

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LEDUP Manufacturing Group Ltd.,
Petitioner

versus

Seasonal Specialties, LLC,
Patent Owner

U.S. Patent No. 11,096,252

Filing Date: Nov. 25, 2019

Issue Date: Aug. 17, 2021

Title: Resistive Bypass for Series Lighting Circuit

Inter Partes Review No.: IPR2024-01258

Reply Declaration of E. Fred Schubert, Ph.D.

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List of documents relied upon

Shorthand	Description
'252 patent	U.S. Patent No. 11,096,252
'252 file history	Prosecution File History of U.S. Patent No. 11,096,252
Inoue	U.S. Patent Application Publication No. 2005 / 0168162
Holler	U.S. Patent No. 1,510,847
Smith	U.S. Patent No. 4,675,575
Fisherman	U.S. Patent No. 2,760,120
Callahan	U.S. Patent No. 7,015,825
Yu	U.S. Patent Application Publication No. 2008 / 0025024
Craford	M. G. Craford "LEDs challenge the incandescents" <i>IEEE Circuits and Devices Magazine</i> , Vol. 8.5, pages 24-29, 1992.
Schubert	E. F. Schubert "Light Emitting Diodes," 2nd edition, Cambridge University Press, Cambridge UK, 2006.
POPR	Patent Owner Preliminary Response
Higman '252 Declaration	Declaration of Dr. Higman in support of the POPR under IPR2024-01258 regarding the '252 patent. ¹
PTAB ID	PTAB Institution Decision, IPR2024-01258 ('252 patent).

¹ It is my understanding that Dr. Higman's statements (including paragraph numbers) made in his '252 Declaration (IPR2024-01258 regarding the '252 patent) track Dr. Higman's statements (including paragraph numbers) made in his '794 Declaration (IPR2024-01259 regarding the '794 patent).

Furthermore, it is my understanding that the '252 and '794 patents share the same specification. For this reason, I take the liberty to cite to the '252 specification in both of my Reply Declarations (IPR2024-01258 regarding the '252 patent, and IPR2024-01259 regarding the '794 patent)

Cotropia	Cotropia, Christopher A. “Predictability and Nonobviousness in Patent Law After KSR” <i>Mich. Telecomm. & Tech. L. Rev.</i> 20 (2013): 391.
Zhang	Dissertation titled “Zinc Oxide based Nanowire Arrays for Selective Detection of Multiple Gaseous Analytes at Elevated Temperature” by Bo Zhang, Ph.D., of the University of Connecticut, published in 2020.

I, E. Fred Schubert declare as follows:

I. Summary of Background and Qualifications

1. I incorporate the section titled “Summary of Background and Qualifications” of my August 2, 2024 Declaration into the present Declaration.

II. Compensation

2. I incorporate the section titled “Compensation” of my August 2, 2024 Declaration into the present Declaration.

III. Materials Reviewed

3. In preparing this declaration, I have reviewed and considered at least the documents cited in the List of Petitioner’s Exhibits above, and the documents referenced in this declaration.

IV. Relevant Legal Standards

4. I incorporate the section titled “Relevant Legal Standards” of my August 2, 2024 Declaration into the present Declaration.

V. Identification of challenge

5. The table below identifies the Grounds that I have considered.

Ground	Basis	Reference	Claims
1	Anticipation	Inoue	1
2	Obviousness	Inoue in view of Holler	1 and 10
3	Obviousness	Holler in view of Smith	1, 10 and 11
4	Obviousness	Fisherman in view of Callahan	1, 2, 4, 8 and 10
5	Obviousness	Inoue in view of Smith	2, 3, 4, 5, 6, 8 and 9
6	Obviousness	Holler in view of Callahan	1, 2, 4, 8, 10, 11, 12, 13 and 14
7	Obviousness	Yu	1, 2 and 10

Table caption: Asserted Grounds of invalidity and the associated claims of the '252 patent.

VI. Summary of opinions

6. My original opinions have not changed. Therefore, I incorporate the section titled "Summary of opinions" of my August 2, 2024 Declaration into the present Declaration.

7. I have carefully reviewed the '252 Declaration of Dr. Higman, and it has not changed my opinion that the challenged claims are anticipated and/or obvious over the asserted prior art. It is further my opinion that the subject matter technology is predictable so that a POSA would have had a reasonable expectation of success, as discussed in greater detail below.

VII. The '252 patent

VII.A. Overview

8. I incorporate the section titled “The '252 patent – Overview” of my August 2, 2024 Declaration into the present Declaration.

VII.B. Inherent resistance of light sources, ohmic resistance of light sources, and operation of lighting strings

9. I incorporate the section titled “The '252 patent – Inherent resistance of light sources, ohmic resistance of light sources, and operation of lighting strings” of my August 2, 2024 Declaration into the present Declaration.

VII.C. Level of Ordinary Skill in the Art

10. I incorporate the section titled “The '252 patent – Level of Ordinary Skill in the Art” of my August 2, 2024 Declaration into the present Declaration.

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

11. I incorporate the section titled “The '252 patent – Claim Construction Under 37 C.F.R. § 42.104(b)(3)” of my August 2, 2024 Declaration into the present Declaration.

VII.E. The Challenged Claims of the '252 Patent

12. I incorporate the section titled “The '252 patent – The Challenged Claims of the '252 Patent” of my August 2, 2024 Declaration into the present Declaration.

VIII. Overview of the prior art

VIII.A. Overview of the Inoue prior art

13. I incorporate the section titled “Overview of the Inoue prior art” of my August 2, 2024 Declaration into the present Declaration.

VIII.B. Overview of the Holler prior art

14. I incorporate the section titled “Overview of the Holler prior art” of my August 2, 2024 Declaration into the present Declaration.

VIII.C. Overview of the Smith prior art

15. I incorporate the section titled “Overview of the Smith prior art” of my August 2, 2024 Declaration into the present Declaration.

VIII.D. Overview of the Fisherman prior art

16. I incorporate the section titled “Overview of the Fisherman prior art” of my August 2, 2024 Declaration into the present Declaration.

VIII.E. Overview of the Callahan prior art

17. I incorporate the section titled “Overview of the Callahan prior art” of my August 2, 2024 Declaration into the present Declaration.

VIII.F. Overview of the Yu prior art

18. I incorporate the section titled “Overview of the Yu prior art” of my August 2, 2024 Declaration into the present Declaration.

IX. Series-parallel lighting circuit configuration

19. In a series lighting circuit, the lighting elements are connected in a series circuit. A well-known drawback of series circuits is that an interruption of the circuit, for example by a burned-out lighting element, causes all lighting elements to become unlit. The '252 patent states about these series lighting circuits: "More recently, series connected lighting sources are becoming popular in task lighting, general illumination, automotive lighting, and specialty lighting utilizing LEDs. Generally, the lights in these lighting circuits are electrically in series rather than in parallel. One particular drawback to these types of lighting circuits is that when a lighting source is removed from the circuit, is burnt out, defective, or has a loose connection, the entire lighting circuit is rendered inoperable." (Underlining added, '252 patent, column 1:29-37)²

20. A series-parallel lighting circuit configuration includes lighting elements that are connected in series, with each of the lighting elements having a parallel resistor that, in the art, is known as "shunt" or "bypass resistor." The bypass resistor allows for an alternative current path when one or more of the lighting elements have failed (burned out). Such a series-parallel lighting circuit avoids the drawback of the series circuit that fails in its entirety when one of the lighting elements burns out.

21. Holler discloses one type of series-parallel lighting circuit. Holler's series-parallel lighting circuit includes incandescent lighting elements connected in series, with each incandescent lighting element being shunted by a bypass resistor, as disclosed in Holler's Figure 2.

22. Inoue discloses another type of series-parallel lighting circuit. Inoue's series-parallel lighting circuit includes LED lighting elements connected in series, with

² The '252 and '794 patents share the same specification.

each LED lighting element being shunted by a bypass resistor, as disclosed in Inoue's Figure 3.

23. Smith discloses yet another type of series-parallel lighting circuit. In Smith, multiple strings ("limb line sets") of series-connected lighting elements ("limb line") are connected in parallel. The configuration can be visualized by a tree having a trunk line to which multiple branch lines ("limb line sets") are connected in parallel, with each branch line ("limb line") being an LED series circuit. Smith discloses the circuit configuration and associated advantages as follows: "This string uses a series-parallel configuration wherein the upper and lower portion of the master trunk line and the individual light-emitting diodes within each limb line are connected in series while the limb line sets are connected in parallel with each other for enabling more lights to be illuminated with less power, for increasing the uniformity of illumination along the length of the string, and for minimizing light outage due to bulb burnout." (Underlining added, Smith, Abstract)

24. In summary, various types of series-parallel lighting circuits have been described in the technical literature and therefore have been well known prior to the priority date of the '252 patent, that is, prior to 2006.

X. Ground 1: Inoue anticipates Claim 1 ('252 patent)

25. I incorporate the section titled "Ground 1: Inoue anticipates Claim 1" of my August 2, 2024 Declaration into the present Declaration.

26. In addition, I respond to statements made by Dr. Higman.

27. Petitioner contends that the Inoue's Figure 3 embodiment, shown below, anticipates the '252 patent. The Figure 3 embodiment shows an LED lighting circuit

in which two LEDs are in series; each LED (LED1 and LED2) is shunted by a bypass resistor (R12 and R13).

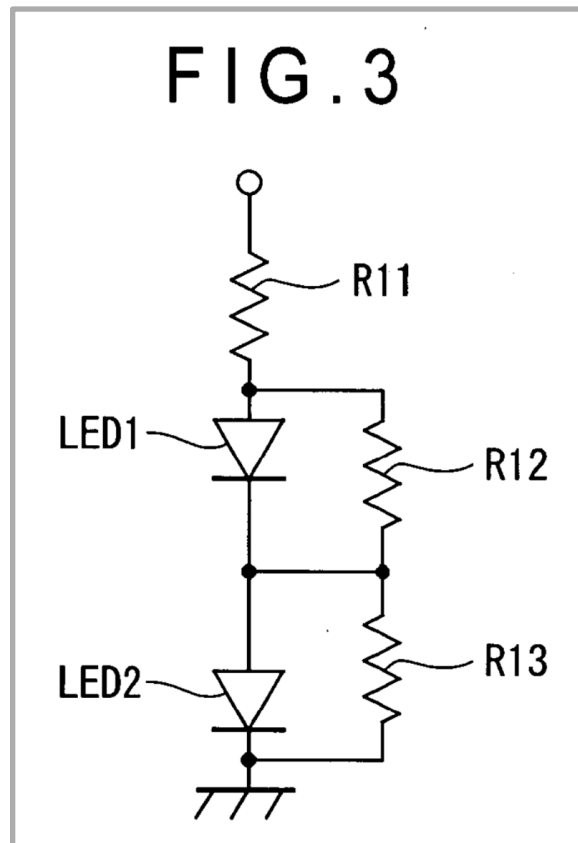


Figure caption: Inoue, Fig. 3, showing two LEDs in a series circuit, with each LED (LED1 and LED2) being shunted by a parallel bypass resistor (R12 and R13).

28. When one of the LEDs fails and “burns out” it becomes an open circuit. The current will necessarily continue to flow through the shunt (bypass resistor) so that the functional LED remains lit.

29. It is my understanding that a prior art reference is assumed to be enabling. Given that the Inoue reference is enabled, a POSA would be able to choose suitable LEDs (LED1 and LED2) and bypass resistors (R12 and R13). Given that the Inoue circuit is an elementary diode circuit (LED circuit), the design of the circuit, including the choice of resistors, would be within the capabilities of a POSA.

30. Dr. Higman disputes that Inoue anticipates the '252 patent. He states:

“57. Inoue’s bypass is not a resistor bypass that continues to conduct electricity and remaining lights lit, even when one [or] more individual lighting elements in the series are burned out. Inoue’s circuit configuration shown in Fig. 3 and other figures in the patent’s specification has the LEDs always carrying current when the circuit is powered.”

(Underlining added, Higman '252 Declaration, paragraph 57)

31. I disagree with Dr. Higman that “Inoue’s bypass is not a resistor bypass that continues to conduct electricity [...] when [...] lighting elements [...] are burned out.” Inoue’s Figure 3 lighting circuit has a continuous resistive path (through R11, R12, and R13) from the positive power supply terminal (shown at the top of Fig. 3) to the negative power supply terminal (ground terminal, shown at the bottom of Fig. 3). Based on the laws of electrical engineering (including Ohm’s law), whenever there is a continuous resistive path between two power supply terminals, a current will flow through the resistive path (R11, R12, and R13). This fact satisfies claim limitation [1b] of the '252 patent which requires: “said bypass resistor being in circuit and conducting current at all times when current is flowing through the circuit regardless of whether the LED light sources are conducting current therethrough” (underlining added, '252 patent, claim limitation [1b]).³ An electrical current will generally flow through all available paths, including through the LEDs,⁴ thereby keeping a current flowing “at all times” and keeping the functioning LEDs

³ Claim limitation [1b] of the '252 patent does not appear to require that current is flowing through the light sources (thereby keeping them lit), but rather through the “bypass resistor [...] conducting current at all times”.

⁴ For the circuit of interest (Inoue’s Fig. 3 circuit), which includes LEDs (with a threshold voltage, such as 2.5 V), I assume that the power supply voltage is sufficiently high so that an LED’s threshold voltage is reached and the lighting circuit emits light.

lit regardless of whether there are additional burned-out LEDs that do not conduct current therethrough. That is, the functioning LEDs remain lit even when other LEDs cease to operate.

32. As a **first example**, let us assume that LED1 in Inoue's Fig. 3 circuit has burned out. For this case, I have illustrated the current flow path in the annotated figure below. The circuit elements LED2 and R13 are in parallel and the current will flow through all available current paths including LED2. That is, an electrical current does not discriminate against any circuit element, and flow through all available circuit elements. Accordingly, Inoue's series-parallel lighting circuit is a resistor bypass circuit that continues to conduct electricity through the resistors (R11, R12, and R13) and the functioning LED2 (and keeps it lit) even when LED1 is burned out.

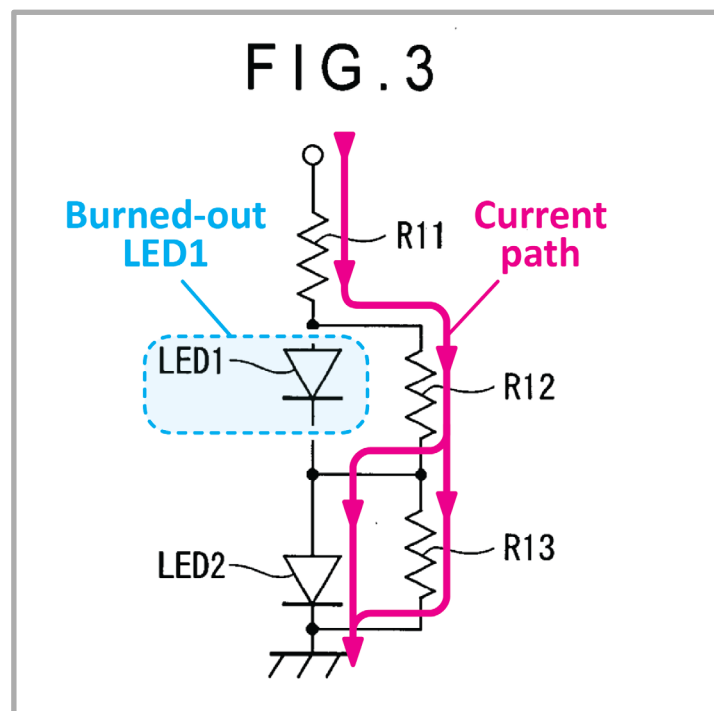


Figure caption: Inoue, Fig. 3, annotated, showing burned-out LED1 and functioning LED2, with current flowing through the bypass resistors R12, R13, and LED2, that, accordingly, remains lit.

33. I have modified Inoue's Fig. 3 circuit to include three LEDs and three associated bypass resistors as shown in the figure below. As a **second example**, let us assume that LED1 and LED2 have burned out. For this case, I have illustrated the

current flow path in the figure below. The circuit elements LED3 and R14 are in parallel and the current will flow through all available current paths including LED3. That is, an electrical current does not discriminate against any circuit element, and will flow through all available circuit elements. Accordingly, Inoue's series-parallel lighting circuit is a resistor bypass circuit that continues to conduct electricity through the resistors (R11, R12, R13, and R14) and the functioning LED3 (and keeps it lit) even when LED1 and LED2 are burned out.

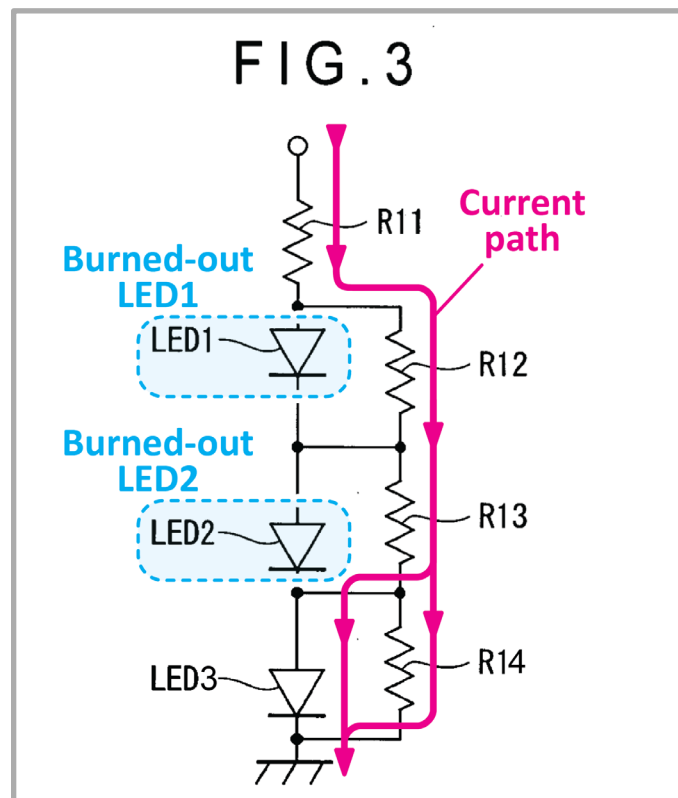


Figure caption: Inoue, Fig. 3, modified and annotated, showing burned-out LED1 and LED2, and functioning LED3, with current flowing through the bypass resistors R12, R13, R14, and LED3 that, accordingly, remains lit.

34. Dr. Higman further states:

“59. Inoue does not disclose that LED2 in Figure 3 will remain lit if LED1 burns out or stops carrying current, and that all current will flow through the bypass containing R12. Inoue teaches how to use R12 and R13 to change the luminance in response to an increased or decreased power voltage level. EX1003 at [0034].”

(Underlining added, Higman '252 Declaration, paragraph 59)

35. I disagree with Dr. Higman that “Inoue does not disclose that LED2 in Figure 3 will remain lit if LED1 burns out or stops carrying current, and that all current will flow through the bypass containing R12.” Although not explicitly described in Inoue, if LED1 fails (“burns out”), as a consequence of the series lighting circuits having shunts, the current continues to flow through the bypass resistors R12, R13, and LED2, so that LED2 remains lit. Electrical currents do not pick and choose their path but proceed along all possible paths, including LED2, thereby keeping it lit.

XI. Ground 2: Inoue in view of Holler obviates Claims 1 and 10 ('252 patent)

36. I incorporate the section titled “Ground 2: Inoue in view of Holler obviates Claims 1 and 10” of my August 2, 2024 Declaration into the present Declaration.

37. In addition, I respond to the comments made by Dr. Higman.

38. Petitioner has asserted that a POSA would use the guidance of Holler with respect to the resistance values of the bypass resistors. Holler discloses: “It has been found that good results are obtained if each of the [bypass] resistances 6 is made of a resistance equal to that of the lamp with which it is in shunt and of approximately twice the current carrying capacity.” (Underlining added, Holler, page 2, right-hand-side column, lines 96-101). Based on Holler’s teaching, a POSA would choose the bypass resistance values to be “equal to that of the lamp.” This obviates the teachings of the '252 patent which claims that “the resistance of the bypass resistor is equal to or greater than the inherent resistance of the light source.” (Underlining added, '252 patent, claim 10)

39. The resistance of a circuit element, such as a resistor, incandescent light source, or LED light source, is defined by Ohm's law as the ratio of voltage to current, that is, $R = V/I$, where R is the resistance of the circuit element, V is the voltage across it, and I is the current through it.

40. The '252 patent uses the term "inherent resistance" ("inherent resistance of the light source" '252 patent, claim 10). The term "inherent resistance" is used in claim 10 yet not further described in the specification of the patent. A POSA would understand the inherent resistance to be defined by Ohm's law. The inherent resistance of an LED light source, based on Ohm's law, is the ratio of voltage to current, that is, $R = V/I$, where R is the resistance of the light source, V is the voltage across the light source, and I is the current through the light source.

41. This understanding of the inherent resistance is consistent with the technical literature, for example the dissertation titled "Zinc Oxide based Nanowire Arrays for Selective Detection of Multiple Gaseous Analytes at Elevated Temperature" by Bo Zhang, Ph.D., of the University of Connecticut, published in 2020. The author defines the resistance based on Ohm's law as the ratio of voltage to current: "Similar to the operating principle of electrical resistance mode [...] based on the ratio of voltage to current [...]." (Zhang, page 101) The author also employs the term "inherent resistance" (Zhang, page 35) and offers no interpretation other than Ohm's resistance, that is, the ratio of voltage to current.

42. Dr. Higman appears to state that LEDs do not have a resistance like an incandescent bulb:

"62. In my opinion, a POSITA would not have been motivated to use the bypass circuit in Holler with the LED light disclosed in Inoue. LEDs have a very different current vs. voltage characteristic than incandescent bulbs. LED lights do not have resistance like an incandescent bulb. LED lights have an exponential current vs. voltage relationship (described by the

Shockley diode equation) rather than a linear current vs. voltage relationship such as is found in a simple resistance. A POSITA who considered using a resistor bypass would quickly come to the conclusion that the design procedure in Holler is not useful.”

(Underlining added, Higman '252 Declaration, paragraph 62)

“65. In contrast, incandescent bulbs have a linear resistive relationship between voltage and current under steady-state conditions (i.e., their resistance changes predictably with temperature which stabilizes in milliseconds as the filament heats up when the incandescent bulb is first turned on).”

(Underlining added, Higman '252 Declaration, paragraph 62)

43. Additionally, Dr. Higman appears to state that LEDs do not have an inherent resistance: “In contrast, LEDs [...] do not exhibit inherent resistance” (Higman '252 Declaration, paragraph 81). However, his opinion contradicts claim 10 of the '252 patent, which discloses “inherent resistance” in conjunction with “LED light sources.” Given these statements, it is my opinion that “inherent resistance” is the resistance based on Ohm’s law, that is, voltage over current: Resistance = voltage / current = V/I .

44. Furthermore, Dr. Higman is incorrect when stating that “incandescent bulbs have a linear resistive relationship between voltage and current.” Incandescent lamps with a tungsten (W) filament do not have a “linear resistive relationship between voltage and current”: Indeed, the resistance of tungsten changes by more than a factor of 10 (!) when the filament heats up (glows). At very low currents, the tungsten filament temperature is close to 300 K and the associated tungsten room-temperature resistivity is $5.65 \mu\Omega \text{ cm}$. At the tungsten filament operating temperature ($> 2,000 \text{ K}$), the tungsten resistivity is at least 10 times greater. For example, at $2,200 \text{ K}$, the tungsten resistivity is $63.40 \mu\Omega \text{ cm}$, more than 10 times the resistivity of room temperature. This shows that the current-voltage characteristic of incandescent lamps is highly non-linear. The resistivity of tungsten

as a function of temperature can be found at:⁵

http://elektron.pol.lublin.pl/elekp/instrukcje_LV/Tungsten_resistance.pdf

45. Dr. Higman further states:

“64. ... The circuit design in Inoue includes Zener diodes ...”

(Underlining added, Higman '252 Declaration, paragraph 64)

46. I disagree with Dr. Higman. Petitioner relies on Inoue's Figure 3 circuit, which does not include Zener diodes.

47. Dr. Higman further states:

“66. Dr. Schubert mentions Holler's disclosure of bypass resistance equal to the resistance of the lamp. EX1013 at 56, citing Holler 1:96-101. However, the word resistance is not useful when describing LEDs as opposed to incandescent bulbs.”

(Underlining added, Higman '252 Declaration, paragraph 66)

48. I disagree. The word “resistance” is as useful for LEDs as it is for incandescent lamps. The resistance of any electrical component is defined by Ohm's law as the ratio of voltage to current.

49. Dr. Higman further states:

“67. ... In other words, Holler's bypass circuit uses resistors without the precise current regulation needed for LEDs, making it unsuitable for LED operation.”

(Underlining added, Higman '252 Declaration, paragraph 67)

“68. The shunt in the bypass circuit of Holler's is designed for incandescent bulbs with their linear resistance and higher voltage tolerances. Applying this shunt to LEDs, like those in

⁵ Website accessed on August 6, 2025.

Inoue, would likely result in overcurrent damage to the LEDs without current-limiting components.”

(Underlining added, Higman '252 Declaration, paragraph 68)

50. I disagree with Dr. Higman and note that both Holler and the challenged patents teach the same “equal” bypass resistors in conjunction with light sources. That is, both Holler and the challenged patent ('252 patent) teach that the bypass resistance be “equal to” the resistance of the light source.⁶ Therefore, to the extent that Holler's resistances are unsuitable for LEDs, so are the resistances claimed by the '252 patent. Indeed, the resistances of Holler are suitable because their values are the same values (“equal”) as taught by the '252 patent.

51. As an example, let us assume that the LEDs in Inoue’s series lighting circuit emit green light and are envisioned to be operated at 10 mA (10 milli-Ampere). The forward voltage of LED typical ranges from 2.0 V (red LEDs), over 2.5 V (green LEDs), to 3.0 V (blue and white LEDs). In the case of a green LED (LED voltage of 2.5 V), the resistance (or inherent resistance) would be $R = V / I = 2.5 \text{ V} / 10 \text{ mA} = 2.5 \text{ V} / 0.01 \text{ A} = 250 \text{ Ohm} = 250 \Omega$.⁷ Accordingly, based on the teachings of Holler

⁶ Holler teaches that the bypass resistor should be “equal to” the light source resistance. Specifically, Holler teaches “... each of the resistances 6 is made of a resistance equal to that of the lamp ...” (Underlining added, Holler, page 2, right-hand side column, lines 97-99).

Similarly, the '252 patent teaches that the bypass resistor should be “equal to” to the light source resistance. Specifically, the '252 patent teaches “wherein the resistance of the bypass resistor is equal to or greater than the inherent resistance of the light source to which the resistor is attached” (underlining added, claim limitation [10c] of the '252 patent).

⁷ I note that the equation $R = V / I$ is known as Ohm’s law, and it is the most basic law of electrical engineering.

(“each of the resistances 6 is made of a resistance equal to that of the lamp”), and Ohm’s law, a POSITA would use a 250 Ω bypass resistor in parallel with each LED.

52. Furthermore, based on the teachings of Holler (“each of the [bypass] resistances [has] approximately twice the current carrying capacity”), a POSITA would select a resistor of 250 Ω capable of carrying 20 mA (“twice the current”) because $2 \times 10 \text{ mA} = 20 \text{ mA}$. We now have determined the value of the bypass resistor (250 Ω) and its current carrying capability (20 mA). A POSITA would have been able to conduct such design analysis because it is based on the most fundamental law of electrical engineering, specifically Ohm’s law, that a POSITA would be familiar with and would have encountered multiple times during education.

53. A POSITA would have had a reasonable expectation of success. Ohm’s law is predictable and has never failed. In addition, the field of electrical circuits is known as a predictable technical field. For example, Cotropia states: “Mechanical, electrical, and computer software technologies are commonly considered to be predictable technologies [...] The way mechanical elements interact is generally easy to predict, as the basics of mechanics are well understood and documented. The same is true of electrical devices and computer software, especially in the digital, binary-based technology space.” (Cotropia, Christopher A. “Predictability and Nonobviousness in Patent Law After KSR” *Mich. Telecomm. & Tech. L. Rev.* 20 (2013): 391, page 430.)

XII. Ground 3: Holler in view of Smith obviates Claims 1, 10, and 11 ('252 patent)

54. I incorporate the section titled “Ground 3: Holler in view of Smith obviates Claims 1, 10, and 11” of my August 2, 2024 Declaration into the present Declaration.

55. The Holler-in-view-of-Smith combination uses Holler’s series lighting circuit and associated bypass resistors, and replaces the incandescent light sources of Holler with the LED light sources of Smith. Smith teaches multiple advantages of LEDs including their energy efficiency and longevity. (Smith, column 1:20-34) Accordingly, a POSA would have been motivated to replace the energy-hungry, short-lived incandescent lamps with energy-saving, long-lived LEDs.

56. Dr. Higman repeats his concern relating to the non-linearity of LED resistance and alleged linearity of a tungsten filament incandescent lamp resistance. I have already addressed Dr. Higman’s concern (above, paragraph 44) and pointed out that the incandescent lamp resistance is highly non-linear, and changes by a factor exceeding 10 (!) between its cold (non-glowing) and hot (glowing) state.

57. Dr. Higman also repeats his concern that the bypass resistance values taught by Holler (“resistance equal to that of the lamp”) would be unsuitable for an LED series lighting circuit. I have already addressed Dr. Higman’s concern (above, paragraphs 50-53) and pointed out that Holler’s bypass resistance values (“resistance equal to that of the lamp”) overlap with the bypass resistance values of the '252 patent (“the resistance of the bypass resistor is equal to or greater than the inherent resistance of the light source,” underlining added, '252 patent, claim 10) and for this reason cannot be unsuitable.

58. Dr. Higman states:

“72. ... A POSITA would not be motivated to replace an incandescent light bulb with an LED as incandescent light sources still have a place in decorative lighting, compared to other industries, both lighting and non-lighting. This is true today and would have been true even more so at the time of [the] effective filing date for the ‘252 patent.”

(Underlining added, Higman ‘252 Declaration, paragraph 72)

59. Smith points to multiple significant advantages of LEDs over incandescent light bulbs. Smith states: “The primary shortcomings of the standard incandescent light bulb include the fact that it consumes very significant amounts of electrical power; it has a relatively short life due to frequent burnout, breakage, and the like; it dissipates a tremendous amount of heat which can burn a person’s hands or otherwise injure person, pets or property. The incandescent light bulbs in use today present significant fire hazards in many uses, both from heat and from short circuits. Additionally, these bulbs have very slow switching speeds; they come in white only; and they break quite easily causing frequent replacement even for those bulbs placed in hard-to-reach areas where replacement is extremely time consuming and results in greatly increased expense.” (Underline added, Smith, column 1:20-34) Furthermore, Smith states: “This string uses a series-parallel configuration [with] each limb line are connected in series while the limb line sets are connected in parallel with each other [...] for increasing the uniformity of illumination along the length of the string, and for minimizing light outage due to bulb burnout, and for minimizing light outage due to bulb burnout.” (Underline added, Smith, Abstract) That is, Smith’s series-parallel configuration improves the “uniformity of illumination.” Based on these extensive and significant advantages, a POSITA would be motivated to replace Holler’s incandescent lamps with Smith’s LEDs.

60. Dr. Higman states:

“78. Additionally, a bypass resistor carrying twice the current of an LED would result in significant overcurrent flowing through the LED during normal operation or a failure.”

(Underlining added, Higman '252 Declaration, paragraph 78)

61. I disagree with Dr. Higman. It appears that Dr. Higman misunderstands or misinterprets the teachings of Holler. Holler teaches that the bypass resistor has the same (“equal”) resistance value as the light source. Accordingly, the bypass resistor carries the same current as the LED. When the LED fails (burns out), the resistor has twice the current carrying capacity and therefore can carry the additional current of the burnt-out LED. This follows from Holler’s teachings: “It has been found that good results are obtained if each of the [bypass] resistances is made of a resistance equal to that of the lamp with which it is in shunt and of approximately twice the current carrying capacity.” (Holler, page 2, right-hand-side column, lines 96-101) Dr. Higman’s contention of “significant overcurrent flowing through the LED during normal operation” lacks justification and for this reason is baseless.

XIII. Ground 4: Fisherman in view of Callahan obviates Claims 1, 2, 4, 8 and 10 ('252 patent)

62. I incorporate the section titled “Ground 4: Fisherman in view of Callahan obviates Claims 1, 2, 4, 8, and 10” of my August 2, 2024 Declaration into the present Declaration.

63. Dr. Higman repeats his concerns regarding the non-linearity of LED resistance versus the alleged linearity of incandescent lamp resistance. I have already addressed this concern (above, paragraph 44).

64. Dr. Higman states:

“81. ... In contrast, LEDs, like the ones disclosed in Callahan, require precise current regulation and do not exhibit inherent resistance present in the incandescent bulbs used with the lighting circuit in Fisherman, making substitution impractical without significant redesign of the circuit.”

(Underlining added, Higman '252 Declaration, paragraph 81)

65. I disagree with Dr. Higman's contentions. **First**, “precise current regulation” for LEDs is not mandatory. Some of the asserted prior art, such as Smith (for example, Smith's Figure 20), does not include “precise current regulation.” In addition, “precise current regulation” is not required by the claims.

66. **Second**, Dr. Higman's statement “LEDs [...] do not exhibit inherent resistance present in the incandescent bulbs” is contradicted by claim 10 of the '252 patent, which attributes an “inherent resistance” to an “LED [...] light source.” The inherent resistance of a light source, regardless of it being an incandescent or LED light source, is given by Ohm's law: $R = V / I$.

XIV. Ground 5: Inoue in view of Smith obviates Claims 2, 3, 4, 5, 6, 8, and 9 ('252 patent)

67. I incorporate the section titled “Ground 5: Inoue in view of Smith obviates Claims 2, 3, 4, 5, 6, 8, and 9” of my August 2, 2024 Declaration into the present Declaration.

68. Smith points to multiple advantages of LEDs over incandescent light bulbs including energy savings and higher reliability (Smith, column 1:20-34). In addition, Smith points to the advantages of a series-parallel lighting circuit configuration. Smith states: “This string uses a series–parallel configuration [with] each limb line

are connected in series while the limb line sets are connected in parallel with each other [...] for increasing the uniformity of illumination along the length of the string, and for minimizing light outage due to bulb burnout, and for minimizing light outage due to bulb burnout.” (Underline added, Smith, Abstract) That is, Smith’s series-parallel configuration improves “uniformity of illumination” and minimizes “light outage due to bulb burnout.” Based on these specific advantages, a POSA familiar with the Inoue prior art would be motivated to adopt Smith’s series-parallel lighting circuit configuration to increase “uniformity of illumination” and minimize “light outage due to bulb burnout.”

69. Dr. Higman states:

“88. Like claim 1, independent claim 9 requires a “resistor bypass circuit for a series lighting circuit comprising ... conducting current at all times when current is flowing through the circuit regardless of whether the LED light sources are conducting current therethrough.”

(Underlining added, Higman ’252 Declaration, paragraph 88)

70. I wish to point out that Inoue’s resistances R12 and R13 accomplish this requirement. That is, based on elementary circuit theory, Inoue’s bypass resistors R12 and R13 conduct “current at all times when current is flowing through the circuit regardless of whether the LED light sources are conducting current therethrough.” Because Inoue has a resistive path from the positive to the negative power supply terminal, the current flows through the shunting bypass resistor regardless of the LEDs being functional or burned out.

71. Claims 3, 5, and 6 of the ’252 patent recite a “twinkling effect” and associated “flashing rate.” Such effects can be introduced by self-contained lighting elements that are twinkling, flashing, blinking, or changing color. When replacing one or

multiple steady-ON lighting elements with twinkling⁸ lighting elements, the lighting string will contain steady-ON as well as twinkling lighting elements. Self-contained twinkling incandescent and LED lighting elements have been disclosed by Fisherman and Smith, respectively. Fisherman uses a “bimetallic strip” (that acts as an open switch when hot, and a closed switch when cold) to induce twinkling effects. Similarly, Smith discloses self-contained LED lighting elements exhibiting a blinking effect. Smith states: “The light-emitting diodes may be adapted for use as Christmas tree strings and various AC and DC control circuits are provided for driving the light-emitting diodes, for blinking effects, for alternating between two colors, for alternating between three colors, for improving the length of the string and uniformity of intensity of illumination and the like.” (Underlining added, Smith, Abstract) The features of the LEDs, specifically the “blinking effects, [...] alternating between two colors, [and] alternating between three colors” embodies the claimed twinkling and flashing effects. To summarize, LEDs exhibiting twinkling effects and flashing effects, known in the prior art, can be introduced into a series lighting circuit, without otherwise modifying the circuit, to induce desirable visual effects such as twinkling, flashing, blinking, and color changes. The replacement of steady-ON LEDs with twinkling LEDs would be accompanied by predictability and a reasonable expectation of success due to the general predictability of electrical circuit components, as discussed above (paragraph 53).

⁸ The terms twinkling, flashing, blinking, and color-changing may be used interchangeably.

XV. Ground 6: Holler in view of Callahan obviates Claims 1, 2, 4, 8, 10, 11, 12, 13, and 14 ('252 patent)

72. I incorporate the section titled “Ground 6: Holler in view of Callahan obviates Claims 1, 2, 4, 8, 10, 11, 12, 13, and 14” of my August 2, 2024 Declaration into the present Declaration.

73. Dr. Higman states:

“92. ... LED lights do not have resistance like an incandescent bulb.”

(Underlining added, Higman '252 Declaration, paragraph 92)

74. I disagree with Dr. Higman. His statement “LED lights do not have resistance like an incandescent bulb” is contradicted by claim 10 of the '252 patent, which attributes an “inherent resistance” to an “LED [...] light source.” The resistance of a light source, regardless of it being an incandescent or LED light source, is given by Ohm’s law: $R = V / I$.

XVI. Ground 7: Yu obviates Claims 1, 2 and 10 ('252 patent)

75. I incorporate the section titled “Ground 7: Yu obviates Claims 1, 2, and 10” of my August 2, 2024 Declaration into the present Declaration.

76. Dr. Higman contends that Yu is not prior art because the inventor Steven Altamura “swears behind” the Yu reference by means of two Section 131 Affidavits, the first one dated August 26, 2020 (the “2020 Affidavit”) and the second one dated September 1, 2022 (the “2022 Affidavit”). I have reviewed both Affidavits and wish to note the following:

77. **First**, the 2020 Affidavit as well as the 2022 Affidavit refer to four Exhibits, Exhibits A, B, C, and D. Whereas the Exhibits appear to be attached to the 2022 Affidavit, no Exhibits appear to be attached to the 2020 Affidavit. Therefore, I assume that Exhibits A, B, C, and D of the 2022 Affidavit also apply to the 2020 Affidavit.

78. **Second**, the Affidavit's Exhibits A to D do not show any LED light sources but rather incandescent light sources. Accordingly, the Exhibits lack evidentiary support for the 2020 Affidavit's statement: "I was working on a by-pass circuit for both LED and incandescent elements." (2020 Affidavit, paragraph 4) The Exhibits also lack evidentiary support for the 2022 Affidavit's statement: "I built LED and incandescent prototype light strings at the same time." (2022 Affidavit, paragraph 5)

79. **Third**, Exhibit A is characterized as showing the concept of the invention ("My first written documentation of this concept is dated January 12, 2006 and written in my own hand. [...] See Exhibit A." Underlining added, 2020 Affidavit, paragraph 5). The hand drawing is shown below.

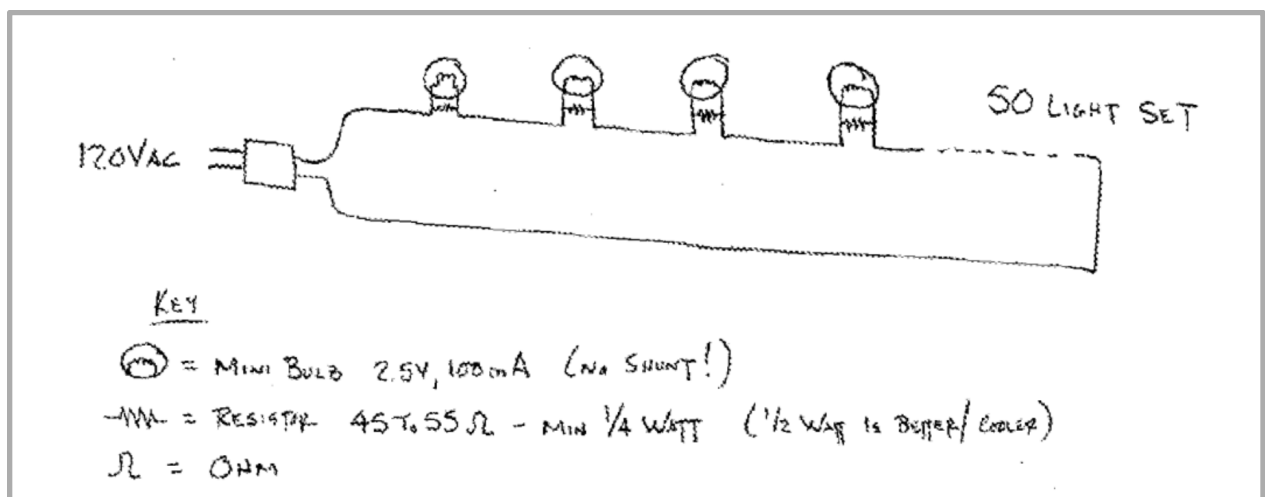


Figure caption: Hand drawing included as Exhibit A in the Altamura 2020 Affidavit showing the "concept" of the invention.

I note that Exhibit A's circuit configuration is identical to the circuit configuration shown in Holler's Figure 2, reproduced below. Both circuits show a series configuration of incandescent light sources with each light source being bypassed by a resistive shunt. To the extent that the Exhibit A hand drawing shows the "concept" of the invention, the "concept" is not new and has been known since 1924, that is, since the issue date of the Holler patent.

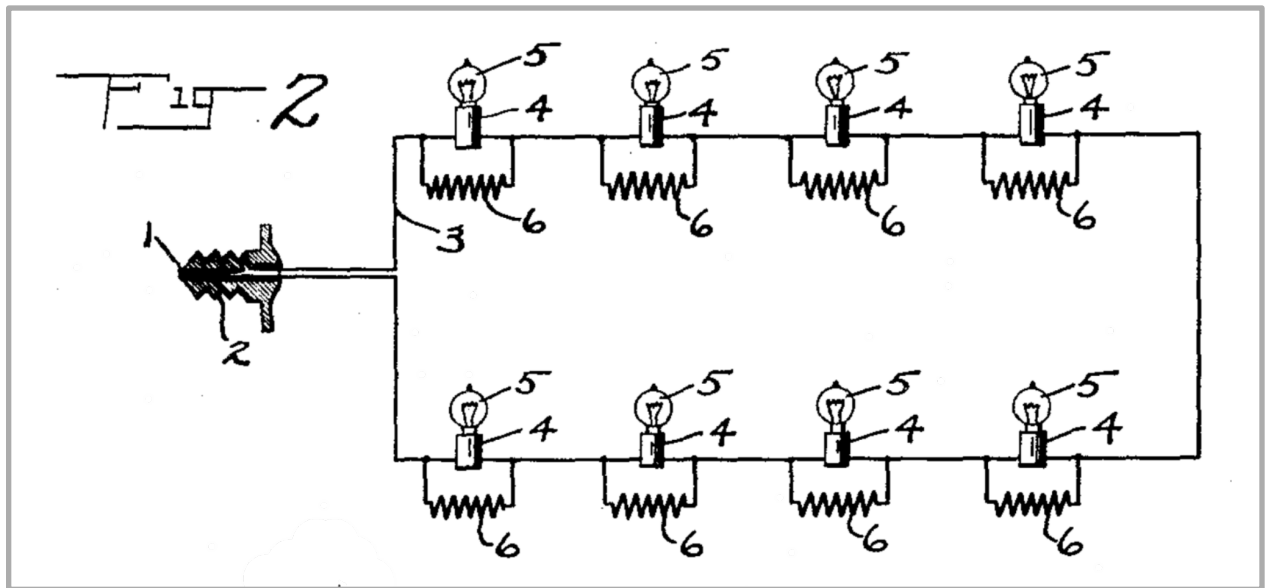


Figure caption: Holler, Figure 2, showing a series-parallel circuit design that includes incandescent light bulbs and associated bypass resistors.

80. **Fourth**, the 2020 Affidavit states: “Both LED and incandescent elements have the same failure problem which can benefit similarly with a solution, such as described in the above patent application.” (Underlining added, 2020 Affidavit, paragraph 4) The 2020 Affidavit points out that LED and incandescent light sources suffer from the “same failure problem,” that is, both can burn out and become non-functional. The 2020 Affidavit also points out that LED and incandescent light sources can “benefit similarly” from the series-parallel “solution” described in the '252 patent. I agree with the 2020 Affidavit that the two types of light sources (incandescents and LEDs) suffer

from the “same failure problem” and “benefit similarly” from Holler’s series-parallel circuit. This insight would further motivate a POSITA to employ Holler’s series-parallel circuit in conjunction with LEDs.

81. **Fifth**, I wish to point out that the 2020 Affidavit (stating that incandescents and LEDs suffer from the “same failure problem” and “benefit similarly” from Holler’s series-parallel circuit) appears to be contradicted by Dr. Higman who opines that LED bulbs cannot readily replace incandescent bulbs because the former ones would require “precise current control” (Higman ’252 Declaration, paragraph 65), “current-limiting components” (Higman ’252 Declaration, paragraph 68), and protection from “overcurrent” (Higman ’252 Declaration, paragraph 92). I disagree with Dr. Higman’s opinions because the features he appears to demand (“precise current control,” “current-limiting components,” and protection from “overcurrent”) are not necessary and not required by the claims. Furthermore, the prior art shows that “precise current control,” “current-limiting components,” and protection from “overcurrent” are optional, yet not required. For example, Smith’s Figure 20 embodiment is devoid of the precise current control features that Dr. Higman appears to demand.

XVII. Conclusion

82. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Executed on August 7, 2025

By:  2025
(E. Fred Schubert)