, Holec, and Guang describes a second capacitor having an end electrically connected to the other end of the inductor, and the other end is the other one of the filtering output terminals. *See* Limitation 19[c]. And as described above in Ground 1, Li-Ono-Holec discloses all limitations of Claim 17.

Claim 23: “The LED tube lamp according to claim 21, wherein the filtering circuit further comprises: an EMI-reducing capacitor, coupled between the two conductive pins of one of the end caps.”

143. It is my opinion that the combination of Li, Ono, Holec, and Guang renders obvious a filtering circuit including an EMI-reducing capacitor coupled

between the two conductive pins of one of the end caps. Li describes “pins 340A and 340B are arranged at one end of the substrate 310 as a first electrode and a second electrode of the LED drive circuit module 330, respectively (therefore, the pins 340A and 340B are hereinafter also referred to as ‘electrode pins’). After assembly, the electrode pins 340A and 340B are electrically connected to the plugs 211A and 211B on the end cover 21.”

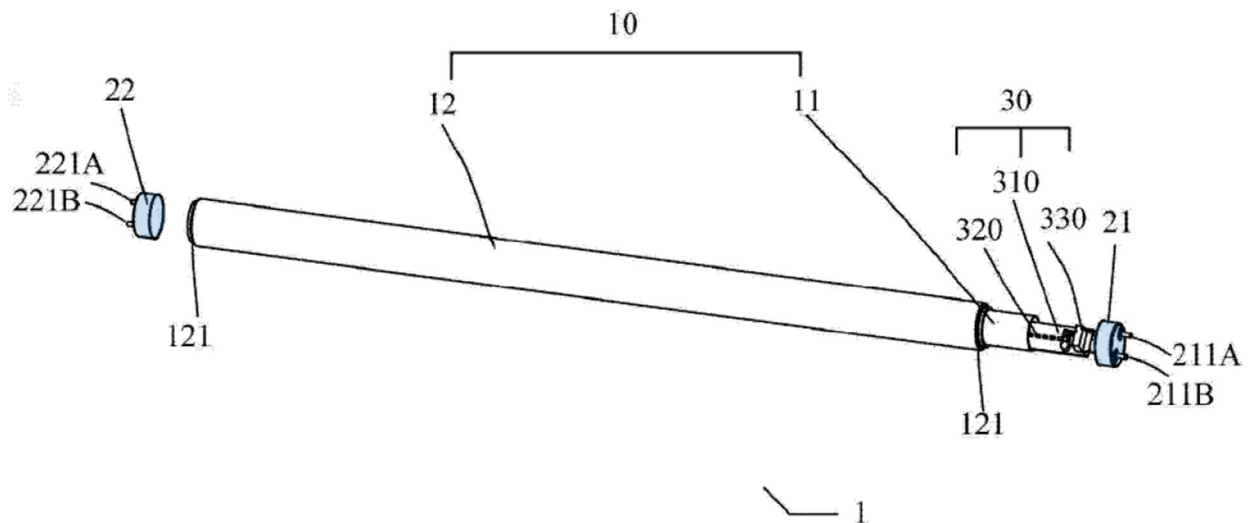
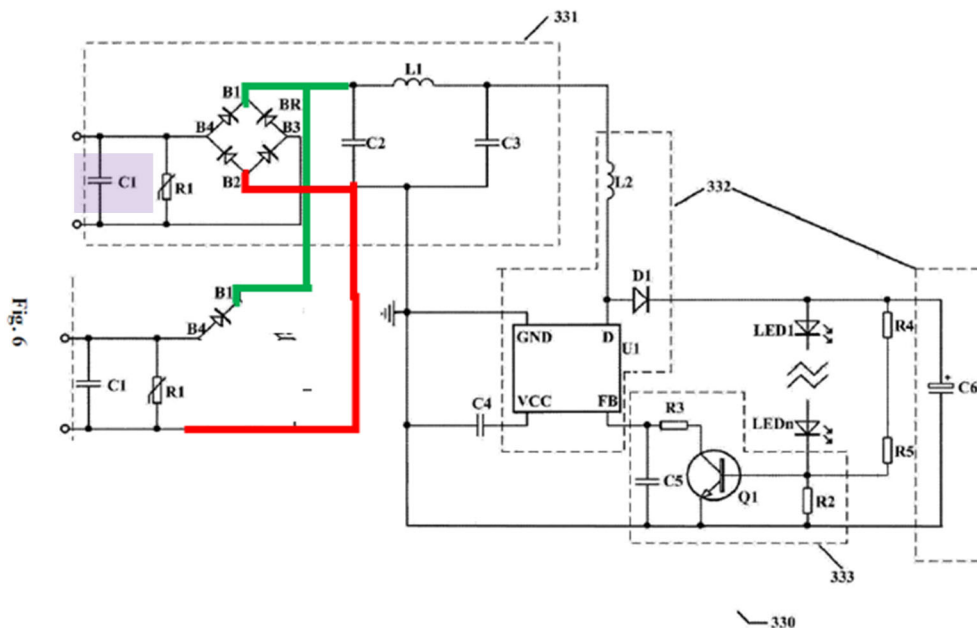


Fig. 1

EX1005, [0100], FIG. 1.

144. In addition to the filter circuit comprising capacitors C2, C3 and inductor L1 located after the bridge rectifier, Li further describes a [purple] capacitor C1 located between the AC inputs of the drive circuit 330 and discloses that the combination of “[t]he filter capacitors C1, C2 & C3, the varistor R1 and the inductor

L1 constitute an EMI filter circuit[]” EX1005, [0113]. A POSITA would have understood the AC input of the drive circuit to be electrically connected to the conductive pins in the end wall at one end of the tube light and thus the capacitor C1 is between the conductive pins of the end wall of the end cap. A POSITA, reviewing Li’s Figure 6, would have understood that the AC inputs of the drive circuit are the pins in the end wall of the end cap and that the capacitor C1 is connected between these input pins.



EX1005, FIG. 6 (as modified by Guang).

145. Additionally, a POSITA would understand that the capacitor C1 reduces EMI because Li refers to it as being part of “an EMI filter circuit.” EX1005, [0113].

C. Ground 3 - Claims 24-25 are Obvious over Li in view of Ono, Holec, and Esaki

1. Motivation to Combine

146. For the reasons I discussed throughout Ground 1, in my opinion, it would have been obvious to combine Li, Ono, and Holec. It is also my opinion that a POSITA would have also been motivated to combine Esaki with Li, Ono, and Holec with a reasonable expectation of success for several reasons.

147. Li teaches that “the driver power supply module shown in the foregoing Fig. 6 and Fig. 7 can also integrate circuits for other functions, such as a dimming control circuit, a sensing circuit, an intelligent lighting control circuit, a communication circuit and a protection circuit.” EX1005, [0136]. In my opinion, a POSITA would have recognized that incorporating the additional functions Li describes, like dimming, would be beneficial. For example, consumers often prefer LED lamps with the additional conveniences that dimming functionality provides. *See, e.g.*, EX1016, 3/36. Li’s dimming circuit specifically includes a boost circuit 332 that steps up the voltage to drive an array of LEDs connected in series. *See, e.g.*, EX1005, [0116].

148. Esaki is another example of a reference describing how to implement dimming functionality in an LED light. Specifically, Esaki describes that “[t]he lighting apparatus in accordance with the present invention includes: a switching regulator including a switching element; and a control circuit configured to adjust a

switching frequency and on-duration of the switching element in accordance with a dimming ratio.” EX1014, Abstract. Esaki’s “lighting apparatus” is “capable of dimming a semiconductor light emitting element” and “widening a dimming range of a light source load with a relatively simple configuration.” EX1014, 1:6-10, 1:65-67. The lighting apparatus is “connected to a light source load 3 comprising a semiconductor light emitting element such as a light emitting diode (LED).” EX1014, 4:50-56. “The light source load 3 may be an LED module formed of a plurality of (for example, 30) light emitting diodes connected in series, parallel, or series and parallel.” EX1014, 4:58-61. A POSITA would have understood that this design would a significant advantage over the boost circuit of Li as it provides for flexibility in the arrangement of LEDS, as opposed to Li which provides only for a series arrangement of LEDs, while retaining the same functionality. Therefore, a POSITA would have looked for ways to implement those functionalities in the Li-Ono-Holec LED lamp, especially in light of Li’s teachings that such functionality could be included.

149. Esaki teaches that the lighting apparatus includes “a step-down chopper circuit (a buck converter) 16; and a control circuit 4.” EX1014, 4:66-5:2. “The control circuit 4 is configured to control the step-down chopper circuit (switching regulator) 16 in order to supply a direct current having a magnitude corresponding to a dimming ratio to the light source load (DC light source) 3.” EX1014, 4:59-62.

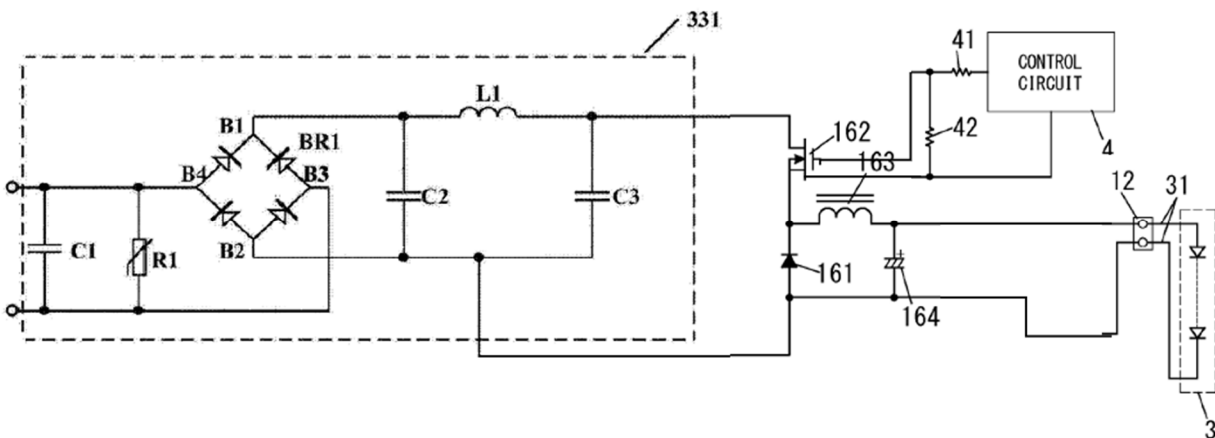
“The control circuit 4 is adapted to turn on and off the switching element 162 of the step-down chopper circuit 16 at a high frequency. In an example of FIG. 1, the switching element 162 includes a metal oxide semiconductor field effect transistor (MOSFET). The control circuit 4 is adapted to supply a gate signal (driving signal) between a gate and a source of the switching element 162, thereby turning the switching element 162 on and off.” EX1014, 6:1-12. Esaki’s dimming circuit specifically includes a buck circuit that steps down the voltage and increases the current to drive an array of LEDs connected in series, in parallel, or in series and parallel. Implementing a control circuit, like Esaki’s control circuit 4, and a switching circuit, like Esaki’s step-down chopper circuit 16, in Li-Ono-Holec would have been a simple replacement of Li-Ono-Holec’s dimming circuit that a POSITA would have expected to predictably achieve Esaki’s dimming benefit in the Li-Ono-Holec lamp with improved flexibility in designing the configuration of the LED load (e.g., providing options for arranging the LED load in parallel, series, or a combination of the two) over Li.

150. The technology of LED drive circuits and components used in such circuits were well-understood and were used in conventional ways in Esaki. *See, e.g.,* EX1014, 5:33-41 (the step-down chopper circuit 16 includes conventional components including a diode, a switch, and an inductor). A POSITA would have expected that Esaki’s circuitry would have behaved predictably when incorporated

into the Li-Ono-Holec drive circuit because Esaki already successfully demonstrated that such circuitry could be used in the same application—an LED lamp. Because the behavior of the circuitry would have been predictable, a POSITA would have expected that the replacement of Li's boost conversion unit 332 with Esaki's dimming circuitry in Li-Ono-Holec's drive circuit would have successfully improved the dimming functionality of the Li-Ono-Holec LED lamp.

2. *Modification of Li-Ono-Holec in view of Esaki*

151. In my opinion, a POSITA would have modified Li-Ono-Holec such that it included dimming functionality, as described by Esaki, using Esaki's step-down chopper circuit 16 and control circuit 4 to replace Li's boost conversion unit 332. The remainder of Li-Ono-Holec's drive circuit would have remained unchanged. Esaki's components would be incorporated into Li-Ono-Holec's drive circuit between the bridge rectifier filter unit 331 and output terminals 12.



Li FIG. 6
(Modified per Li-Ono-Holec-Esaki)

3. *Element-by-Element Analysis*

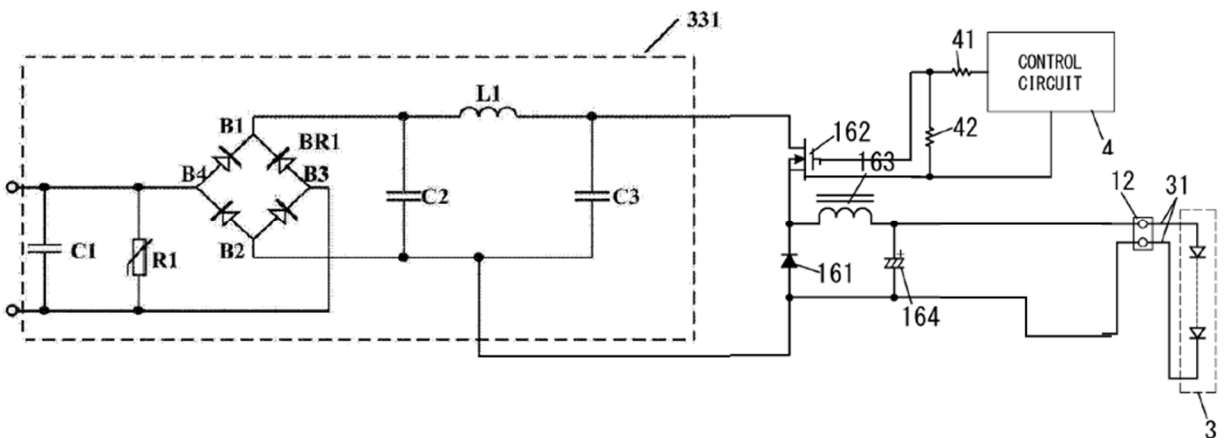
Limitation 24[a]: “The LED tube lamp according to claim 17, wherein at least some of the electronic components form a driving circuit electrically connected to the filtering output terminals of the filtering circuit and have two driving output terminals electrically connected to the LED light strip; and further wherein the driving circuit comprise: a controller;”

152. It is my opinion that the combination of Li, Ono, Holec, and Esaki renders obvious that at least some of the electronic components form a driving circuit electrically connected to the filtering output terminals of the filtering circuit, having two driving output terminals electrically connected to the LED light strip, and including a controller. As I explained above in Section VIII.A, Li, Ono, and Holec describe all elements of Claim 17. Further, as I previously explained in Section

VIII.C.1, a POSITA would have been motivated to include Esaki's control and step-down chopper circuits in Li-Ono-Holec to provide dimming functions over a wider range of LED arrangements.

153. Esaki discloses a driving circuit. Specifically, the step-down chopper circuit 16 is connected to the output connector 12 which outputs electrical signals to the LEDs on the light strip. EX1014, 5:29-32, 5:55-57. Therefore, Esaki's step-down chopper circuit is a driving circuit and is connected to the output of the filtering circuit included in the bridge rectifier filter unit 331. It is also connected to output terminals 12 to which the LED light strip is connected such that it provides power to the LEDs on the LED light strip.

154. The drive circuit includes a controller in the form of Esaki's control circuit 4. "The control circuit 4 is configured to adjust a switching frequency and on-duration of the switching element 162 in accordance with the dimming ratio." EX1014, 5:62-65. Esaki's control circuit 4 is part of the drive circuit connected between the bridge rectifier filter unit 331 and the LED loads 3.



EX1005, FIG. 6 (as modified by Esaki).

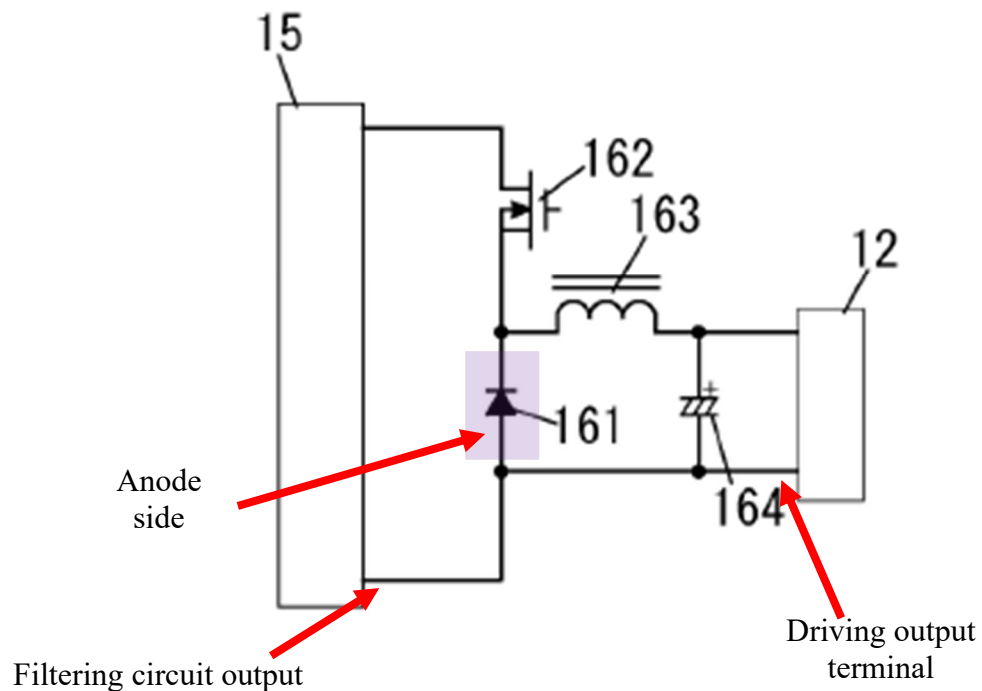
Limitation 24[b]: “a diode, having an anode electrically connected to one of the filtering output terminals and one of the driving output terminals;”

155. It is my opinion that the combination of Li, Ono, Holec, and Esaki renders obvious a diode having an anode electrically connected to one of the filtering output terminals and one of the driving output terminals. Further, as I previously explained in Section VIII.C.1, a POSITA would have been motivated to include Esaki’s control and step-down chopper circuits in Li-Ono-Holec to provide dimming functions.

156. Esaki’s “step-down chopper circuit 16 includes: a [purple] diode (a regenerative diode) 161.” EX1014, 5:35-41. The step-down chopper circuit 16 can have multiple configurations. EX1014, 25:64-26:6. In the configuration shown in

Figure 16, the diode 161 is arranged such that the anode side is connected to both an output of circuit 15 and the driving output terminal 12.

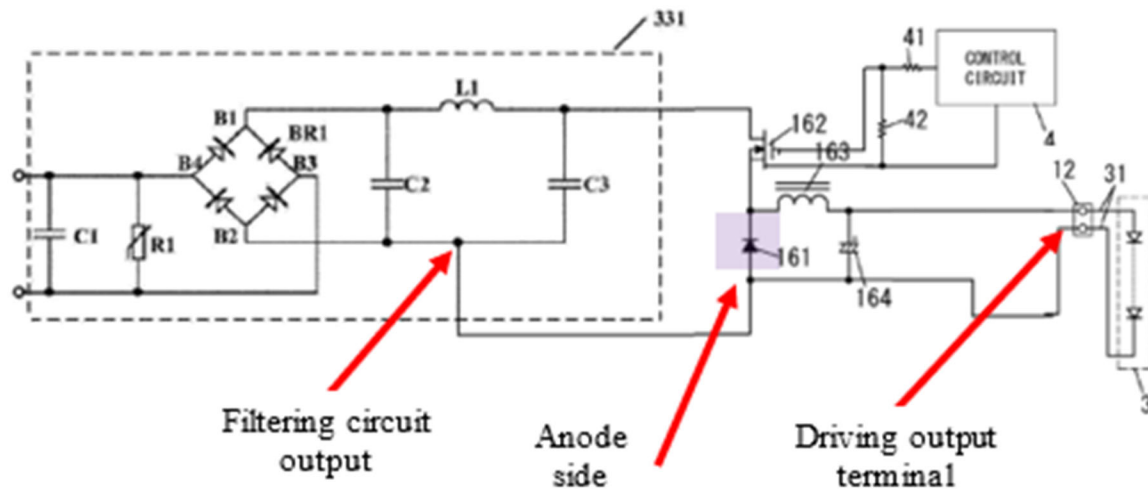
FIG. 16



EX1014, FIG. 16. The DC power supply circuit 15 includes a smoothing capacitor, which a POSITA would have understood to be a type of filter. EX1014, 5:29-31. Thus, a POSITA would have understood that the connection between the anode side of the diode 161 and the DC power supply circuit 15 is a connection between the anode side of the diode 161 and a filtering circuit.

157. When Esaki's step-down chopper circuit is incorporated into Li-Ono-Holec-Esaki, the anode of the diode 161 is connected to an output of the π -shaped

filter loop of the bridge rectifier filter unit 331. The anode of the diode 161 is also connected to a driving output terminal to which the LED loads 3 are connected.



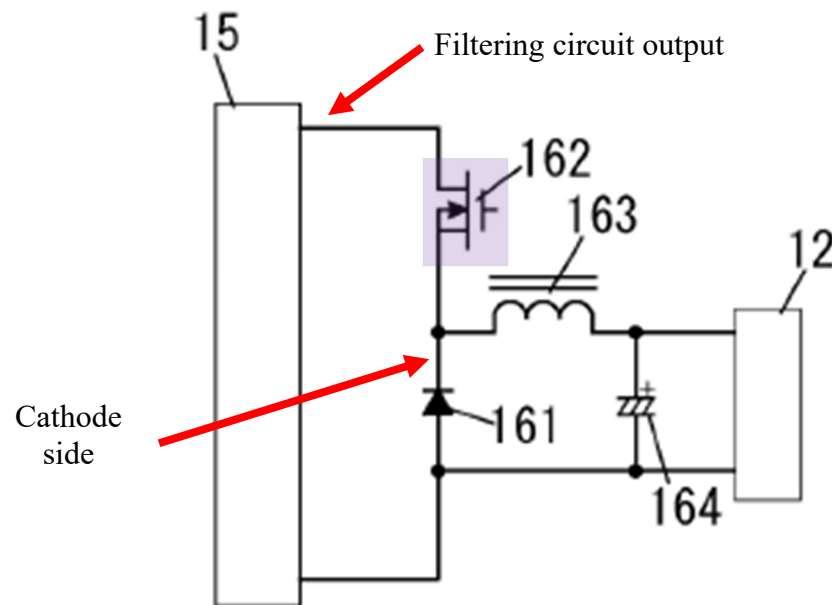
EX1005, FIG. 6; EX1014, FIG. 16.

Limitation 24[c]: “a switch, having a first terminal coupled to the other one of the filtering output terminals, a second terminal electrically connected to a cathode of the diode, and a control terminal coupled to the controller, wherein the switch is turned on or off in response to a signal received from the controller; and”

158. It is my opinion that the combination of Li, Ono, Holec, and Esaki renders obvious a switch having a first terminal coupled to the other one of the filtering output terminals, a second terminal electrically connected to a cathode of the diode, and a control terminal coupled to the controller, where the switch is turned

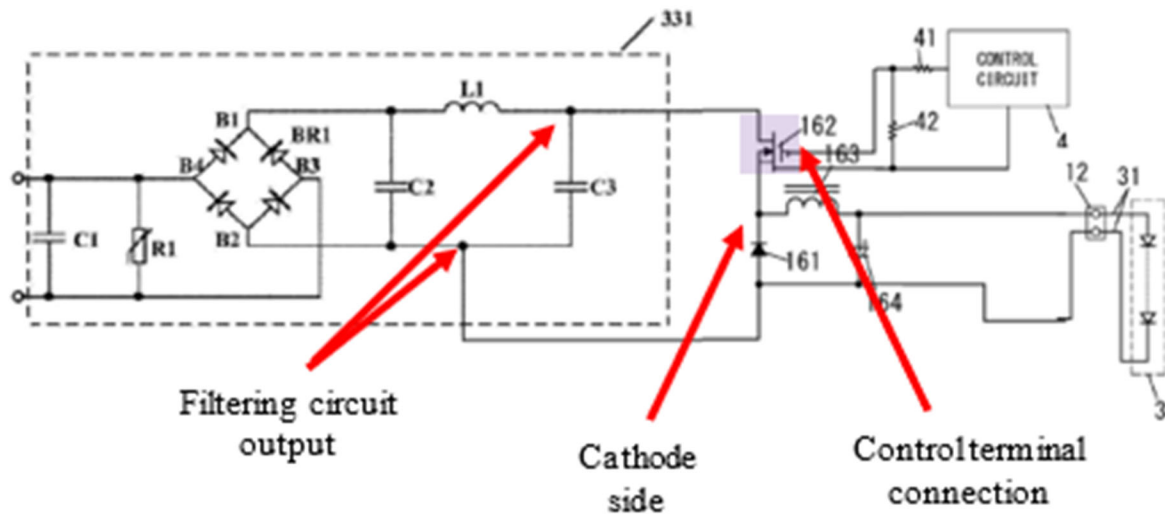
on or off in response to a signal received from the controller. Further, as I previously explained in Section VIII.C.1, a POSITA would have been motivated to include Esaki's control and step-down chopper circuits in Li-Ono-Holec to provide improved dimming functions.

159. Esaki's "step-down chopper circuit 16 includes: ... a [purple] switching element 162 connected in series to each other and connected between the output terminals of the DC power supply circuit (the DC power supply) 15; and an inductor 163 connected in series to the light source load 3 between both ends of the diode 161." EX1014, 5:35-41. In the configuration of Figure 16, one end of the switching element 162 is connected to the cathode side of the diode 161 and the other end is connected to the DC power supply circuit 15. As I explained in Limitation 24[b], the DC power supply circuit 15 includes a smoothing capacitor that acts as a filter.

FIG. 16

EX1014, FIG. 16.

160. When Esaki's step-down chopper circuit is incorporated into Li-Ono-Holec-Esaki, one end of the switching element 162 is connected to an output of the π -shaped filter loop of the bridge rectifier filter unit 331 and the other end is connected to the cathode side of the diode 161. Further, the control terminal is connected to the control circuit 4 to allow control circuit to the switching element 162 on and off. EX1014, 5:59-6:8, 6:34-40.



EX1005, FIG. 6; EX1014, FIG. 16.

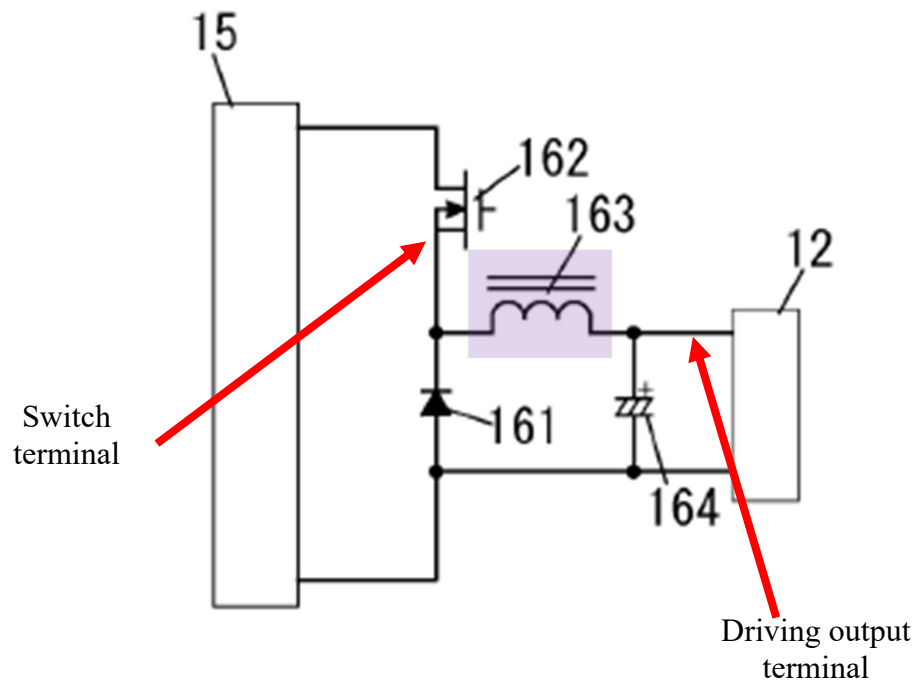
Limitation 24[d]: “an inductor, having an end electrically connected to the second terminal of the switch, and another end electrically connected to the LED light strip via the other one of the driving output terminals.”

161. It is my opinion that the combination of Li, Ono, Holec, and Esaki renders obvious an inductor having an end electrically connected to the second terminal of the switch and another end electrically connected to the LED light strip via the other one of the driving output terminals. Further, as I previously explained in Section VIII.C.1, a POSITA would have been motivated to include Esaki’s control and step-down chopper circuits in Li-Ono-Holec to provide dimming functions.

162. Esaki’s “step-down chopper circuit 16 includes: . . . an [purple] inductor 163 connected in series to the light source load 3 between both ends of the

diode 161.” EX1014, 5:35-41. In the configuration of Figure 16, one end of the inductor 163 is connected to the terminal of the switching element 162 that is connected the cathode side of the diode 161 and the other end of the inductor 163 is connected to the driving output terminal 12. As I explained in Limitation 24[b], the DC power supply circuit 15 includes a smoothing capacitor that acts as a filter.

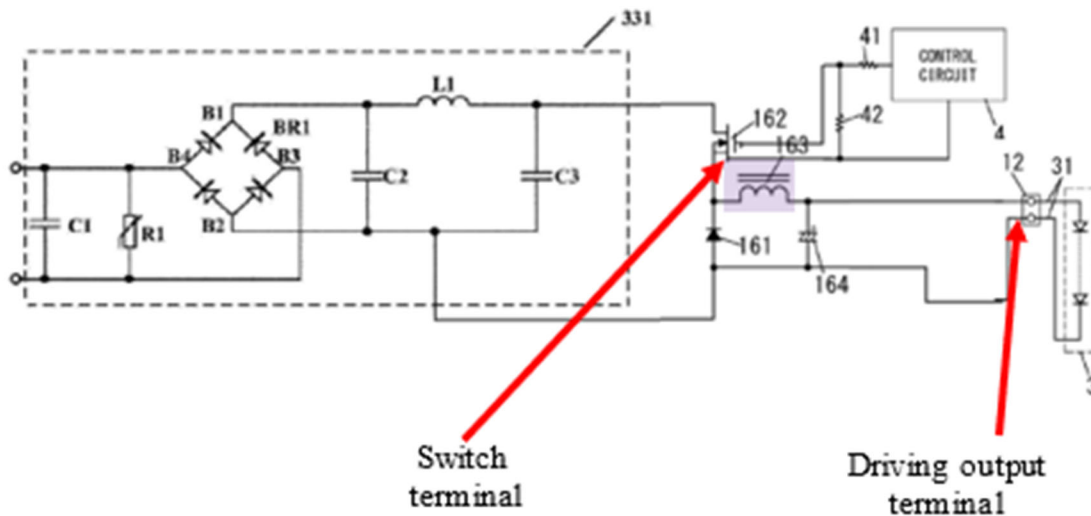
FIG. 16



EX1014, FIG. 16.

163. When Esaki’s step-down chopper circuit is incorporated into Li-Ono-Holec-Esaki, one end of the inductor 163 is connected to a terminal of the switching element 162 that is also connected to the cathode side of the diode 161. Further, the

other end of the inductor 163 is connected to the circuit output that drives the LED loads 3.



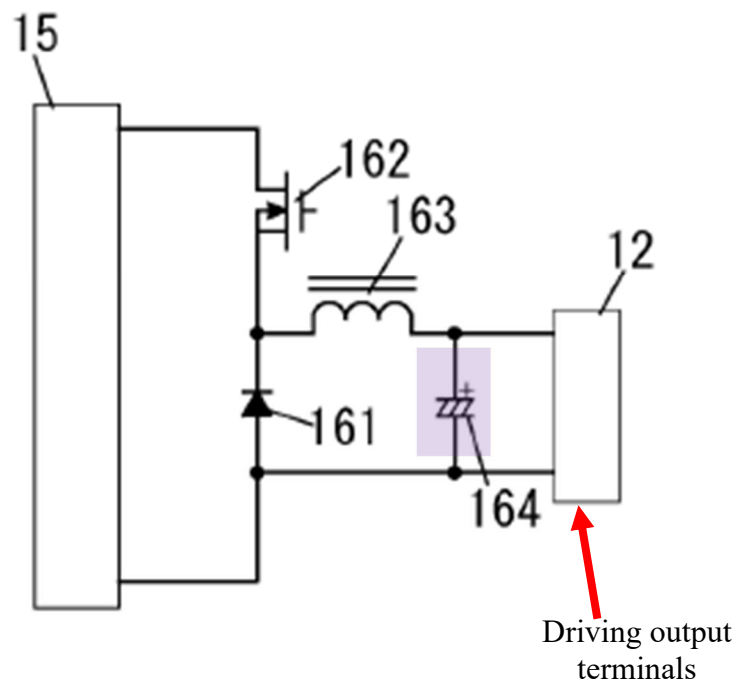
EX1005, FIG. 6; EX1014, FIG. 16.

Claim 25: “The LED tube lamp according to claim 24, wherein the electronic components forming the driving circuit further comprise: a capacitor, electrically connected between the driving output terminals.”

164. It is my opinion that the combination of Li, Ono, Holec, and Esaki renders obvious a driving circuit including a capacitor electrically connected between the driving output terminals. Further, as I previously explained in Section VIII.C.1, a POSITA would have been motivated to include Esaki’s control and step-down chopper circuits in Li-Ono-Holec to provide improved dimming functions and flexibility in the LED load configuration.

165. Esaki discloses that “The step-down chopper circuit 16 also includes an output capacitor 164.” EX1014, 5:50-51. “The [purple] output capacitor 164 is connected between output terminals thereof (between both terminals of the output connector 12).” EX1014, 5:52-54.

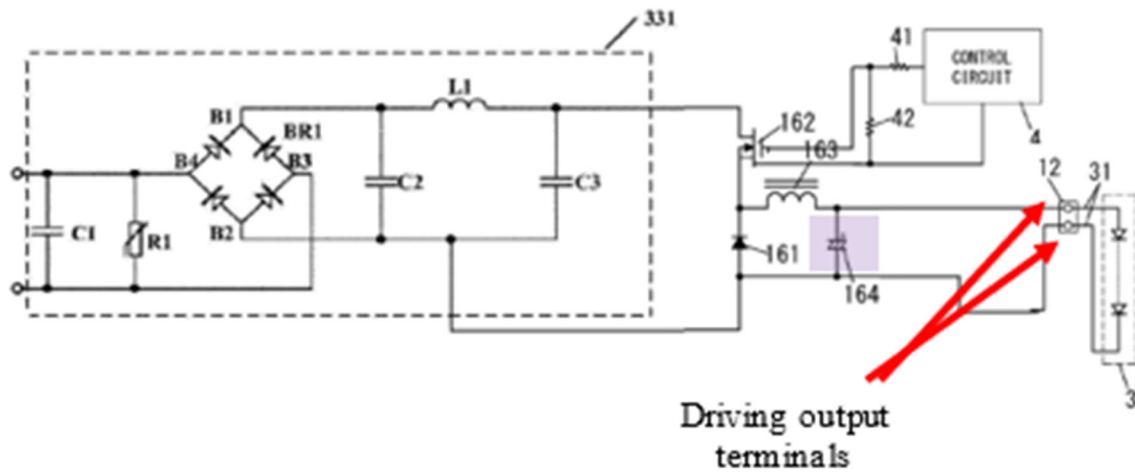
FIG. 16



EX1014, FIG. 16.

166. When Esaki’s step-down chopper circuit is incorporated into Li-Ono-Holec-Esaki, the capacitor 164 is connected in parallel with the circuit outputs that drive the LED loads LED1 to LEDn. Additionally, the circuit includes the [blue]

capacitor C6 that is also connected in parallel with the circuit outputs that drive the LED loads LED1 to LEDn. EX1005, [0119].



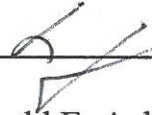
EX1005, FIG. 6; EX1014, FIG. 16.

X. CONCLUSION

167. 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.

March 8, 2023

Date



Donald E. Ackley, Ph.D.