

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Hisense USA Corporation
Petitioner

v.

Brightplus Ventures LLC
Patent Owner

Patent No. 8,330,710
Filing Date: October 11, 2011
Issue Date: December 11, 2012
Title: SYSTEMS AND METHODS FOR CONTROLLING A SOLID STATE
LIGHTING PANEL

Inter Partes Review No. IPR2023-01412

Ex. 1005 – Declaration of Rafael Betancourt

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I, Rafael J. Betancourt, declare as follows:

I. Introduction

1. I am an independent consultant. I am over eighteen years of age, and I would otherwise be competent to testify as to the matters set forth herein if I am called upon to do so.

2. I have prepared this Declaration for consideration by the Patent Trial and Appeal Board in the *Inter Partes* Reviews of U.S. Patent No. 8,330,710 (“the ’710 Patent”).

3. I provide this Declaration at the request of and have been retained by Kilpatrick Townsend & Stockton, LLP, which represents Hisense USA Corporation (“Hisense”) in connection with the above-captioned *Inter Partes* Review. I have been informed and understand that Hisense contends that claims 1-2, 5, 11-13, 16-17, and 47-48 of the ’710 Patent are invalid.

4. I am being compensated at an hourly rate of \$750 per hour. My compensation is not dependent on the outcome of or any issue in relation to the above-captioned *Inter Partes* Review, and I have no interest in either party.

5. In forming my opinions, I relied on my knowledge, education, experience, and training in the field and on documents and information referenced in this Declaration.

II. Qualifications

6. My curriculum vitae (“CV”) is attached hereto as Ex. 1006 and provides an accurate identification of my background and experience.

7. I hold the title of President of Betasoft Consulting, Inc., where I specialize in Analog Mixed-signal (“AMS”) architecture, debugging, modeling, and verification. Since 2019, I have worked with many major clients, including Applied Materials Inc., Palo Alto Electron, Inc., Scientific Analog Inc., Vidatronic, Inc., and zGlue Inc., to provide them with R&D engineering services and tools for AMS architecture, design, and verification of silicon integrated circuits.

8. I received a B.S. (1987) in Electrical Engineering from the University of Puerto Rico; an M.S. (1989) in Electrical Engineering from the University of Southern California; and an Engineers Degree in Electrical Engineering (2005) from Stanford University.

9. From 2002 to 2018, I worked at Synaptics, Inc., a leading manufacturer of human interface sensing devices. From 2014 to 2018, I held the title of Director of Analog Mixed-Signal Systems and Verification at Synaptics, Inc., where I was responsible for a global team that performs AMS verification of complex capacitive touch controllers, as well as integrated touch and LCD display controllers (TDDI) for mobile and automotive applications. While at Synaptics, Inc., I also worked as a technical lead for touchscreen CMOS controllers for

mobile, tablet, and notebook PCs and as a technical lead for various touch controller ASICs.

10. From 1998 to 2001, I worked as a Senior Mixed-Signal IC Design Engineer at Innovative Semiconductors, Inc. During that time, I designed a 480Mb/s analog transceiver for USB 2.0 in TSMC's 0.25um and 0.18um CMOS processes. I also wrote specifications for a 480MHz PLL clock synthesizer and interfaced with a PLL design contractor for post-layout verification and performance characterization. I also performed analog verification of a 400Mb/s serial transceiver 1394 PHY chip in TSMC's 0.35um CMOS, bench-tested, troubleshot, and characterized 1394 PHY, and assisted with porting of IEEE-1394 PHY to UMC's 0.18um CMOS.

11. I am currently an IEEE Senior Member and a member of IEEE Solid-State Circuits and Circuits & Systems societies, and I have held the following professional memberships and affiliations:

- IEEE Silicon Valley Chapter of the Technology and Engineering Management Society ("TEMS"): 2020-21 Chair; 2018-19 Vice-Chair; 2022-23/2017 Secretary; Reviewer for 2019 TEMSCON.
- IEEE Santa Clara Valley Section: 2020 Vice-Chair.
- Volunteer at IEEE Global Humanitarian Technology Conference 2018
- Volunteer Judge at International Science & Engineering Fair (ISEF), 7 times

12. I have authored over six (6) publications including:

- 1-GHz and 2.8-GHz CMOS Injection-locked Ring Oscillator Prescalers, *Symposium on VLSI Circuits, June 14-16, 2001, Kyoto, Japan.*
- CMOS VCOs for Frequency Synthesis in Wireless Biotelemetry, *International Symposium on Low Power Electronics and Design, August 10-12, 1998, Monterey, California.*
- Low Phase Noise CMOS Ring Oscillator VCOs for Frequency Synthesis, *2nd International Workshop on Design of Mixed-Mode Integrated Circuits, July 27-29, 1998, Guanajuato, Mexico.*
- A Low Power Frequency Synthesizer for Wireless Biotelemetry, *33rd. International Telemetering Conference, October 27-30, 1997, Las Vegas, Nevada.*
- A 1.5mW, 200MHz CMOS VCO for Wireless Biotelemetry, *First International Workshop on Design of Mixed-Mode Integrated Circuits and Applications, July 28-30, 1997, Cancun, Mexico.*
- A High-speed GaAs Transversal Filter Circuit for Clutter Rejection Systems, *SPIE's Tech. Symp. Optical Eng. & Photonics in Aerospace Sensing, April 1990.*

13. I am a named inventor on several issued patents: U.S. Pat. No.

9,778,804; U.S. Pat. No. 9,740,351; and U.S. Pat. No. 8,058,884. I have previously testified in multiple cases, including those concerning capacitive touch sensors, and circuits used in capacitive touch and display controllers as well as LCD touch screens. My CV (attached as Exhibit 1004) contains a list of cases in which I have testified in the last five years.

III. Summary of Legal Issues

14. I am not a lawyer. Thus, in expressing my opinions and considering the subject matter of the claims of the '710 Patent, I am relying upon certain legal principles that counsel has explained to me.

A. Obviousness

15. First, I understand that for an invention claimed in a patent to be found patentable, it must be, among other things, new and not obvious from what was known before the invention was made.

16. I understand the information that is used to evaluate whether an invention is new and not obvious is generally referred to as “prior art” and generally includes patents and printed publications (e.g., books, articles, product manuals, company publications, etc.).

17. I understand that in this proceeding Hisense has the burden of proving that the claims of the patents-at-issue are obvious in view of the prior art by a preponderance of the evidence. I understand that “a preponderance of the evidence” is evidence sufficient to show that a fact is more likely true than it is not true.

18. I understand that in this proceeding, the information that may be evaluated is limited to patents and printed publications. My analysis below compares the claims to patents and printed publications that I understand are prior art to the patents-at-issue.

19. I have been informed and understand that a claim is obvious in light of the prior art if the difference or differences between the claimed subject matter and the prior art are such that the subject matter as a whole would have been

obvious, at the time the invention was made, to a person having ordinary skill in the art. I have been informed and understand that the Supreme Court provided an outline for analyzing obviousness in which it rejected an earlier test in favor of an “expansive and flexible approach” using “common sense.” I have also been informed and understand that the Supreme Court explained that under the correct analysis, any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed. I have also been informed and understand that the Supreme Court explained that “[t]he combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results.” I further have been informed and understand that the Court pointed to other factors that may show obviousness. These factors included the following principles:

- a. combination that unites old elements with no change in their respective functions is unpatentable. As a result, the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results,
- b. a predictable variation of a work in the same or a different field of endeavor is likely obvious if a person of ordinary skill would be able to implement the variation,

- c. an invention is obvious if it is the use of a known technique to improve a similar device in the same way, unless the actual application of the technique would have been beyond the skill of the person of ordinary skill in the art. In this case, a key inquiry is whether the improvement is more than the predictable use of prior art elements according to their established functions,
- d. an invention is obvious if there existed at the time of invention a known problem for which there was an obvious solution encompassed by the patent's claims,
- e. inventions that were “obvious to try” — chosen from a finite number of identified, predictable solutions, with a reasonable expectation of success — are likely obvious,
- f. known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art, and
- g. an explicit teaching, suggestion, or motivation in the art to combine references, while not a requirement for a finding of obviousness, remains “a helpful insight” in determining upon which a finding of obviousness may be based.

B. Claim Construction

20. I have been informed and understand that in an *inter partes* review claim terms are construed according to their ordinary and customary meaning as understood by one of ordinary skill in the art in view of the specification and the prosecution history of the patent.

C. Level of Skill in the Art

21. I am informed and understand that a person of ordinary skill in the art is a hypothetical person who is presumed to have known the relevant art at the time of the alleged invention. I am informed and understand that factors that may be considered in determining the level of ordinary skill in the art may include: (A) the type of problems encountered in the art; (B) prior art solutions to those problems; (C) the rapidity with which innovations are made; (D) the sophistication of the technology; and (E) the educational level of active workers in the field.

IV. The '710 Patent

22. The '710 Patent is entitled "Systems and Methods for Controlling a Solid State Lighting Panel" and was filed on October 11, 2011. I am informed that the earliest claimed priority date of the '710 Patent is May 8, 2007. Each of the prior art references I address herein was available prior to May 8, 2007, thus I have not analyzed whether each claim of the '710 Patent is entitled to that priority date.

A. Person of Ordinary Skill in the Art of the '710 Patent

23. The '710 Patent relates to solid state lighting (e.g., LEDs) and “controlling a solid state lighting panel.” '710 Patent, 1:14-15.

24. Upon consideration of this and the factors outlined in Section III.C above, in my opinion, a person of ordinary skill in the art as of May 8, 2007, the earliest claimed priority date of the '710 Patent, would have had at least a graduate degree in mechanical engineering, physics, materials science, electrical engineering, or a related discipline, coupled with at least four years' experience in designing backlighting systems for displays; the level of ordinary skill in the art is approximate and additional education could make up for a lack of experience or vice-versa.

25. As I explain above, I have the relevant educational background and I have worked in the technical area of the '710 Patent for many years. As of May 8, 2007, which I understand to be the time of the alleged invention, I possessed at least such experience and knowledge of a person of ordinary skill in the art.

B. Construction of Claim Terms of the '710 Patent

26. As explained in further detail below, under any reasonable construction, the claims are obvious in view of the prior art I address herein. Thus, I do not separately offer an opinion with respect to the proper construction of the terms of the claims of the '710 Patent.

V. Materials Considered

27. In forming my opinions, in addition to my knowledge and experience, I have considered the following documents and things that I have obtained, or that have been provided to me:

Exhibit	Description
1001	U.S. Patent No. 8,330,710 (“the ’710 Patent”)
1002	Prosecution History of U.S. Patent No. 8,330,710
1003	U.S. Patent No. 8,049,709 (“the ’709 Patent”)
1004	Prosecution History of U.S. Patent No. 8,049,709
1007	U.S. 2008/0116818 to Shteynberg (“Shteynberg”)
1008	U.S. 2007/0121320 to Arai (“Arai”)
1009	CN 1750732 to Zhang (“Zhang”)
1010	Certified Translation of Zhang
1011	U.S. 2006/0139954 to Kobori (“Kobori”)
1012	U.S. 2003/0016205 to Kawabata (“Kawabata”)
1013	U.S. 2007/0013647 to Lee (“Lee”)

28. In addition to the documents above, in forming the opinions expressed below, I have also considered my own knowledge and experience based upon my education and work in the field, as described above and in my *curriculum vitae* (Ex. 1006).

VI. State of the Art as of May 8, 2007.

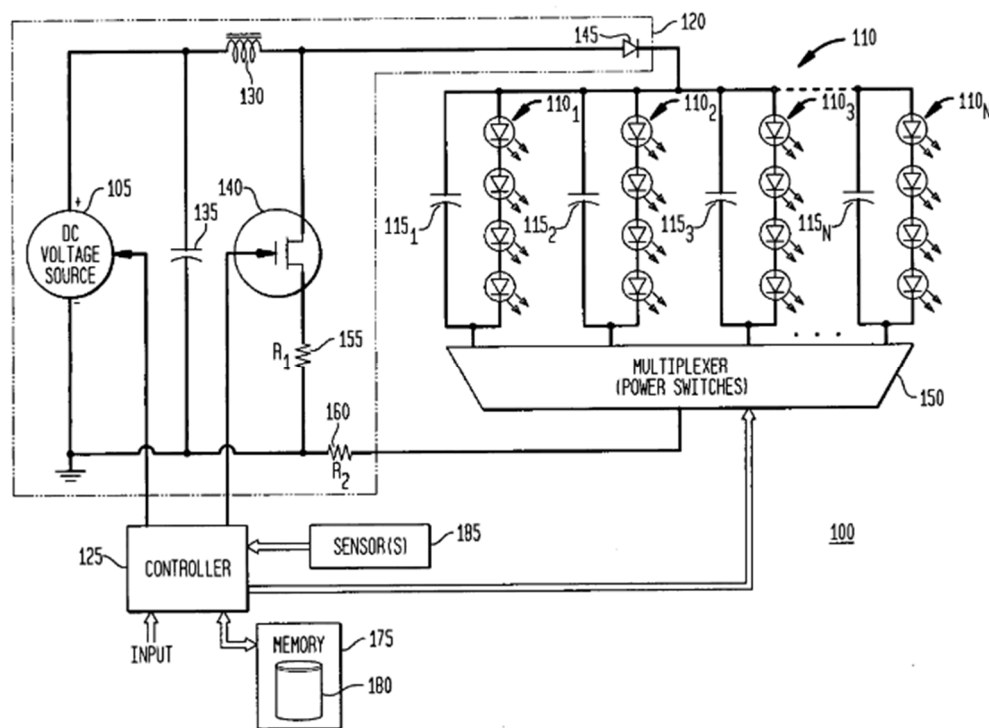
29. As of May 8, 2007, there were some commonly used techniques for controlling LED strings of a backlight system used in a display. For instance, digitally programmable Pulse-Width Modulation (PWM) LED constant current drivers were well known. Modulating the average output current of the driver with a square wave of programmable duty cycle allows for very precise control of LED

brightness. Digital control of the duty cycle allows for easy control of the LED's brightness, as well as other features such as dimming and color temperature control. For a display backlight system comprised of multiple LED strings, a driving circuit, under the control of a controller, supplies drive currents to each of the LED strings to independently control the light emitted by each. The firing order of these LED strings matters. Control over the firing order is achieved by phase-shifting the control signals to turn ON different LED strings at different times in a firing cycle. Even as admitted in the '710 Patent itself, a continuous firing (i.e., one by one, for example, from top to the bottom of the panel) may result in visual artifacts— “[A] noticeable ‘sweep’ or ‘waterfall’ [phenomenon] across the display may result. This effect can be more exaggerated at a beat frequency that is related to the difference between the refresh frequency of the panel and the pulse-width-modulation (PWM) frequency of a pulse-width modulation signal used to adjust the brightness of the display.” ’710 Patent, 7:60-67. These backlight/display interference mechanisms were well understood by a person skilled in the art as well as their commonly used mitigation methods. These mitigation methods include varying the LED string firing order and/or the phase of the various ON/OFF control signals on each of the LED strings.

A. Shteynberg

30. Shteynberg is a publication of a U.S. Application, and I am informed that Shteynberg is prior art to the '710 Patent. Shteynberg relates to “separately and independently sourcing current to a series of light emitting diodes.” Shteynberg, Abstract.

31. Shteynberg discloses a lighting system, which “comprises a plurality of series of light-emitting diodes, a power converter, a first multiplexer, and a controller.” Shteynberg, [0021]. As shown in Fig. 3, the lighting system includes a parallel array of LEDs 110, which includes a plurality of series-connected LEDs, and these independent series or *strings* (or channels) *of LEDs* are illustrated as “N” individual series of LEDs 110₁, 110₂, 110₃, ... , 110_N. Shteynberg, [0043]-[0044].



Id., Fig. 3.

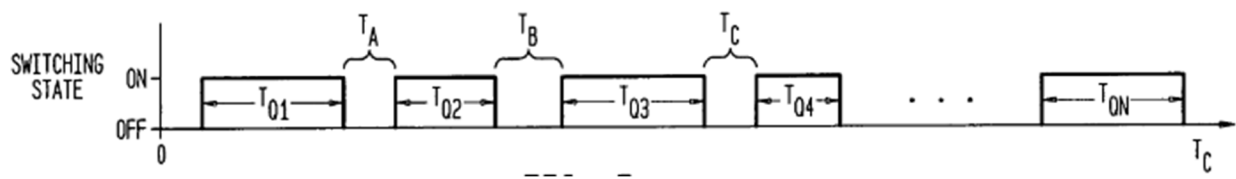
32. The lighting system includes a power converter 120, which includes “a DC voltage source 105, a filter capacitor 135, an inductor 130, a switch 140, and a peak current sense resistor (R1) 155.” Shteynberg, [0048]. The power converter 120 is operable to “deliver a controlled current level to a load.” *Id.* In the example shown in Fig. 3, the load is the LED strings 1101, 1102, 1103, ... , 110N.

33. The lighting system further includes a multiplexer 150, which “provides for individually and selectively allowing current to flow through each of the series of LEDs 1101, 1102, 1103, through 110N.” Shteynberg, [0047]. As a result, any selected one of the LED strings 1101, 1102, 1103, through 110N is turned on or off accordingly. *Id.* The LED strings 1101, 1102, 1103, through 110N are energized using time-division modulation. Shteynberg, [0044]. “Under the control of the controller 125,” the multiplexer 150 is configured to “allow current through one or more of the series of LEDs 1101, 1102, 1103, through 110N in any combination, and for any selected duration.” Shteynberg, [0047].

34. In addition, the controller 125 may “receive input from a wide variety of sources, including open or closed-loop feedback of various signals and measurements from within the LED array driver circuit 100.” *Id.*, [0049]. As shown in Fig. 3, the controller 230 may receive input from one or more sensors 185. Alternatively, the controller 230 may “be coupled within a larger system, such

as a computer-controlled lighting system in a building, and may interface with other computing elements.” Shteynberg, [0049]. Shteynberg suggests input coming from “a larger system” (as illustrated by the arrow in Fig. 3), and the user input could be one example of input coming from a larger system.

35. Shteynberg further describes, with reference to Fig. 4, that each of the LED strings 1101, 1102, 1103, through 110N is provided with a selected and independent current level, “through control (by controller 125) of the switching state of each channel (via multiplexer 150),” for a selected time period (or duration).” Shteynberg, [0054].



Id., Fig. 4.

36. Importantly, Shteynberg stresses that “[e]ach energizing time period may be provided in any order or combination.” Shteynberg, [0054]. As one example, and as illustrated in the Fig. 4, LED string 1103 is provided with current for third time period T_{Q3} , followed by LED string 1102 being provided with current for second time period T_{Q4} , and followed by both LED strings 1101 and 110N being provided with selected current levels for corresponding first and Nth time periods T_{Q1} and T_{QN} , respectively. At least in the example shown in Fig. 4,

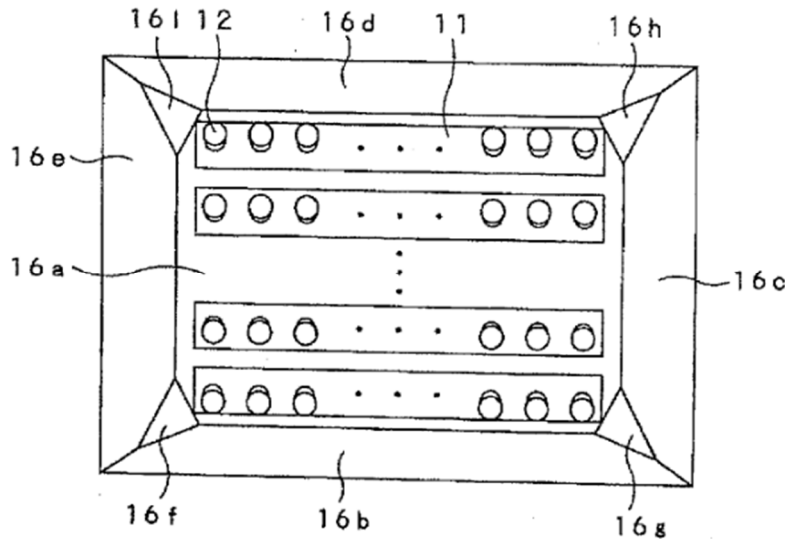
the “flipping” firing order (i.e., LED string 1103 is fired before LED string 1102 is fired) is non-spatially sequential.

37. Therefore, the controller 125, via the multiplexer 150, determines the order of the energizing time periods, which is equivalent to the firing order according to the definition of the “firing order.”

B. Arai

38. Arai is a publication of a U.S. Application, and I am informed that Arai is prior art to the '710 Patent. Arai relates to “backlight device[s].” Arai, Abstract.

39. Arai discloses a backlight unit 3 of a transmission type liquid crystal display panel 1, having LEDs 12 that are “two-dimensionally arranged.” Arai, [0006] and [0024]. As shown in Fig. 5, the LEDs 12 are arranged in a first direction (from left to right, as shown in Fig. 5) to form LED strings and positioned at intervals in a second direction (from top to bottom, as shown in Fig. 5). Arai explains that such a two-dimensional arrangement could permit “display of high luminance on large-sized liquid crystal panel by low power consumption.” Arai, [0006].



Arai, Fig. 5.

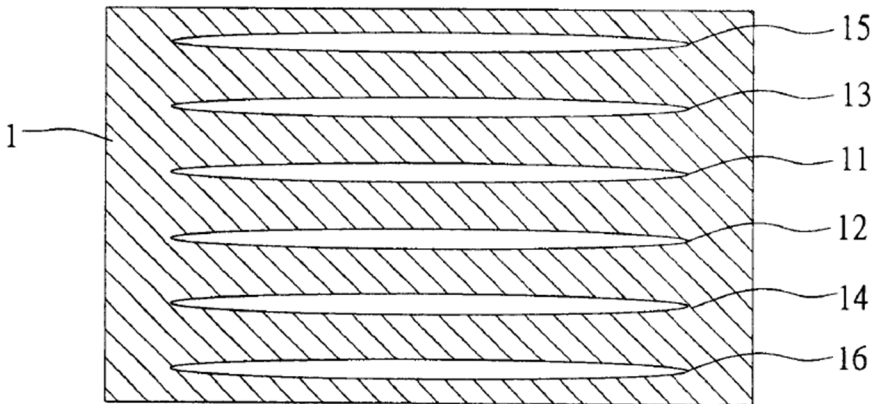
C. Zhang

40. Zhang is a publication of a Chinese Application, and I am informed that Zhang is prior art to the '710 Patent. Zhang relates to “adjustment method[s] for backlight of flat panel display[s].” Zhang, Abstract.

41. Zhang is a publication of a Chinese Application, and I am informed that Zhang is prior art to the '710 Patent. Zhang relates to “adjustment method[s] for backlight of flat panel display[s].” Zhang, Abstract.

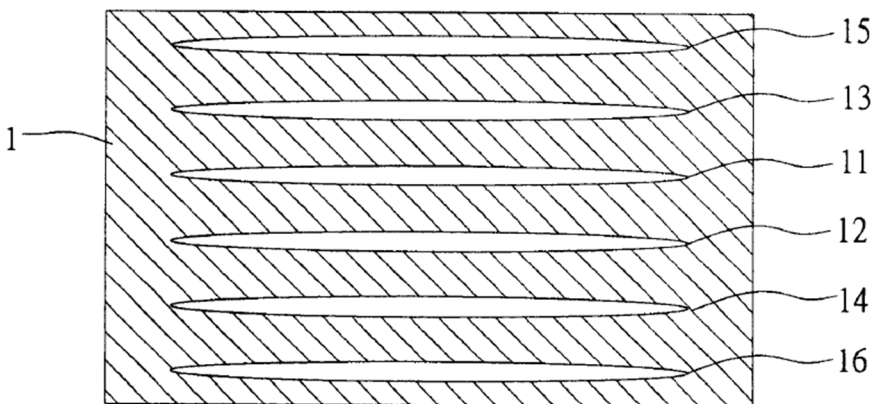
42. Zhang discloses, with reference to Fig. 1A, a display panel 1, which corresponds to an even number (e.g., six) of backlight modules. Zhang, 5:8-11. The first backlight module 11 and the second backlight module 12 are located at the center of the display panel 1. Zhang, 5:12-14. The third backlight module 13 and the fourth backlight module 14 are situated on two sides, respectively, toward the outside of the first backlight module 11 and the second backlight module 12.

Id. The fifth backlight module 15 and the sixth backlight module 16 are situated on two sides, respectively, toward the outside of the four backlight modules 11-14. *Id.*



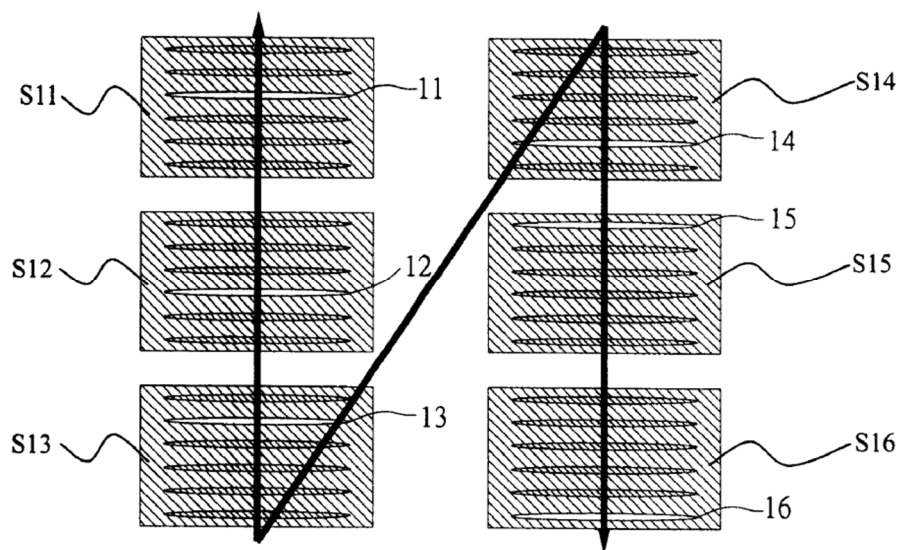
Zhang, Fig. 1A.

43. Zhang describes, with reference to Fig. 1B, a lighting sequence as follows: the first backlight module 11, the second backlight module 12, the third backlight module 13, the fourth backlight module 14, the fifth backlight module 15, and the sixth backlight module 16. Zhang, 5:14-23.



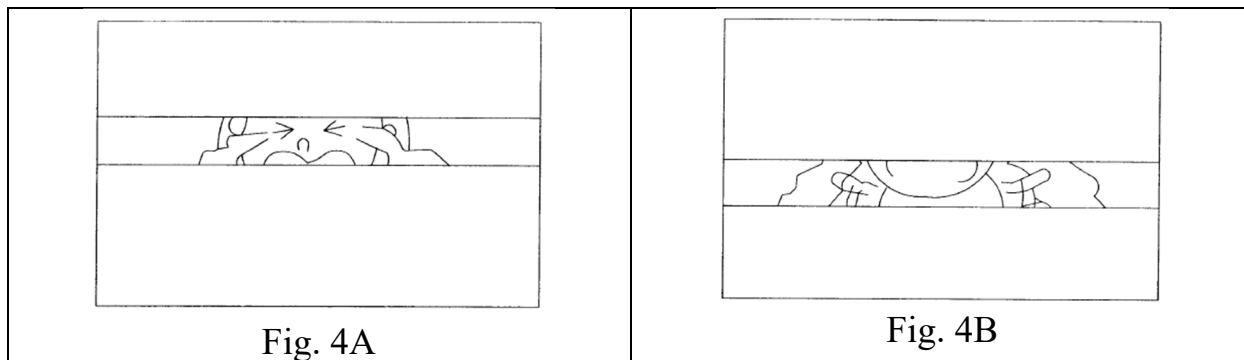
Zhang, Fig. 1A.

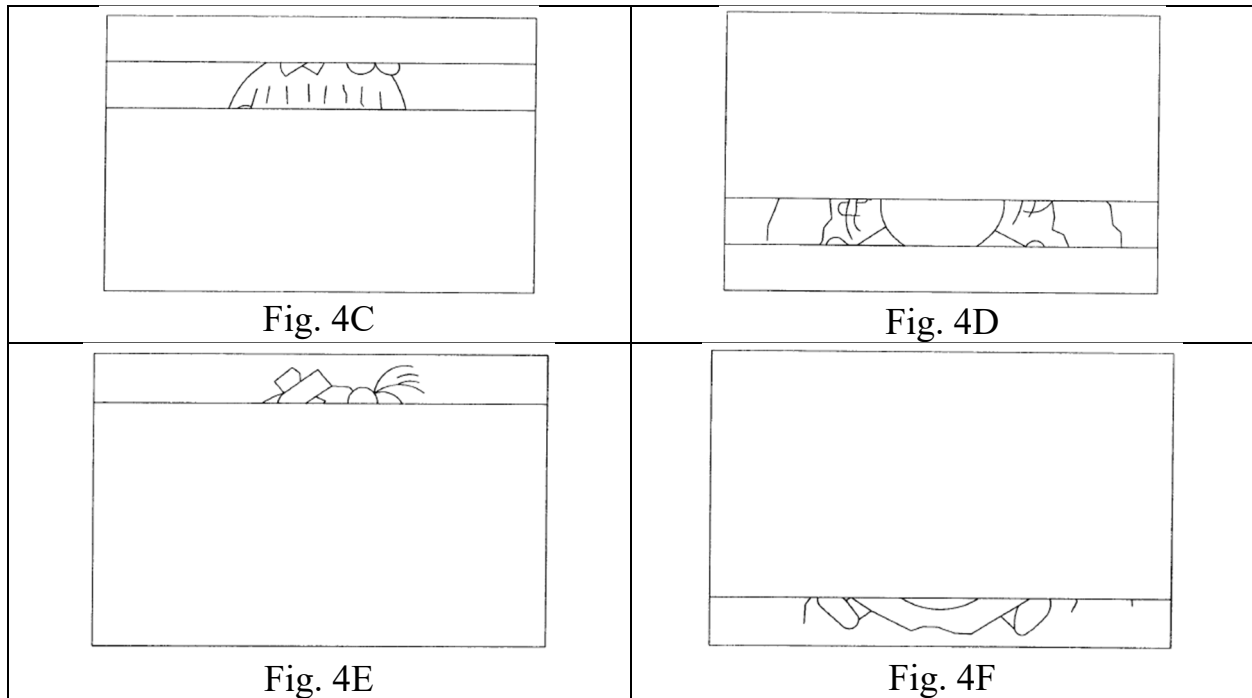
44. Zhang discloses non-spatially-sequential firing orders. For instance, the firing order shown in Fig. 1B is: the *third* backlight module from the top, the *fourth* backlight module from the top, the *second* backlight module from the top, the *fifth* backlight module from the top, the *first* backlight module from the top, and the *sixth* backlight module from the top (i.e., III→IV→II→V→I→VI). Zhang, 5:14-23.



Zhang, Fig. 1B.

45. The resultant display image is shown in Figs. 4A-4F. Zhang, 6:13-36.



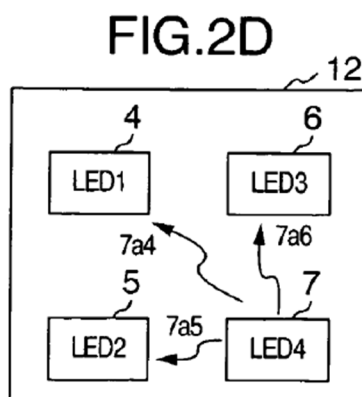
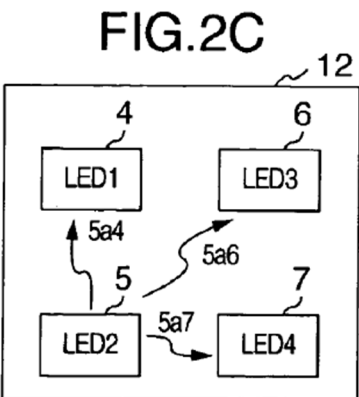
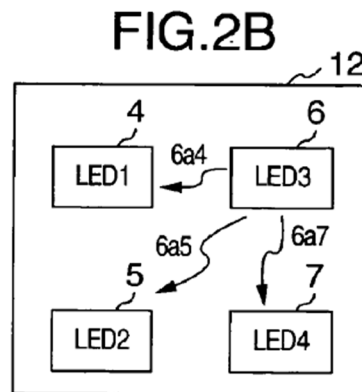
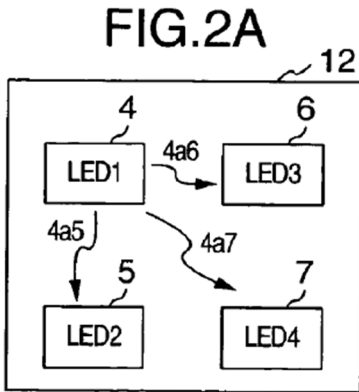


Zhang, Figs. 4A-4F.

D. Kobori

46. Kobori is a publication of a U.S. Application, and I am informed that Kobori is prior art to the '710 Patent. Kobori relates to “drive circuit[s] of light emission device arrays.” Kobori, Abstract.

47. Kobori admits the need to “obtain highly-accurate *uniform luminiferous characteristics* at a low cost.” Kobori, [0007]. Kobori describes, with reference to Figs. 2A-2D, “*arbitrarily changing* the PWM interval, the number of times, the phase for each LED so as to diversify the ON/OFF relationship.” Kobori, [0035].



Kobori, Figs. 2A-2D.

E. Kawabata

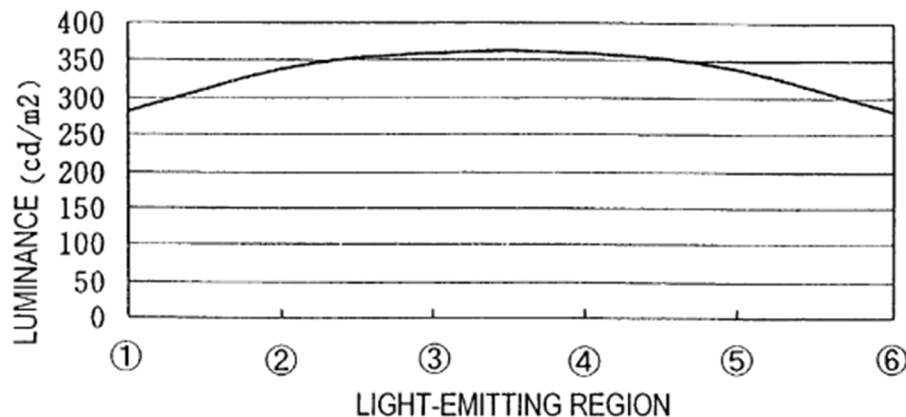
48. Kawabata is a publication of a U.S. Application, and I am informed that Kawabata is prior art to the '710 Patent. Kawabata relates to “a lighting unit” having a controller that “supplies a periodic drive signal.” Kawabata, Abstract.

49. Kawabata describes, with reference to Figure 5, “scan lighting.” Kawabata, [0070]. Specifically, Kawabata states: “Then, the controller 30 may supply a drive signal, which has a first signal intensity high enough to turn each of the light-emitting elements 2 ON in 50% of one period thereof and a second signal intensity low enough to turn the light-emitting element 2 OFF in the remaining

50% of the one period, to one of the light-emitting elements 2 after another at different points of times. In this case, the drive signal supplied to one of the light-emitting elements 2 should have its phase shifted from that of the drive signal supplied to adjacent one of the light-emitting elements 2.” *Id.* Kawabata further states: “It should be noted that each light-emitting element 2 should start to emit light synchronously with the input of a video signal to a predetermined display area of the liquid crystal panel 300 that is associated with the light-emitting region 4 of the light-emitting element 2. Each predetermined display area of the liquid crystal panel 300 includes the same number of gate lines (e.g., 80 gate lines in this specific example). Thus, the “timing at which the video signal starts to be input to the predetermined display area” herein means a point in time at which a scanning pulse signal is input to the first one of the gate lines included in that predetermined display area and the video signal starts to be input to the pixels that are connected to the first gate line.” *Id.*

50. As shown in Fig. 5 of Kawabata, each of the six light emitting elements 2 are turned on at different times. The ***timing rule*** in this example is the “adjacent one” of the light emitting elements 2 is turned next. According to the specification of the ’710 Patent, the firing logic 802 can include rule-based logic. ’710 Patent, 10:51-53.

51. Following the discussion of the timing rule shown in Figure 5 of Kawabata, Kawabata further discusses “a variation in luminance.” Kawabata, [0071]. As shown in Figure 6, the innermost light emitting regions (labeled as ③ and ④) have a higher luminance than the outermost light emitting regions (labeled as ① and ⑥).

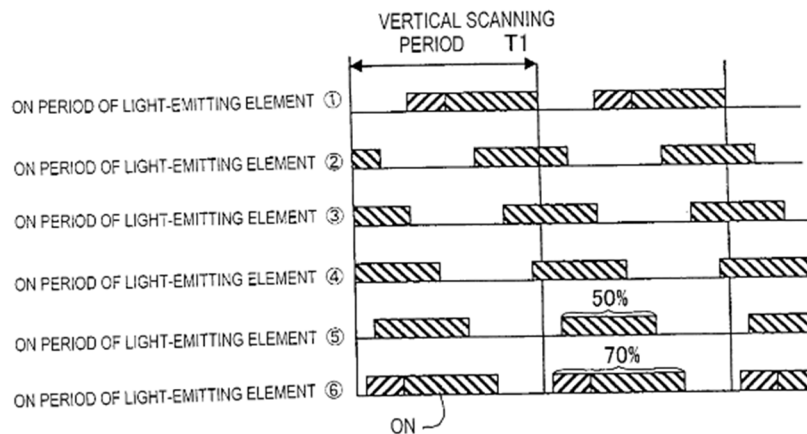


Kawabata, Fig. 6.

52. Kawabata further discloses that “some of the light-emitting elements 2 for some of the light-emitting regions 4 may be turned ON in a different percentage of one vertical scanning period” to reduce such a variation in luminance. *Id.*, [0073]. In the example shown in Figure 7 of Kawabata, the light emitting elements for the outermost light emitting regions (labeled as ① and ⑥) are turned on in 70%, instead of 50%, of one vertical scanning period. *Id.*

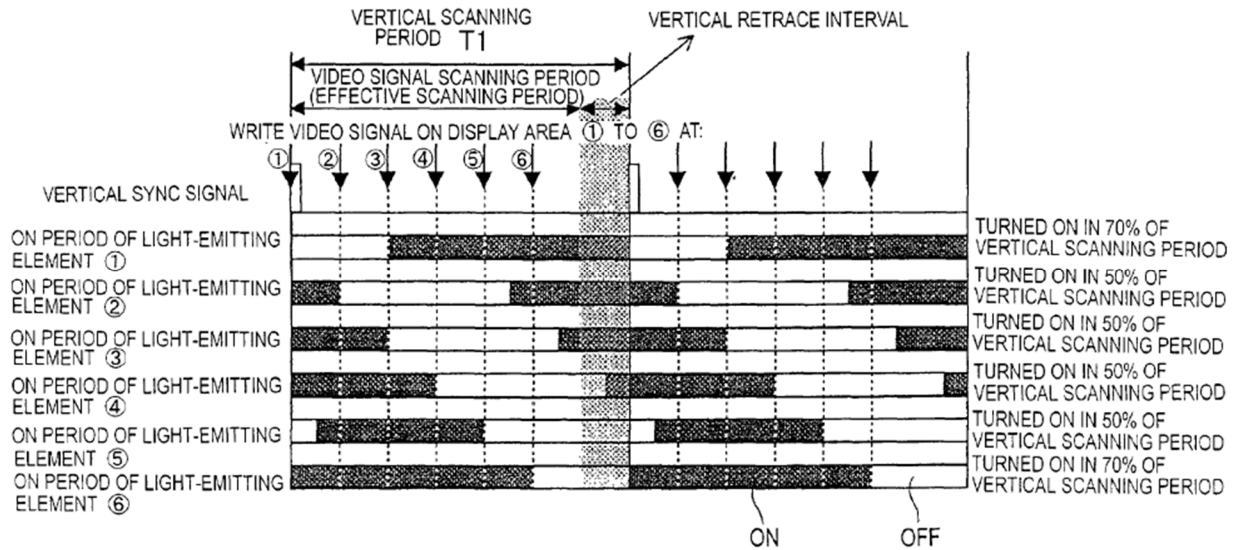
53. The result is shown in Figure 7 of Kawabata. As shown in Figure 7, the timing deviates from the previous timing shown in Figure 5 due to the change from 50% to 70%. Specifically, the light emitting element corresponding to region

⑥ is turned on *before, not after*, the light emitting element corresponding to region ⑤. Therefore, the light emitting elements are turned on according to a *non-spatially-sequential firing order*.



Kawabata, Fig. 7.

54. Kawabata discloses a non-spatially-sequential firing order in additional embodiments. For instance, as shown in Figure 8, the firing order is ①→②→③→④→⑥→⑤→①, instead of ①→②→③→④→⑤→⑥→①. *Id.*, [0076]. The flipping order of ⑤ and ⑥ makes the firing order non-spatially-sequential (i.e., the temporally sequential strings are not spatially sequential/adjacent).



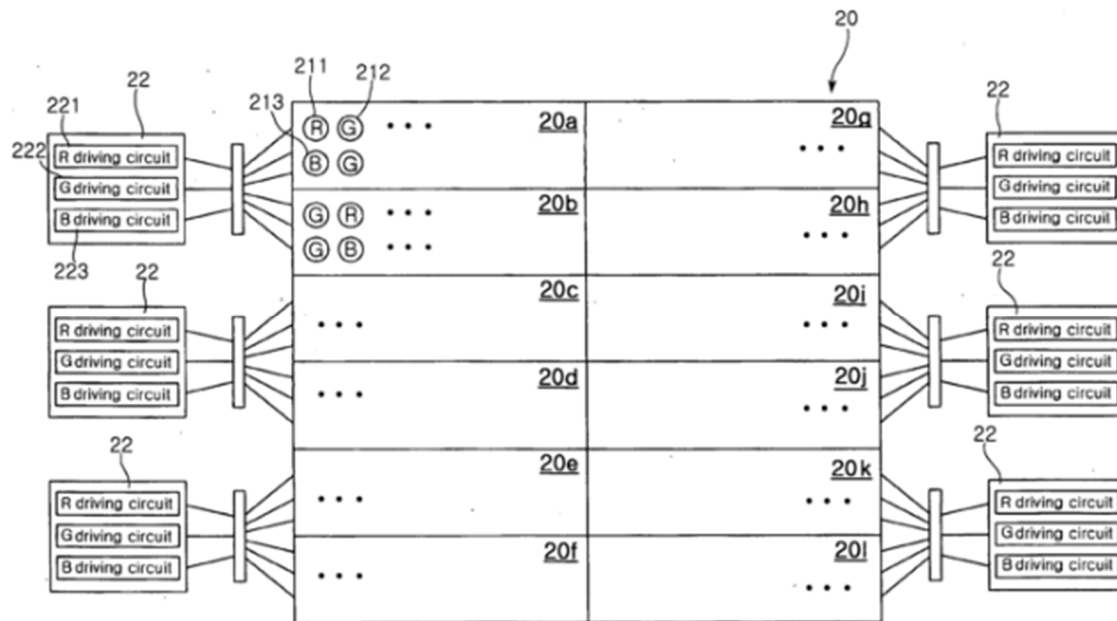
Kawabata, Fig. 8.

55. Kawabata describes another example with reference to Figure 23. The firing order is ①→②→④→③→⑤→⑥ and ⑧(simultaneous)→⑦→①, which is a non-spatially-sequential firing order. Kawabata, [0113].

F. Lee

56. Lee is a publication of a U.S. Application, and I am informed that Lee is prior art to the '710 Patent. Lee relates to LEDs arranged on divided regions of a substrate. Lee, Abstract.

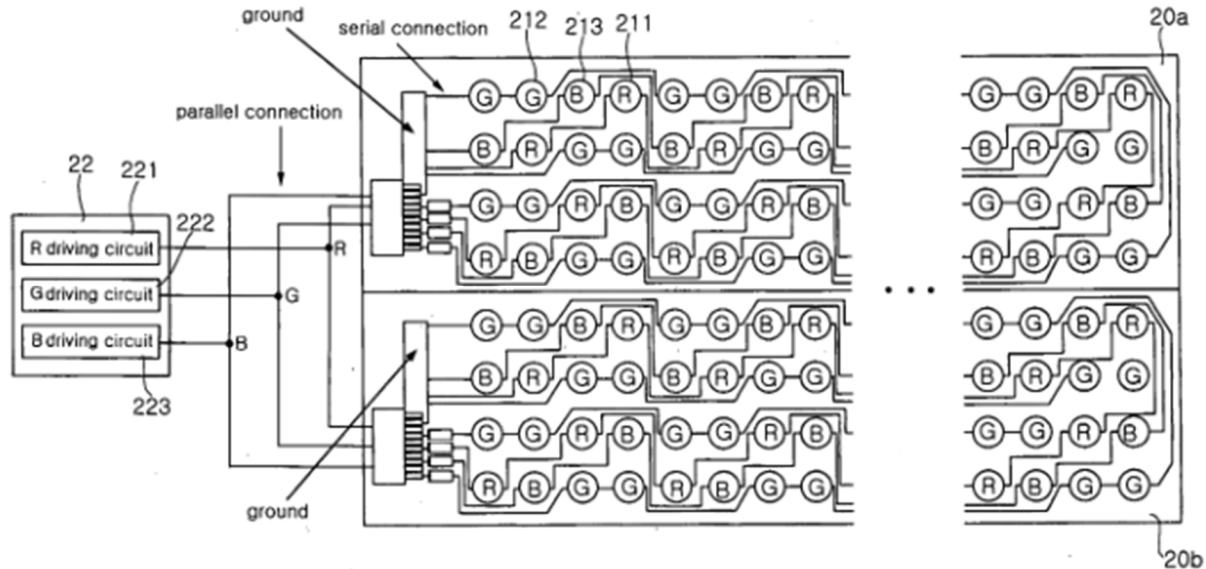
57. Lee discloses, with reference to Figs. 2 and 3, a plurality of LED driving units 22 are provided, each having red, green, and blue LED driving circuits 221, 222, and 223 for respectively driving the red, green, and blue LEDs 211, 212, and 213. *Id.*



Lee, Fig. 2.

58. Lee describes that each driving unit 22 has red, green, and blue LED driving circuits 221, 222, and 223 for respectively driving the red, green, and blue LEDs 211, 212, and 213. Lee, [0029]. As shown in Fig. 3, which is an enlarged view of a part of Fig. 2, the series connection structure of the identical color LEDs in the divided region 20a is connected to the series connection structure of the identical color LEDs in the divided region 20b. *Id.*, [0034]. The parallel connection structure is electrically connected to the corresponding color LED driving circuit (i.e., the red driving circuit 221, the green driving circuit 222, or the blue driving circuit 223). Lee, [0034]. As a result, the parallel connection structure between the series connection structures of the identical color LEDs in the different divided regions 20a and 20b is connected to the corresponding driving circuit 221, 222, or 223. *Id.*, [0035]. The LEDs are electrically connected to each

other by the combination of the series (*strings*) and parallel connections (*string groups*). *Id.*



Lee, Fig. 3.

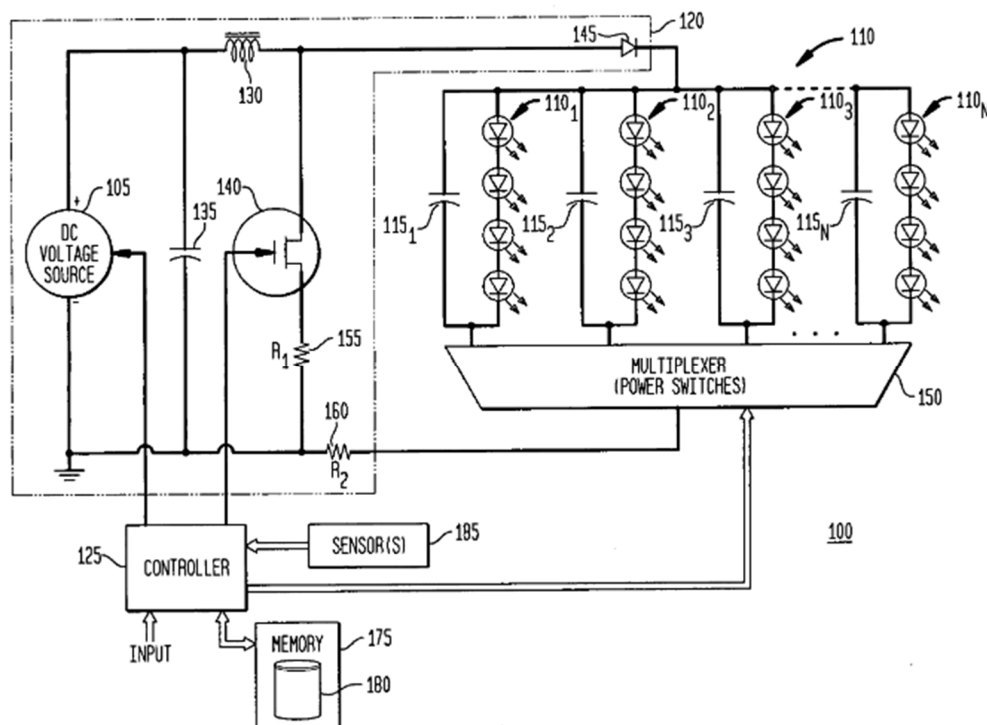
59. Lee further describes that the red LED driving circuit 221, the green LED driving circuit 222, and the blue LED driving circuit 223 function to apply electric power or current to the LEDs “while properly controlling a luminance, a color coordinate, or a color temperature to drive the LEDs under a desired condition.” Lee, [0041].

VII. The Prior Art Renders Every Element of Claims 1-2, 5, 11-13, 16-17, and 47-48 Obvious.

A. Backlighting Systems for Displays Using Multiple Strings of LEDs Were Known in the Art (Claims 1A, 16, 17[preamble], 47 [preamble])

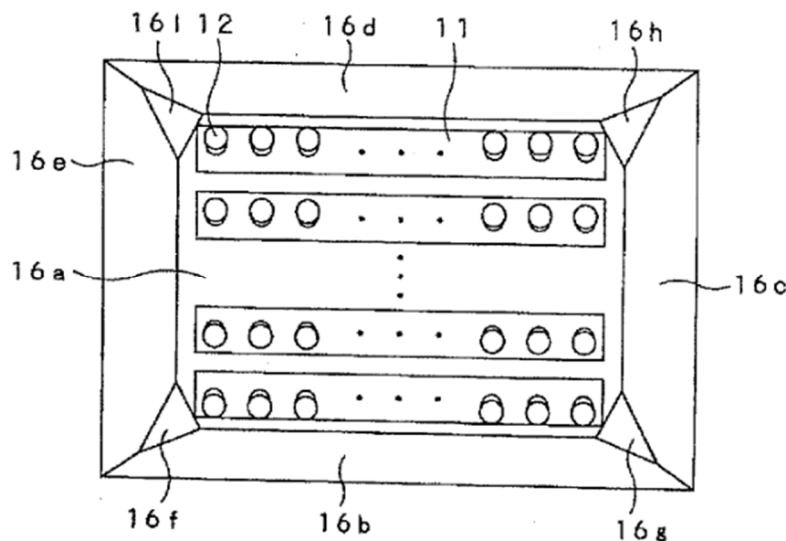
60. Backlighting systems for displays using multiple strings of LEDs were known in the art. As one example, Shteynberg discloses a lighting system,

which “comprises a plurality of series of light-emitting diodes, a power converter, a first multiplexer, and a controller.” Shteynberg, [0021]. Shteynberg discusses, with reference to Fig. 3, the lighting system includes a parallel *array* of LEDs 110, which includes a plurality of series-connected LEDs, and these independent series or *strings* (or channels) *of LEDs* are illustrated as “N” individual series of LEDs 110₁, 110₂, 110₃, ... , 110_N. Shteynberg, [0043]-[0044]. As shown in Fig. 3, LEDs in each LED string are arranged in a first direction (from top to bottom, as shown in Fig. 3), and these strings of LEDs are positioned at intervals in a second direction (from left to right, as shown in Fig. 3). Since the LEDs are organized in an “array,” the LEDs are organized in columns (each column corresponding to one LED string) and rows (multiple LED strings are distributed to form a row, i.e., positioned at intervals), as shown in Fig. 3. The second direction (from left to right, as shown in Fig. 3) is substantially orthogonal to the first direction (from top to bottom, as shown in Fig. 3).



Id., Fig. 3.

61. Similarly, Arai discloses a backlight unit 3 of a transmission type liquid crystal display panel 1, having LEDs 12 that are “two-dimensionally arranged.” Arai, [0006] and [0024]. As shown in Fig. 5, the LEDs 12 are arranged in a first direction (from left to right, as shown in Fig. 5) to form LED strings and positioned at intervals in a second direction (from top to bottom, as shown in Fig. 5). Arai explains that such a two-dimensional arrangement could permit “display of high luminance on large-sized liquid crystal panel by low power consumption.” Arai, [0006]. The second direction (from left to right, as shown in Fig. 3) is substantially orthogonal to the first direction (from top to bottom, as shown in Fig. 3).



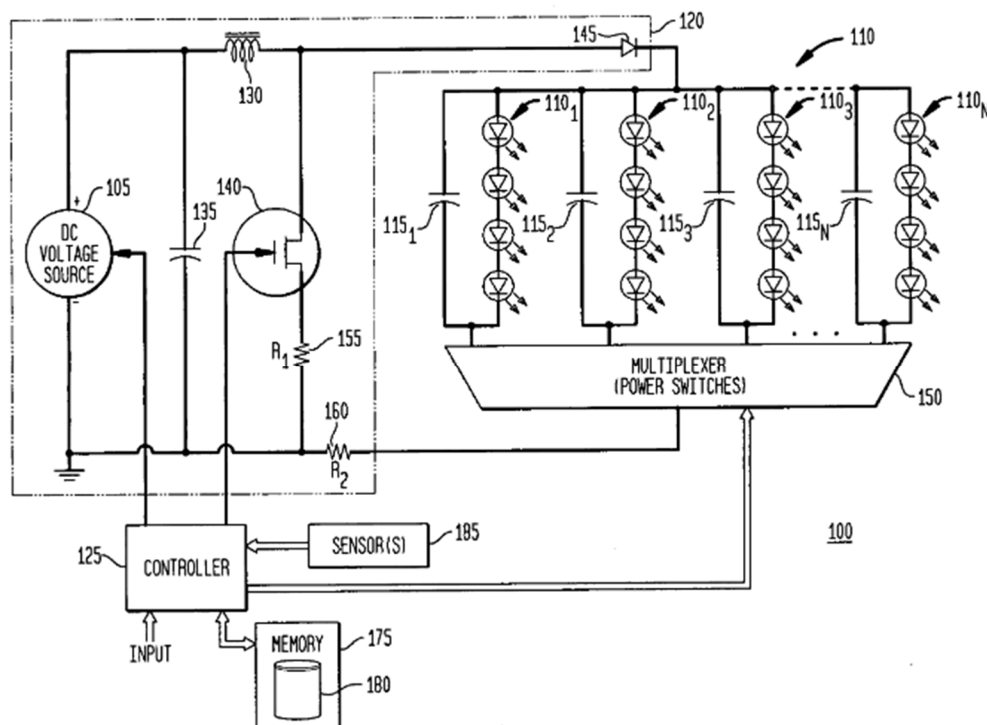
Arai, Fig. 5.

B. Current Supply Circuits that Provide Strings of LEDs with On-State Drive Currents Were Known in the Art (Claims 1B, 17B, 47A).

62. Current supply circuits that provide strings of LEDs with on-state drive currents were known in the art. As one example, Shteynberg describes, with reference to Fig. 3, the lighting system includes a power converter 120, which includes “a DC voltage source 105, a filter capacitor 135, an inductor 130, a switch 140, and a peak current sense resistor (R1) 155.” Shteynberg, [0048]. The power converter 120 is operable to “*deliver a controlled current level* to a load.”

Id. In the example shown in Fig. 3, the load is the LED strings 110₁, 110₂, 110₃, ... , 110_N. The DC voltage source 105 may be an AC/DC converter in some embodiments or an AC/DC converter connected to a phase modulation AC device.

Id.



Id., Fig. 3.

63. Shteynberg further describes that the lighting system further includes a multiplexer 150, which “provides for *individually and selectively allowing current to flow through* each of the series of LEDs 110₁, 110₂, 110₃, through 110_N.” Shteynberg, [0047]. As a result, any selected one of the LED strings 110₁, 110₂, 110₃, through 110_N is turned ON or OFF accordingly. *Id.* The LED strings 110₁, 110₂, 110₃, through 110_N are energized using time-division modulation. Shteynberg, [0044]. “*Under the control of the controller 125*,” the multiplexer 150 is configured to “allow current through one or more of the series of LEDs 110₁, 110₂, 110₃, through 110_N *in any combination*, and *for any selected duration*.” Shteynberg, [0047]. In my opinion, a person of ordinary skill in the art

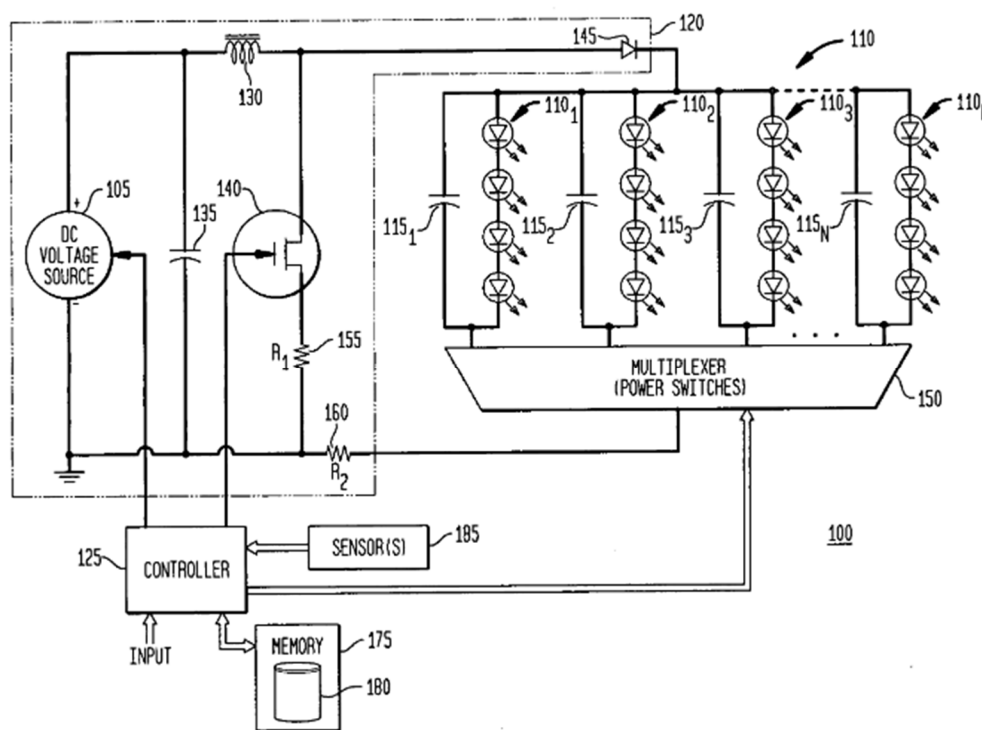
would understand that the power converter 120 and the multiplexor 150, as a whole, operate as a current supply circuit to multiple LED strings.

64. Moreover, the multiplexer 150 may be implemented as *multiple* power switches, as shown in Fig. 3. Shteynberg, [0043]. Shteynberg further states that the controller 125 “may be embodied as” *multiple controllers*, “adapted to perform the functionality.” *Id.*, [0051]. In my opinion, a person of ordinary skill in the art would appreciate that a common sense implementation would use multiple control signals of various phases and durations to control the multiple power switches to achieve individual and selective control over the LED strings. Therefore, the “controlled current level” generated by the power converter 120 is selectively supplied, with the help of the multiplexer 150, to the LED strings responsive to the control signals generated by the controller 125.

C. Controllers to Generate Control Signals, Based on User Input, for Current Supply Circuits for LEDs Were Known in the Art (Claims 1C, 17A, 17B, 48).

65. Controllers to generate control signals, based on user input, for current supply circuits for LEDs were known in the art. As one example, Shteynberg describes that the lighting system includes a controller 125. Shteynberg, [0043]. The controller may “receive input from a wide variety of sources.” *Id.*, [0049]. The controller 230 may “be coupled within a larger system, such as a computer-controlled lighting system in a building, and may interface with other computing

elements.” Shteynberg, [0049]. Therefore, Shteynberg describes a variety of sources where the input for the controller 125 comes from. More importantly, Shteynberg suggests input coming from “a larger system” (as illustrated by the arrow in Fig. 3), and in my opinion, a person of ordinary skill in the art would understand that **user input** is one possible input coming from a larger system. It is the user who ultimately decides on various operating settings such as brightness or color temperature of an LED array.



Id., Fig. 3.

66. Shteynberg further discloses that the multiplexer 150 “provides for ***individually and selectively allowing current to flow through*** each of the series of

LEDs 110₁, 110₂, 110₃, through 110_N ... *[u]nder the control of the controller 125.*”

Shteynberg, [0047].

67. Therefore, Shteynberg discloses a control system (the controller 125) configured to receive a user input (input coming from a larger system and illustrated as the arrow in Fig. 3) and to selectively provide control signals (control signals generated by the controller 125) to the current supply circuit (the power converter 120 and the multiplexer 150) responsive to the user input to selectively (individually and selectively allowing current to flow through) drive the plurality of strings (LED strings 110₁, 110₂, 110₃, through 110_N).

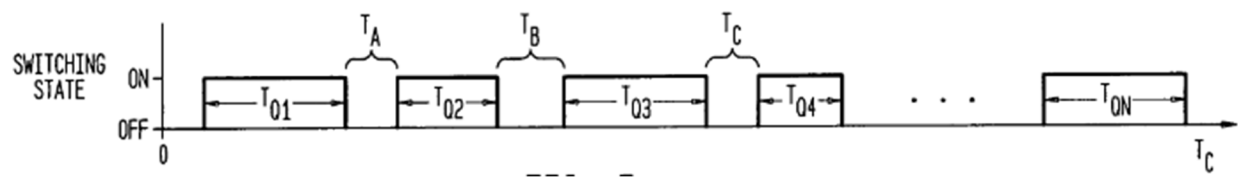
D. Determining a Firing Order of Multiple LED Strings Was Known in the Art (Claims 1D, 2, 11, 17B).

68. Determining a firing order of multiple LED strings was known in the art. First of all, the '710 Patent defines the “firing order” as “an order in which individual strings of solid state lighting devices and/or groups of strings of solid state lighting devices are supplied current.” '710 Patent, 10:30-33.

69. Shteynberg describes that the multiplexer 150 is configured to “allow current through one or more of the series of LEDs 110₁, 110₂, 110₃, through 110_N *in any combination*, and *for any selected duration*” under the control of the controller 125. Shteynberg, [0047].

70. Shteynberg further describes, with reference to Fig. 4, that each of the LED strings 110₁, 110₂, 110₃, through 110_N is provided with a selected and

independent current level, “**through control (by controller 125)** of the switching state of each channel (via multiplexer 150),” for a selected time period (or duration).” Shteynberg, [0054].



Id., Fig. 4.

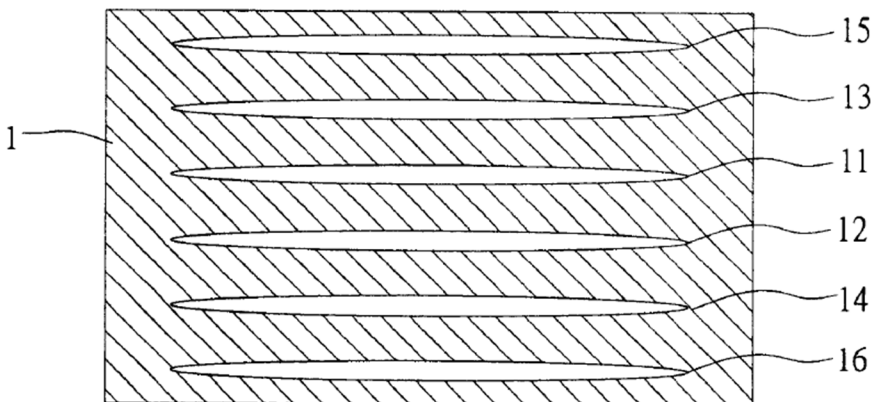
71. Shteynberg stresses that “[e]ach **energizing time period** may be provided **in any order or combination**.” Shteynberg, [0054]. As one example, and as illustrated in the annotated Fig. 4, **LED string 1103** is provided with current for third time period T_{Q3} , **followed by LED string 1102** being provided with current for second time period T_{Q4} , and followed by both LED strings 110₁ and 110_N being provided with selected current levels for corresponding first and N_{th} time periods T_{Q1} and T_{QN} , respectively.

72. Therefore, the controller 125, via the multiplexer 150, determines the order of the energizing time periods, which is equivalent to the firing order according to the definition of the “firing order.”

73. Shteynberg at least suggests that the control system (the controller 125) includes a firing logic because the firing order (the order of the energizing time periods) is determined “**through control of**” the control system (the controller 125). Shteynberg, [0054]. Thus, in my opinion, a person of ordinary skill in the art

would understand that the control system could include *logic* configured to determine the firing order, i.e., *firing logic*.

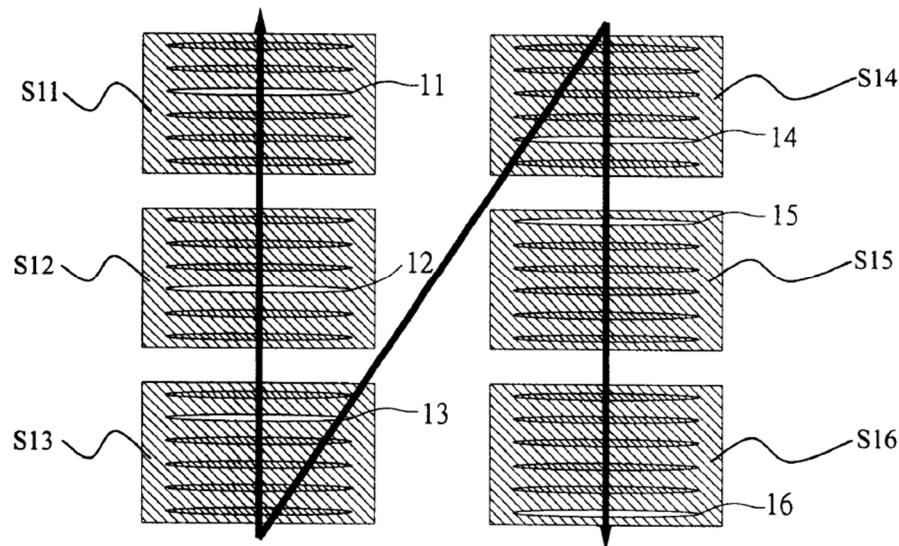
74. As another example, Zhang discloses, with reference to Fig. 1A, a display panel 1, which corresponds to an even number (e.g., six) of backlight modules. Zhang, p. 5:8-11. The first backlight module 11 and the second backlight module 12 are located at the center of the display panel 1. Zhang, p. 5:11-14. The third backlight module 13 and the fourth backlight module 14 are situated on two sides, respectively, toward the outside of the first backlight module 11 and the second backlight module 12. *Id.* The fifth backlight module 15 and the sixth backlight module 16 are situated on two sides, respectively, toward the outside of the four backlight modules 11-14. *Id.*



Zhang, Fig. 1A.

75. Zhang describes, with reference to Fig. 1B, a lighting sequence as follows: the first backlight module 11, the second backlight module 12, the third

backlight module 13, the fourth backlight module 14, the fifth backlight module 15, and the sixth backlight module 16. Zhang, p. 5:14-23.



Zhang, Fig. 1B.

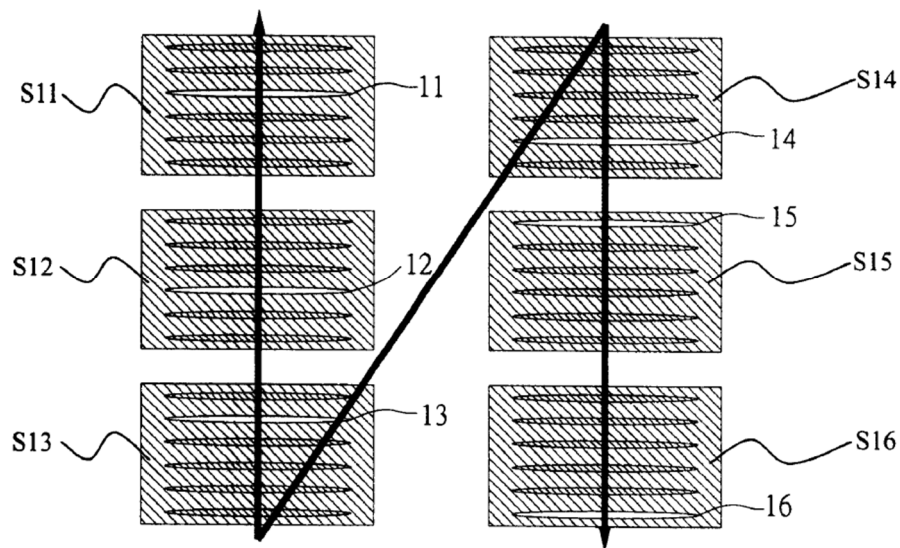
76. In addition, Zhang describes, with reference to Figs. 2A and 2B, another embodiment with an odd number (e.g., five) of backlight modules. Zhang, p. 5:24-37. Zhang stresses that the lighting sequence is from the central backlight module(s) to the outside backlight modules, or vice versa, regardless of an even number or an odd number of backlight modules. Zhang, p. 5:38-42. Therefore, Zhang discloses a firing order (the lighting sequence) under the definition stated in the '710 Patent.

77. Moreover, the flowchart shown in Fig. 5 illustrates a process, by which the lighting sequence is determined, and the process includes, in part, the following steps: (i) step 32, determine whether the number of backlight modules is

even or odd; (ii) step 33, when the number is odd, drive and turn on the central backlight module; and (iii) step 34, when the number is even, drive and turn on one of the two central backlight modules. Zhang, p. 7:1-16. The flowchart shown in Fig. 6 illustrates a similar process, except that the lighting sequence is from the outmost backlight modules to the central backlight module(s). Zhang, p. 7:17-33. Thus, Zhang discloses a firing logic (a component that executes the processes shown in Figs. 5 and 6) that is configured to determine a firing order.

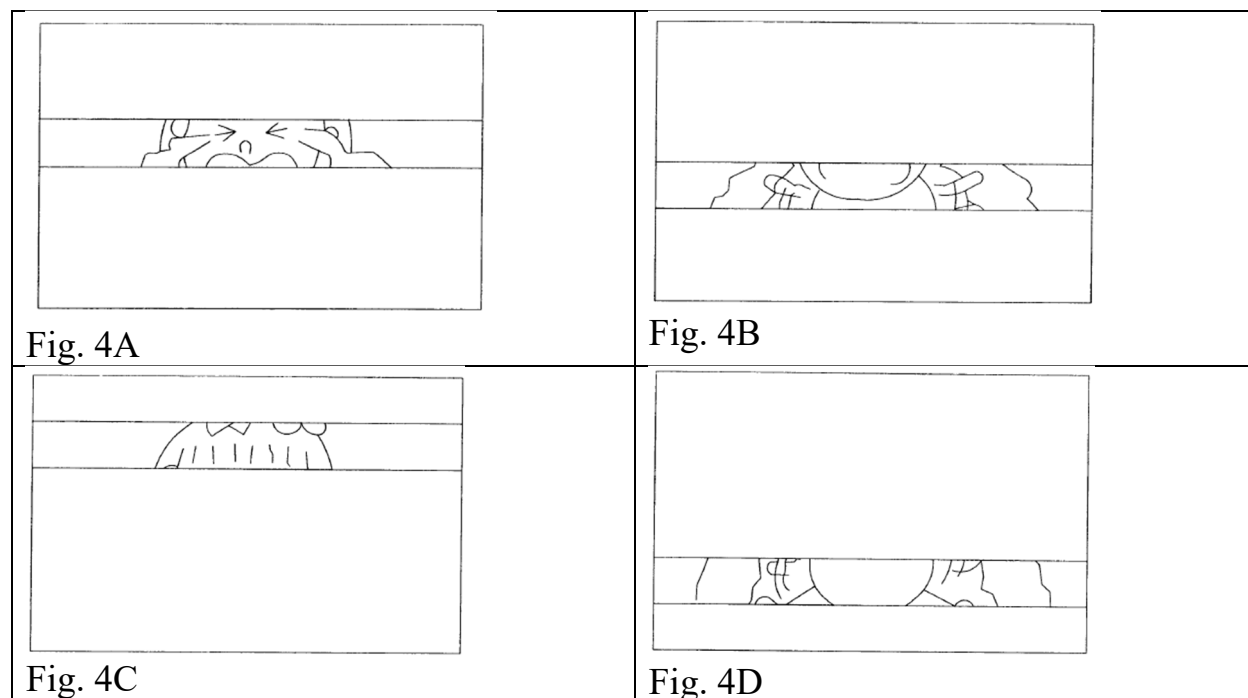
78. As shown in Figs. 5 and 6, the firing logic comprises rule-based logic because the processes shown in Figs. 5 and 6 are based on rules (e.g., step 33, when the number is odd, drive and turn on the central backlight module; step 34, when the number is even, drive and turn on one of the two central backlight modules). Zhang, p. 7:1-33. Thus, Zhang discloses rule-based logic.

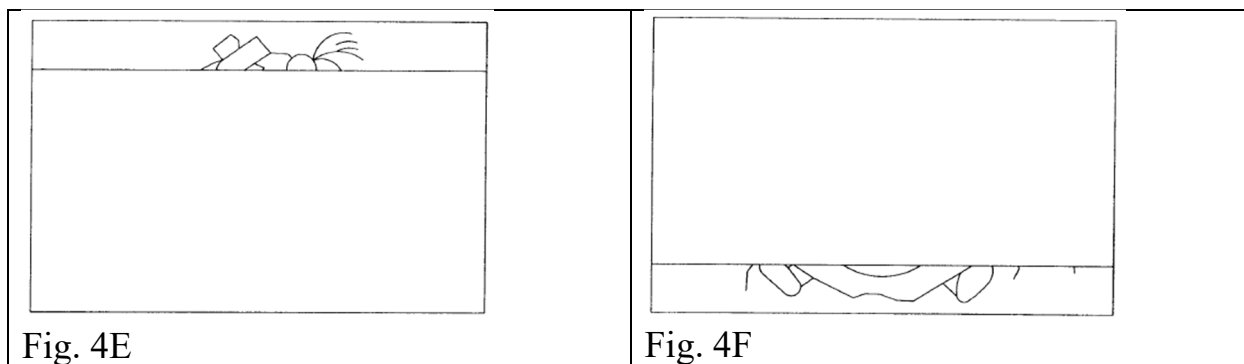
79. Importantly, the firing order discussed in Zhang is a non-spatially-sequential firing order. For instance, the firing order shown in Fig. 1B is as follows: the *third* backlight module from the top, the *fourth* backlight module from the top, the *second* backlight module from the top, the *fifth* backlight module from the top, the *first* backlight module from the top, and the *sixth* backlight module from the top (i.e., a simplified illustration being III→IV→II→V→I→VI). Zhang, p. 5:14-23.



Zhang, Fig. 1B.

80. The resultant display image is shown in Figs. 4A-4F. Zhang, p. 6:13-36. Figs. 4A-4F clearly show that the firing order is not spatially-sequential (i.e., one-by-one from the top to the bottom).

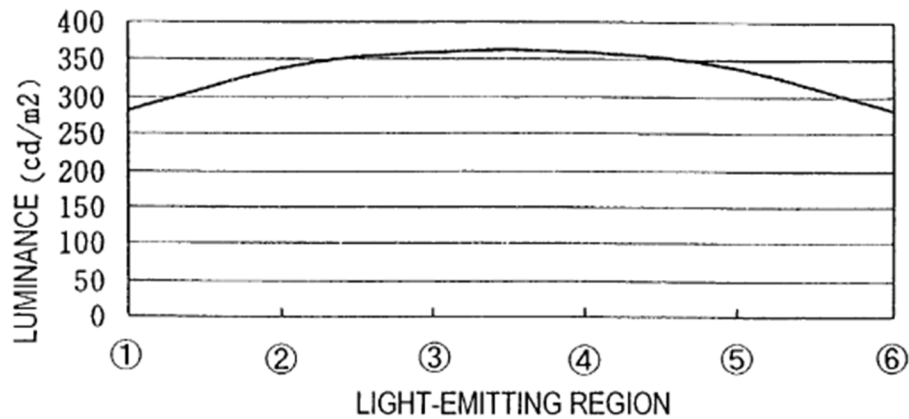




Zhang, Figs. 4A-4F.

81. In my opinion, a person of ordinary skill in the art would recognize that the non-spatially-sequential firing order discussed in Zhang could be used as the firing order discussed in Shteynberg to achieve desired benefits, such as mitigating display artifacts and increasing the brightness uniformity.

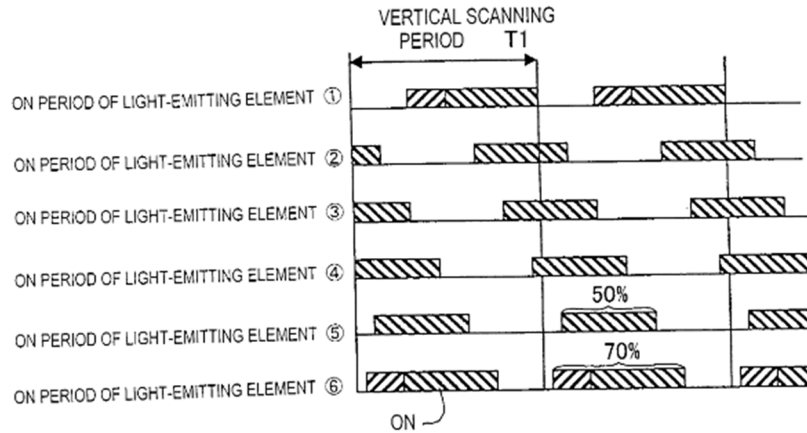
82. As yet another example, Kawabata further discloses a *non-spatially-sequential firing order*. Following the discussion of the timing rule shown in Figure 5 of Kawabata, Kawabata further discusses “a variation in luminance.” Kawabata, [0071]. As shown in Figure 6, the innermost light emitting regions (labeled as ③ and ④) have a higher luminance than the outermost light emitting regions (labeled as ① and ⑥).



Kawabata, Fig. 6.

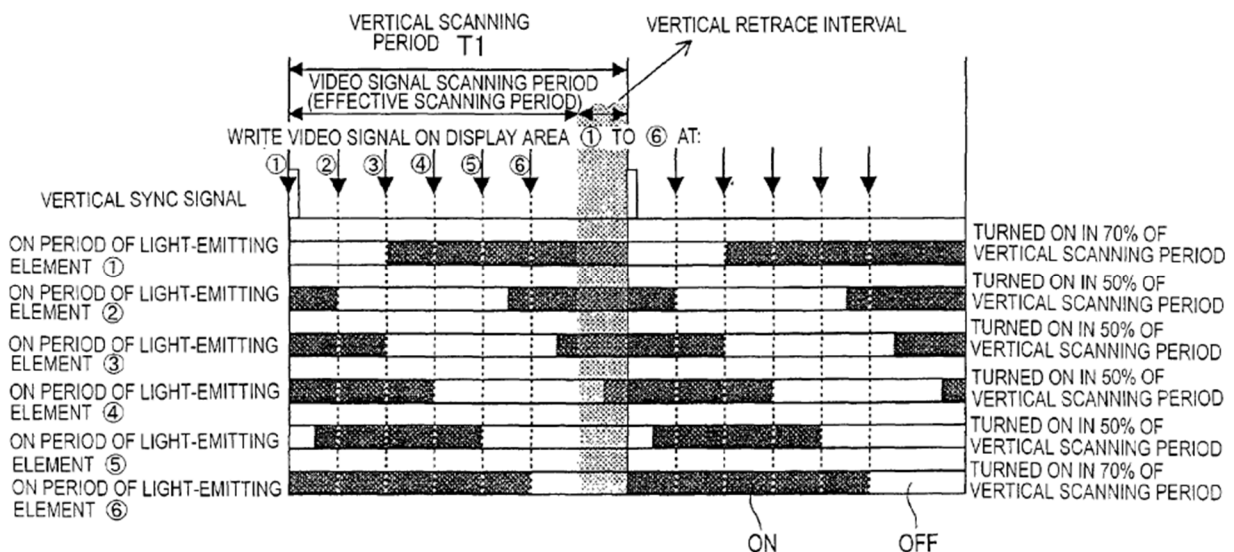
83. Kawabata further discloses that “some of the light-emitting elements 2 for some of the light-emitting regions 4 may be turned ON in a different percentage of one vertical scanning period” to reduce such a variation in luminance. *Id.*, [0073]. In the example shown in Figure 7 of Kawabata, the light emitting elements for the outermost light emitting regions (labeled as ① and ⑥) are turned on in 70%, instead of 50%, of one vertical scanning period. *Id.*

84. The result is shown in Figure 7 of Kawabata. As shown in Figure 7, the timing deviates from the previous timing shown in Figure 5 due to the change from 50% to 70%. Specifically, the light emitting element corresponding to region ⑥ is turned on ***before, not after***, the light emitting element corresponding to region ⑤. Therefore, the light emitting elements are turned on according to a ***non-spatially-sequential firing order***.



Kawabata, Fig. 7.

85. Kawabata discloses a non-spatially-sequential firing order in additional embodiments. For instance, as shown in Figure 8, the firing order is ①→②→③→④→⑥→⑤→①, instead of ①→②→③→④→⑤→⑥→①. *Id.*, [0076]. The flipping order of ⑤ and ⑥ makes the firing order non-spatially-sequential (i.e., the temporally sequential strings are not spatially sequential/adjacent).



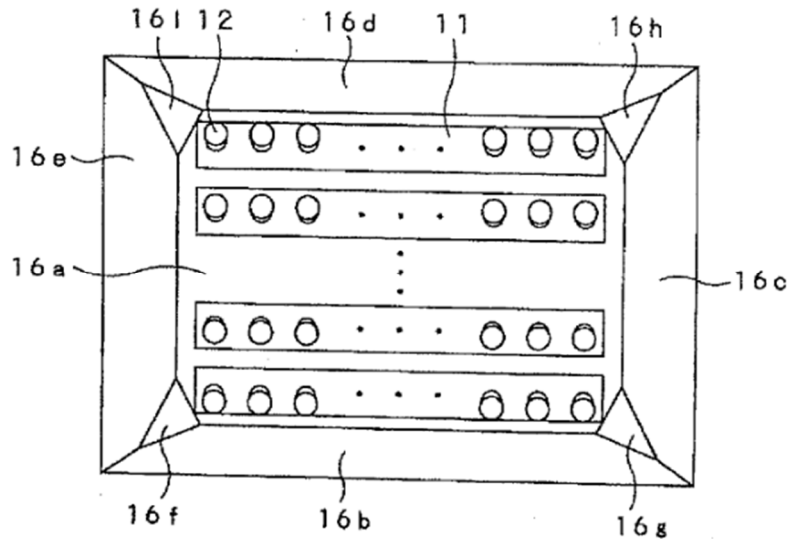
Kawabata, Fig. 8.

86. Kawabata describes another example with reference to Figure 23. The firing order is ①→②→④→③→⑤→⑥ and ⑧(simultaneous)→⑦→①, which is a non-spatially-sequential firing order. Kawabata, [0113].

87. In my opinion, a person of ordinary skill in the art would recognize that the non-spatially-sequential firing order discussed in Kawabata could be used as the firing order discussed in Shteynberg to achieve desired benefits, such as such as mitigating display artifacts and increasing the brightness uniformity. Thus, this element is obvious in view of the combination of Shteynberg, Arai, and Kawabata.

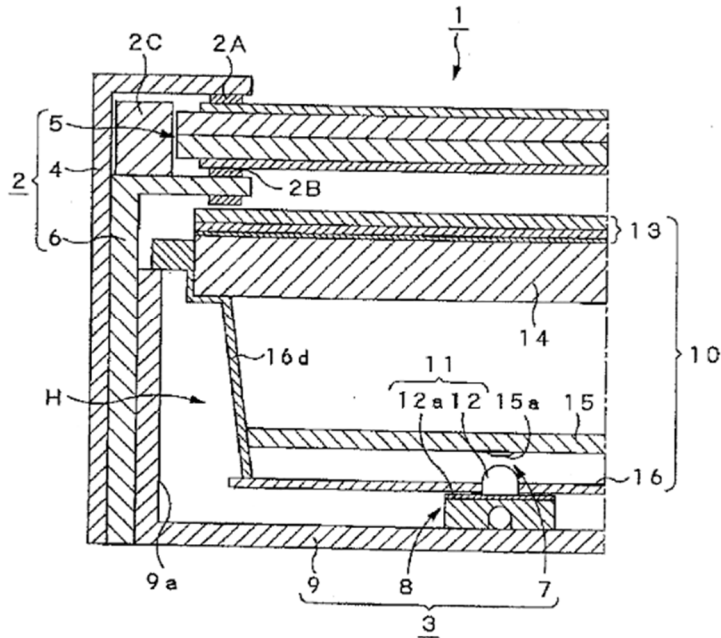
E. Organizing Multiple LED Strings into Multiple Bars Was Known in the Art (Claim 5).

88. Organizing multiple LED strings into multiple bars was known in the art. As one example, Arai describes that a light emitting block 11 is composed of LEDs 12 and a “*laterally elongated rectangular wiring board* 12a on which these LEDs 12 are mounted *in a predetermined order*.” Arai, [0029]. Fig. 5 shows that the laterally elongated rectangular wiring boards 12a extend in the first direction (from left to right, as shown in Fig. 5) and are positioned adjacent to one another in substantially parallel arrangement (parallel to each other in the first direction, as shown in Fig. 5).



Arai, Fig. 5.

89. Additionally, as shown in Fig. 4, the LEDs 12 are arranged corresponding to the laterally elongated rectangular wiring boards 12a as the LEDs 12 are “mounted *in a predetermined order*” on the laterally elongated rectangular wiring boards 12a. Arai, [0029]. Thus, Arai discloses that ones of the plurality of strings (a series of LEDs as shown in Fig. 5) are arranged corresponding (arranged, in a predetermined order, on) to a plurality of bars (the laterally elongated rectangular wiring boards 12a).



Arai, Fig. 4.

90. In my opinion, a person of ordinary skill in the art would understand that the rectangular arrangement of a plurality of bars (the laterally elongated rectangular wiring boards 12a) would be a natural choice to incorporated into the LED array lighting system described in the Shteynberg.

F. Controllers Receiving Feedback Signals Were Known in the Art (Claim 12).

91. Controllers receiving feedback signals were known in the art. As one example, Shteynberg describes that the controller 125 “may receive input from a wide variety of sources, including *open or closed-loop feedback* of various signals and measurements from within the LED array driver circuit 100.” *Id.* In one embodiment, the sensor 185 is used to measure, for example, the actual output voltage across each of the LED strings 110₁, 110₂, 110₃, through 110_N. Shteynberg,

[0072]. Therefore, Shteynberg discloses a means (the sensor 185) for generating a feedback signal (open or closed-loop feedback).

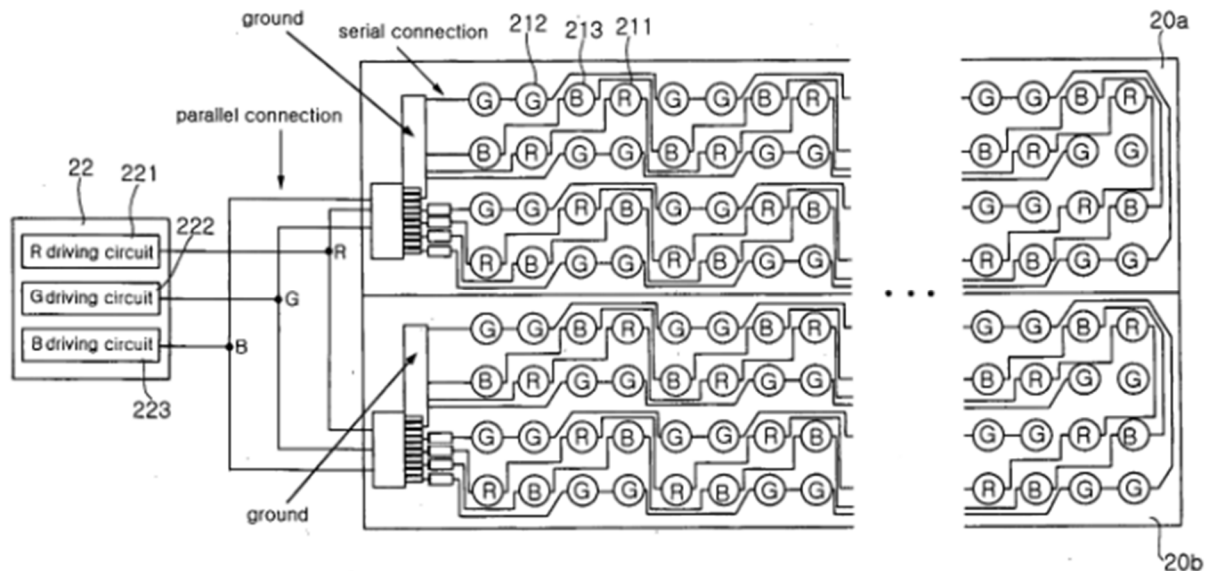
92. Shteynberg further states: “Corresponding to such measurements, compensation coefficients are introduced, stored in memory 175, and *utilized* for subsequent output voltage prediction *by the controller 125.*” *Id.* Also, Fig. 3 shows that the sensor 185 provides (illustrated as an arrow in Fig. 3) display performance information (e.g., the actual output voltage across each of the LED strings 110₁, 110₂, 110₃, through 110_N) to the controller 125.

93. Thus, Shteynberg discloses “a means (e.g., the sensor 185) for generating a feedback signal (open or closed-loop feedback) configured to provide display performance information (the actual output voltage across each LED string) to the control system (the controller 125).”

G. Circuits Utilizing Phase Drivers to Provide Drive Currents at a Plurality of Times in a Firing Cycle Were Known in the Art (Claim 13).

94. Circuits utilizing phase drivers to provide drive currents at a plurality of times in a firing cycle were known in the art. As an example, Lee describes that each driving unit 22 has red, green, and blue LED driving circuits 221, 222, and 223 for respectively driving the red, green, and blue LEDs 211, 212, and 213. Lee, [0029]. As shown in Fig. 3, which is an enlarged view of a part of Fig. 2, the series connection structure of the identical color LEDs in the divided region 20a is

connected to the series connection structure of the identical color LEDs in the divided region 20b. *Id.*, [0034]. The parallel connection structure is electrically connected to the corresponding color LED driving circuit (i.e., the red driving circuit 221, the green driving circuit 222, or the blue driving circuit 223). Lee, [0034]. As a result, the parallel connection structure between the series connection structures of the identical color LEDs in the different divided regions 20a and 20b is connected to the corresponding driving circuit 221, 222, or 223. *Id.*, [0035]. Therefore, the LEDs are electrically connected to each other by the combination of the series (*strings*) and parallel connections (*string groups*). *Id.*



Lee, Fig. 3.

95. Lee further describes that the red LED driving circuit 221, the green LED driving circuit 222, and the blue LED driving circuit 223 function to ***apply electric power or current*** to the LEDs “while properly controlling a luminance, a

color coordinate, or a color temperature to drive the LEDs under a desired condition.” Lee, [0041].

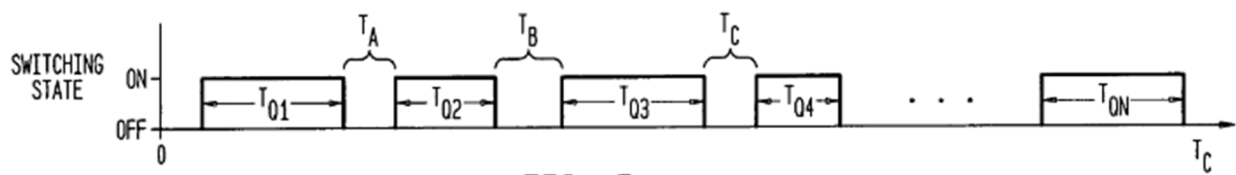
96. Thus, Lee discloses the current supply circuit (the LED driving unit 22) comprises a plurality of driving circuits (the red LED driving circuit 221, the green LED driving circuit 222, and the blue LED driving circuit 223) configured to supply a plurality of on-state drive currents (apply electric currents). Lee discloses a plurality of string groups (a *red string group* that is two or more red LED strings connected in parallel, a *green string group* that is two or more green LED strings connected in parallel, and a *blue string group* that is two or more blue LED strings connected in parallel).

97. As another example, Kawabata states: “[T]he drive signal supplied to one of the light-emitting elements 2 should *have its phase shifted from that of the drive signal supplied to adjacent one* of the light-emitting elements 2.” Kawabata, [0070]. In my opinion, a person of ordinary skill in the art would understand that in the time-domain, phase-shifting is a synonym for applying a time-offset, therefore, it is equivalent to having the current signals starting at different times in a firing cycle. In other words, Kawabata discloses phase drivers configured to supply a plurality of on-state drive currents at a plurality of times in a firing cycle (have its phase shifted from the phase of the drive signal supplied to an adjacent LED string).

98. In my opinion, a person of ordinary skill in the art would understand that the phase drivers that supply on-state drive currents and corresponding phase-shifting technique described in Kawabata could be combined with the multiple driving circuits and strings described in Lee to achieve the benefits stated in Lee (“properly controlling a luminance, a color coordinate, or a color temperature to drive the LEDs under a desired condition.”).

99. As yet another example, Shteynberg describes that the multiplexer 150 is configured to “allow current through one or more of the series of LEDs 110₁, 110₂, 110₃, through 110_N in any combination, and *for any selected duration*” under the control of the controller 125. Shteynberg, [0047].

100. Importantly, Shteynberg stresses that “[e]ach *energizing time period* may be provided *in any order or combination*.” Shteynberg, [0054].



Id., Fig. 4.

101. Therefore, the controller 125, via the multiplexer 150, determines the order of the energizing time periods, which is equivalent to the firing order according to the definition of the “firing order,” for the LED strings. Thus, Shteynberg discloses “to determine a firing order of the plurality of strings” recited in claim 1D.

102. In my opinion, a person of ordinary skill in the art would understand that the phase drivers and the plurality of string groups disclosed in Kawabata and Lee, respectively, could be incorporated into the lighting system disclosed in the Shteynberg-Kawabata combination, where the controller 125 determines the firing order. In other words, the firing order disclosed in the Shteynberg-Kawabata combination could be applied to the phase drivers and the plurality of string groups disclosed in Kawabata and Lee, respectively.

VIII. Shteynberg, Arai, and Zang in View of the Knowledge of a Person of Ordinary Skill in the Art Renders Obvious Claims 1-2, 5, 12, and 16-17 of the '710 Patent.

103. In my opinion, a person of ordinary skill in the art would have been motivated to modify the display system in Shteynberg to introduce the two-dimensional arrangement of LEDs described in Arai and the non-spatially-sequential firing order described in Zhang.

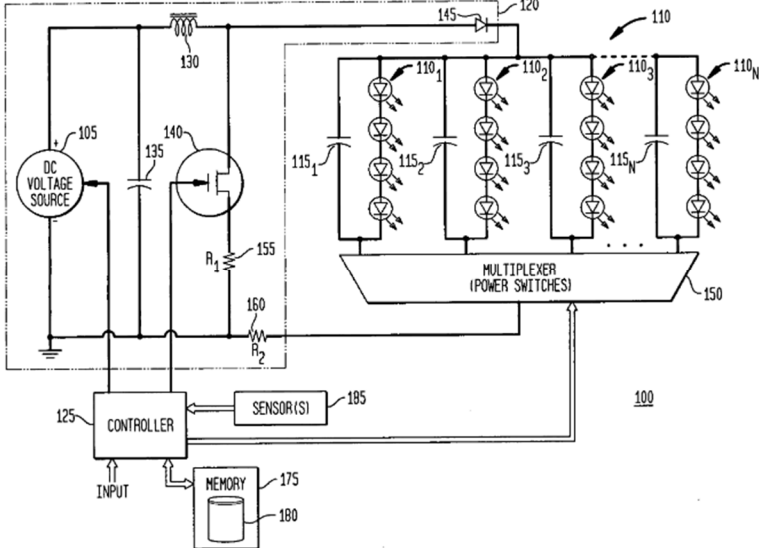
104. First, Shteynberg, Arai, and Zhang are in the same field of endeavor, i.e., achieving the emission of light perceived as white light. Consequently, a person of ordinary skill in the art would have had a reasonable expectation of success in combining their various disclosures to achieve the emission of light perceived as white light. Furthermore, it was well within the technical ability of a person of ordinary skill in the art at the time to incorporate the improvements to brightness uniformity by changing the firing order described in Zhang and the LED

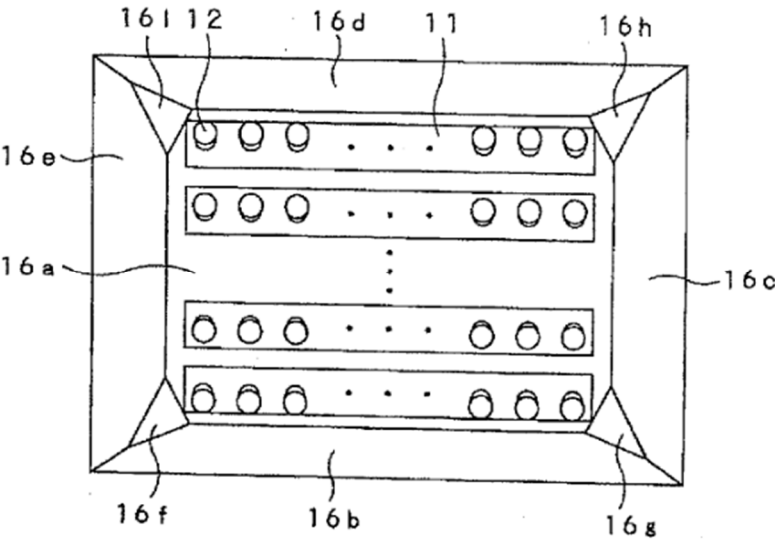
string two-dimensional arrangement described in Arai into the independent control of an array of LEDs disclosed by Shteynberg.

105. *Second*, a primary motivation of one of ordinary skill in the art would have been to ***improve brightness uniformity***, as described in Zhang, and to achieve ***high luminance on large-sized display***, as described in Arai. Modifying Shteynberg to include the non-spatially-sequential firing order, as disclosed by Zhang, and the two-dimensional arrangement, as disclosed by Arai, would meet this goal. For example, Zhang states that the display delay and the brightness non-uniformity can be mitigated by changing the lighting sequence of backlight modules. Zhang, p. 2:8-12. For example, Arai states: “Such LED backlight unit permits reduction of cost with realization of reduction of cost of LED, and permits display of high luminance on large-sized liquid crystal panel by low power consumption.” Arai, [0006].

106. Thus, in my opinion, combining these three references—Shteynberg, Arai, and Zhang—that both use the same components to achieve the same goal would have been obvious to a person of ordinary skill in the art.

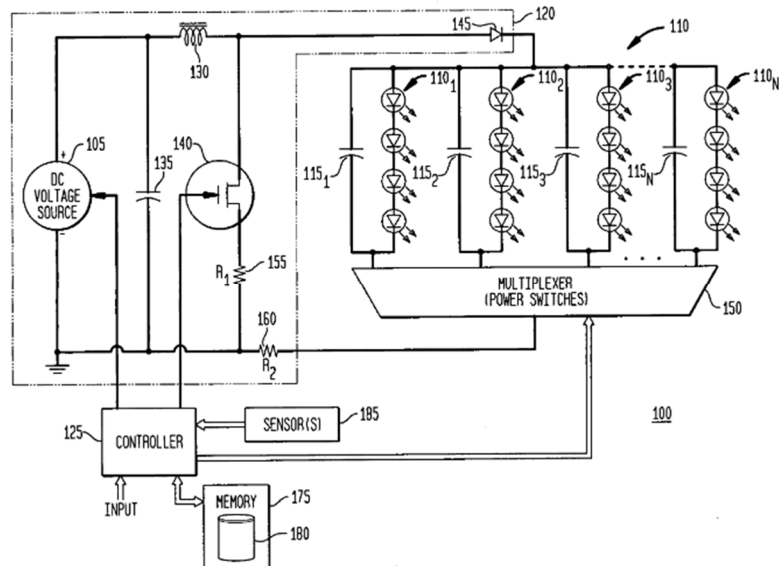
107. In my opinion, a person of ordinary skill in the art would have recognized that each element of 1-2, 5, 12, and 16-17 was obvious in view of the combination of Shteynberg and Zhang. This is further demonstrated by the claim chart below.

Claims of the '710 Patent	Prior Art
[’710 Claim 1 Preamble] A lighting panel system, comprising:	Shteynberg discloses a lighting system, which “comprises a plurality of series of light-emitting diodes, a power converter, a first multiplexer, and a controller.” Shteynberg, [0021].
[’710 Claim 1A] a plurality of strings of solid state lighting devices arranged in a first direction and positioned at intervals in at least one second direction;	Shteynberg discusses, with reference to Fig. 3, the lighting system includes a parallel array of LEDs 110, which includes a plurality of series-connected LEDs, and these independent series or strings (or channels) of LEDs are illustrated as “N” individual series of LEDs 110₁, 110₂, 110₃, ... , 110_N. Shteynberg, [0043]-[0044]. As shown in Fig. 3, LEDs in each LED string are arranged in a first direction (from top to bottom, as shown in Fig. 3), and these strings of LEDs are positioned at intervals in a second direction (from left to right, as shown in Fig. 3). Since the LEDs are organized in an “array,” the LEDs are organized in columns (each column corresponding to one LED string) and rows (multiple LED strings are distributed to form a row, i.e., positioned at intervals), as shown in Fig. 3.  <i>Id.</i>, Fig. 3. To the extent that someone would argue that Fig. 3 fails to show LED strings “arranged in a first direction

	and positioned at intervals in at least one second direction,” Arai discloses a backlight unit 3 of a transmission type liquid crystal display panel 1, having LEDs 12 that are “two-dimensionally arranged.” Arai, [0006] and [0024]. As shown in Fig. 5, the LEDs 12 are arranged in a first direction (from left to right, as shown in Fig. 5) to form LED strings and positioned at intervals in a second direction (from top to bottom, as shown in Fig. 5). Arai explains that such a two-dimensional arrangement could permit “display of high luminance on large-sized liquid crystal panel by low power consumption.” Arai, [0006].  Arai, Fig. 5.
[’710 Claim 1B] a current supply circuit configured to selectively supply a plurality of on-state drive currents to the plurality of strings responsive to a plurality of control signals; and	As discussed in paragraph [0048] of Shteynberg, with reference to Fig. 3, the lighting system includes a power converter 120, which includes “a DC voltage source 105, a filter capacitor 135, an inductor 130, a switch 140, and a peak current sense resistor (R1) 155.” Shteynberg, [0048]. The power converter 120 is operable to “deliver a controlled current level to a load.” <i>Id.</i> In the example shown in Fig. 3, the load is the LED strings 110₁, 110₂, 110₃, ... , 110_N. The DC voltage source 105 may be an AC/DC converter in some embodiments or an AC/DC converter connected to a phase modulation AC device. <i>Id.</i>

[’710 Claim 1C] a control system configured to receive a user input and to selectively provide control signals to the current supply circuit responsive to the user input to selectively drive the plurality of strings,

Shteynberg describes that the lighting system includes a controller 125. Shteynberg, [0043]. The controller may “receive input from a wide variety of sources.” *Id.*, [0049]. The controller 230 may “be coupled within a larger system, such as a computer-controlled lighting system in a building, and may interface with other computing elements.” Shteynberg, [0049]. Therefore, Shteynberg describes a variety of sources where the input for the controller 125 comes from. More importantly, Shteynberg suggests input coming from “a larger system” (as illustrated by the arrow in Fig. 3).



Id., Fig. 3.

The multiplexer 150 “provides for *individually and selectively allowing current to flow through* each of the series of LEDs 110₁, 110₂, 110₃, through 110_N ... *[u]nder the control of the controller 125.*” Shteynberg, [0047].

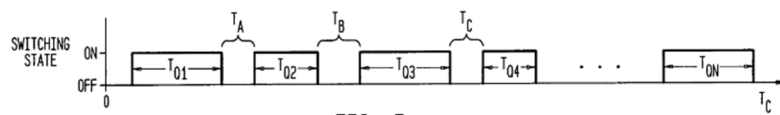
[’710 Claim 1D] the control system further including firing logic configured to determine

Shteynberg describes that the multiplexer 150 is configured to “allow current through one or more of the series of LEDs 110₁, 110₂, 110₃, through 110_N *in any combination, and for any selected duration*”

a firing order of the plurality of strings.

under the control of the controller 125. Shteynberg, [0047].

Shteynberg further describes, with reference to Fig. 4, that each of the LED strings 110_1 , 110_2 , 110_3 , through 110_N is provided with a selected and independent current level, “**through control (by controller 125)** of the switching state of each channel (via multiplexer 150),” for a selected time period (or duration).” Shteynberg, [0054].

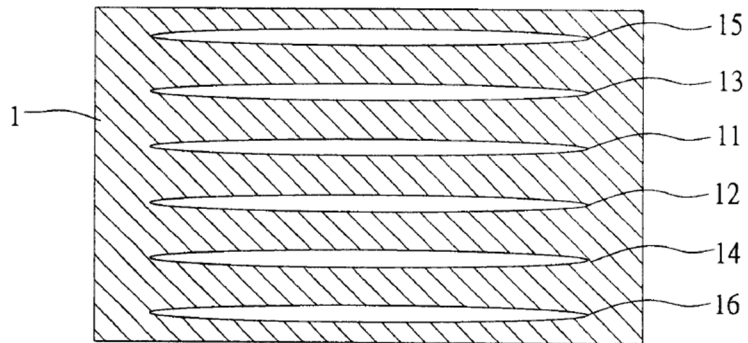


Id., Fig. 4.

Importantly, Shteynberg stresses that “[e]ach **energizing time period** may be provided **in any order or combination**.” Shteynberg, [0054]. As one example, and as illustrated in the annotated Fig. 4, **LED string 1103** is provided with current for third time period T_{Q3} , **followed by LED string 1102** being provided with current for second time period T_{Q4} , and followed by both LED strings 110_1 and 110_N being provided with selected current levels for corresponding first and N_{th} time periods T_{Q1} and T_{QN} , respectively.

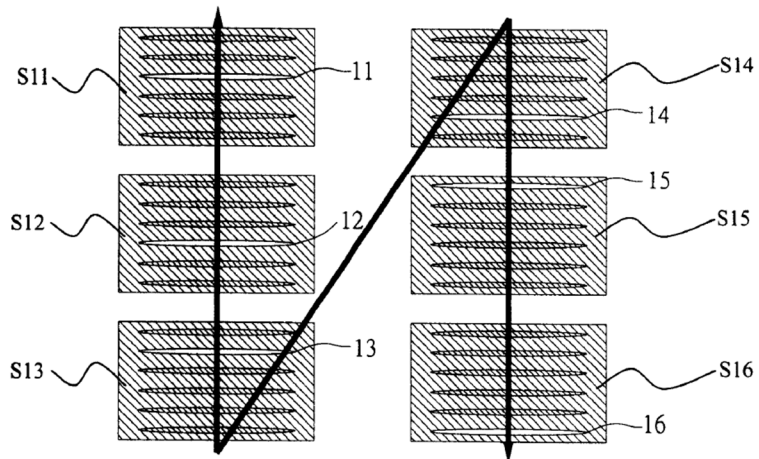
Zhang discloses, with reference to Fig. 1A, a display panel 1, which corresponds to an even number (e.g., six) of backlight modules. Zhang, p. 5:8-11. The first backlight module 11 and the second backlight module 12 are located at the center of the display panel 1. Zhang, p. 5:11-14. The third backlight module 13 and the fourth backlight module 14 are situated on two sides, respectively, toward the outside of the first backlight module 11 and the second backlight module 12. *Id.* The fifth backlight module 15 and the sixth backlight module 16 are

situated on two sides, respectively, toward the outside of the four backlight modules 11-14. *Id.*



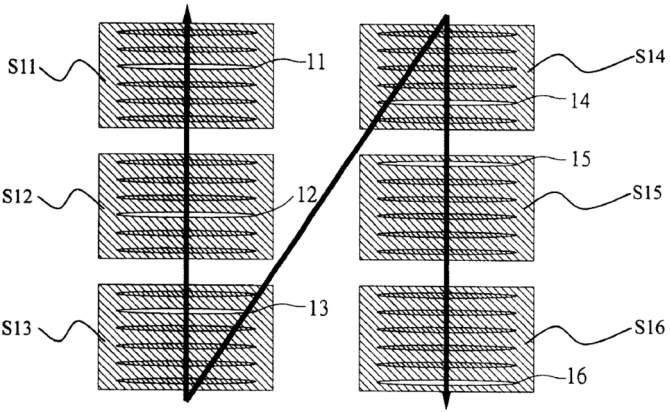
Zhang, Fig. 1A.

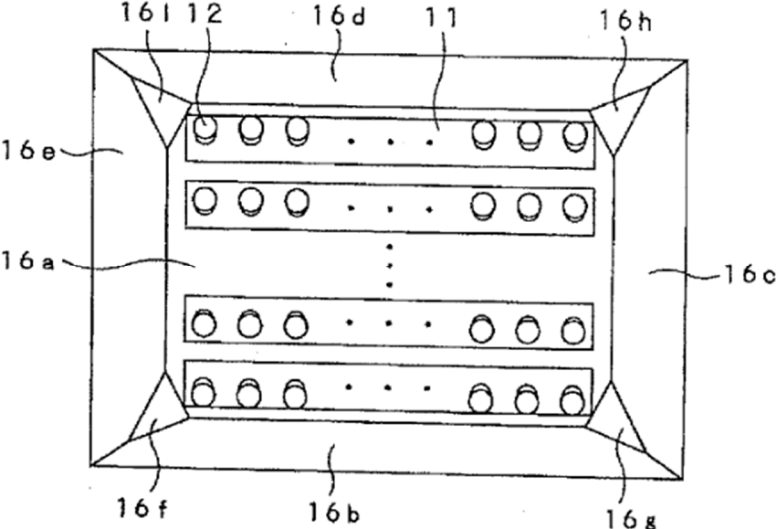
Zhang describes, with reference to Fig. 1B, a lighting sequence as follows: the first backlight module 11, the second backlight module 12, the third backlight module 13, the fourth backlight module 14, the fifth backlight module 15, and the sixth backlight module 16. Zhang, p. 5:14-23.



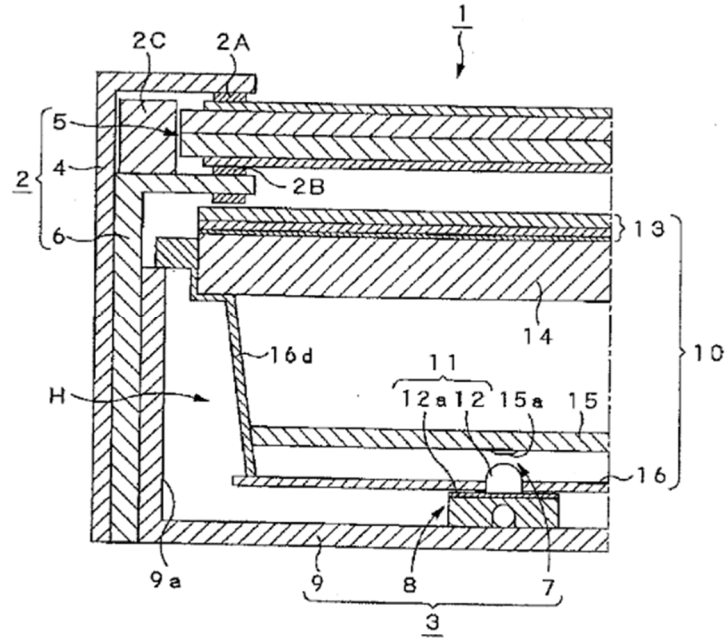
Zhang, Fig. 1B.

In addition, Zhang describes, with reference to Figs. 2A and 2B, another embodiment with an odd number (e.g., five) of backlight modules. Zhang, p. 5:24-37. Zhang stresses that the lighting sequence is from the central backlight module(s) to the outside backlight modules, or vice versa, regardless of an even number

	or an odd number of backlight modules. Zhang, p. 5:38-42.
[’710 Claim 2] The system of claim 1, wherein the firing logic comprises rule-based logic operative to generate a non-spatially-sequential firing order.	As shown in Figs. 5 and 6 of Zhang, the firing logic comprises rule-based logic because the processes shown in Figs. 5 and 6 are based on rules (e.g., step 33, when the number is odd, drive and turn on the central backlight module; step 34, when the number is even, drive and turn on one of the two central backlight modules). Zhang, p. 7:1-33. Thus, Zhang discloses rule-based logic. The firing order discussed in Zhang is a non-spatially-sequential firing order. For instance, the firing order shown in Fig. 1B is as follows: the <i>third</i> backlight module from the top, the <i>fourth</i> backlight module from the top, the <i>second</i> backlight module from the top, the <i>fifth</i> backlight module from the top, the <i>first</i> backlight module from the top, and the <i>sixth</i> backlight module from the top (i.e., a simplified illustration being III→IV→II→V→I→VI). Zhang, p. 5:14-23.  Zhang, Fig. 1B. The resultant display image is shown in Figs. 4A-4F.

	Zhang, p. 6:13-36. Figs. 4A-4F clearly show that the firing order is not spatially-sequential (i.e., one-by-one from the top to the bottom). Zhang, Figs. 4A-4F.
[’710 Claim 5] The system of claim 1, wherein ones of the plurality of strings are arranged corresponding to a plurality of bars that include portions of the plurality of strings, wherein the plurality of bars extend in the first direction and are positioned adjacent one another in a substantially parallel arrangement.	Arai describes that a light emitting block 11 is composed of LEDs 12 and a “laterally elongated rectangular wiring board 12a on which these LEDs 12 are mounted in a predetermined order.” Arai, [0029]. Fig. 5 shows that the laterally elongated rectangular wiring boards 12a extend in the first direction (from left to right, as shown in Fig. 5) and are positioned adjacent to one another in substantially parallel arrangement (parallel to each other in the first direction, as shown in Fig. 5).  Arai, Fig. 5. Additionally, as shown in Fig. 4, the LEDs 12 are arranged corresponding to the laterally elongated rectangular wiring boards 12a as the LEDs 12 are “mounted in a predetermined order” on the laterally elongated rectangular wiring boards 12a. Arai, [0029]. Thus, Arai discloses that ones of the plurality of strings (a series of LEDs as shown in Fig. 5) are

arranged corresponding (arranged, in a predetermined order, on) to a plurality of bars (the laterally elongated rectangular wiring boards 12a).

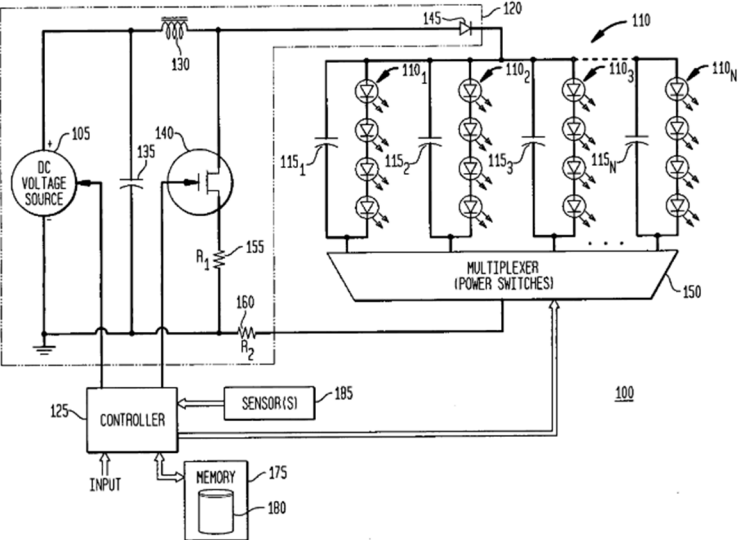


Arai, Fig. 4.

[’710 Claim 12] The system of claim 1, further comprising a means for generating a feedback signal configured to provide display performance information to the control system.

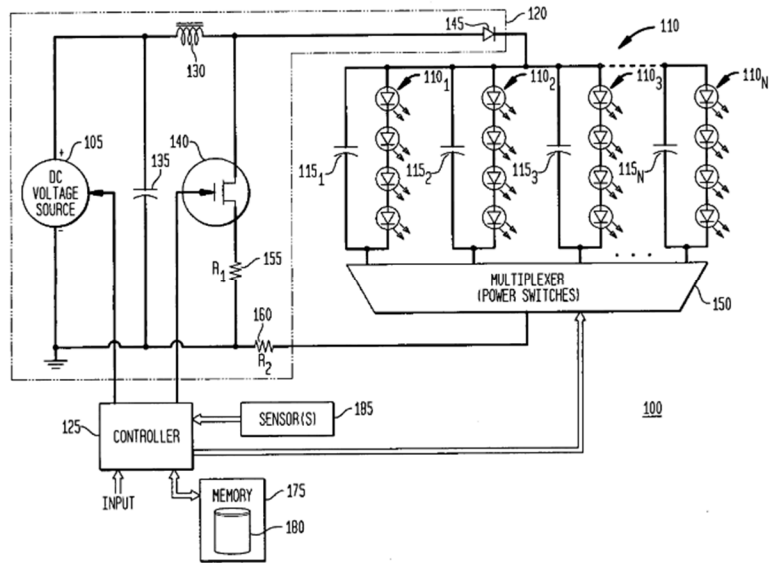
Shteynberg describes that the controller 125 “may receive input from a wide variety of sources, including *open or closed-loop feedback* of various signals and measurements from within the LED array driver circuit 100.” *Id.* In one embodiment, the sensor 185 is used to measure, for example, the actual output voltage across each of the LED strings 110₁, 110₂, 110₃, through 110_N. Shteynberg, [0072].

Shteynberg further states: “Corresponding to such measurements, compensation coefficients are introduced, stored in memory 175, and *utilized* for subsequent output voltage prediction *by the controller 125.*” *Id.* Also, Fig. 3 shows that the sensor 185 provides (illustrated as an arrow in Fig. 3) display performance information (e.g., the actual output voltage across each of the LED strings

	110 ₁ , 110 ₂ , 110 ₃ , through 110 _N) to the controller 125.
[’710 Claim 16] The system of claim 1, wherein the second direction is substantially orthogonal to the first direction.	Shteynberg discloses that the LEDs are organized in an “array,” i.e., the LEDs being organized in columns (each column corresponding to one LED string) and rows (multiple LED strings are distributed to form a row, i.e., positioned at intervals), as shown in Fig. 3. Shteynberg, therefore, discloses that LEDs in each LED string are arranged in a first direction (from top to bottom, as shown in Fig. 3), and these strings of LEDs are positioned at intervals in a second direction (from left to right, as shown in Fig. 3). Therefore, the second direction (from left to right, as shown in Fig. 3) is substantially orthogonal to the first direction (from top to bottom, as shown in Fig. 3).  <i>Id.</i>, Fig. 3. Arai describes that the LEDs 12 are arranged in a first direction (from left to right, as shown in Fig. 5) to form LED strings and positioned at intervals in a second direction (from top to bottom, as shown in Fig. 5). Therefore, Arai discloses that the second direction (from top to bottom) is substantially orthogonal to the first direction (from left to right).

[’710 Claim 17 Preamble] A method for controlling a plurality of strings of solid state lighting devices configured to extend in a first direction and to be arranged in substantially adjacent positions relative to one another in a second direction that is different from the first direction, the method comprising:	Shteynberg discusses, with reference to Figs. 14A and 14B, a method of time-division modulation for “separately and independently energizing” a selected LED string of the LED strings 110₁, 110₂, 110₃, through 110_N. Shteynberg, [0110]. Shteynberg describes, with reference to Fig. 3, that a parallel array of LEDs 110 includes a plurality of LED strings 110₁, 110₂, 110₃, ... , 110_N. Shteynberg, [0044]. As shown in Fig. 3, Shteynberg discloses that the LEDs are organized in an “array,” i.e., the LEDs being organized in columns (each column corresponding to one LED string) and rows (multiple LED strings are distributed to form a row, i.e., arranged in substantially adjacent positions relative to one another), as shown in Fig. 3. LEDs in each LED string are arranged in a first direction (from top to bottom, as shown in Fig. 3), and these strings of LEDs are arranged in substantially adjacent positions relative to one another in a second direction (from left to right, as shown in Fig. 3). As shown in Fig. 3, the second direction is substantially orthogonal to, therefore, different from the first direction. Arai discloses that the LEDs 12 extend in a first direction (from left to right, as shown in Fig. 5) to be arranged in substantially adjacent positions relative to one another in a second direction (from top to bottom, as shown in Fig. 5).
[’710 Claim 17A] receiving an input from a user; and	Shteynberg describes that controller 125 may “receive input from a wide variety of sources, including open or closed-loop feedback of various signals and measurements from within the LED array driver circuit 100.” <i>Id.</i> As shown in Fig. 3, the controller 230 may receive input from one or more sensors 185. Alternatively, the controller 230 may “be coupled within a larger system, such as a computer-controlled lighting system in a building, and may interface with

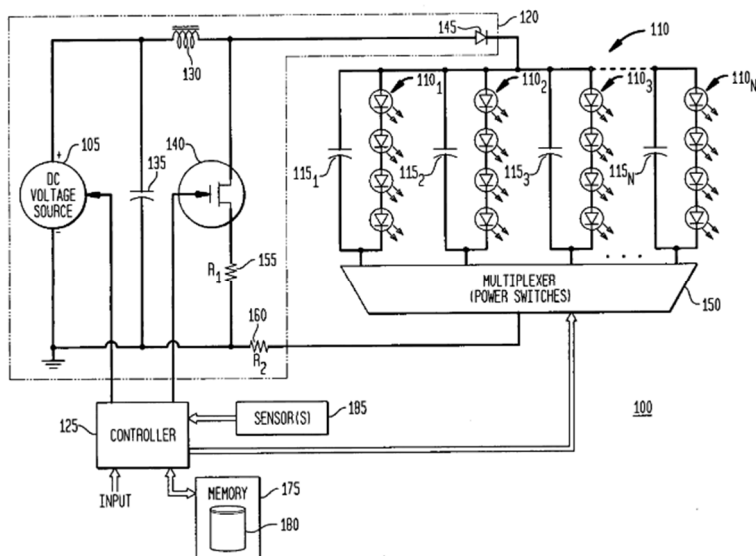
other computing elements.” Shteynberg, [0049]. Therefore, Shteynberg describes receiving, by the controller 125, *input* coming from “*a wide variety of sources.*”



Id., Fig. 3.

[’710 Claim 17B] supplying, based in part on the input from the user, a plurality of pulsed drive currents to the plurality of strings in a non-spatially-sequential firing order.

Shteynberg describes that the power converter 120 is operable to “deliver a controlled current level to” the LED strings 110₁, 110₂, 110₃, ... , 110_N. Shteynberg, [0048]. Under the control of the controller 125, the multiplexer 150 is configured to “*individually and selectively*” allow current through one or more of the LED strings 110₁, 110₂, 110₃, through 110_N *in any combination*, and *for any selected duration.*” Shteynberg, [0047].



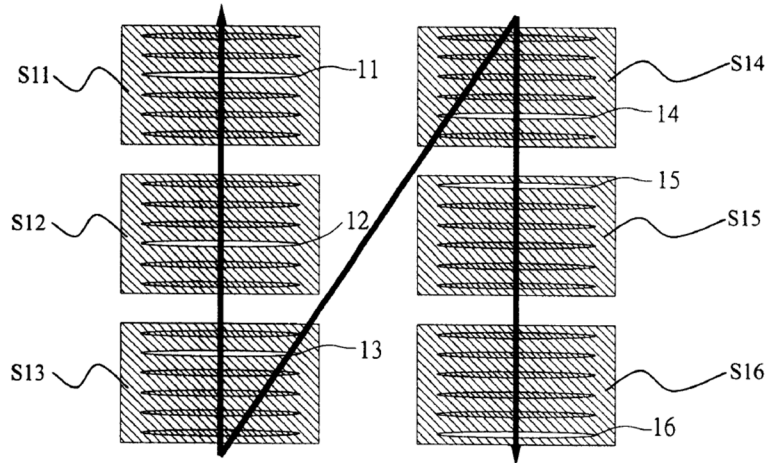
Id., Fig. 3.

Shteynberg describes that the controller 125 receives input coming from a larger system, which includes *input from the user*. Shteynberg, [0049]. *Under the control of the controller 125*, the multiplexer 150 “provides for *individually and selectively allowing current to flow through* each of the LED strings 110₁, 110₂, 110₃, through 110_N.

Shteynberg discloses that the controller 125 determines the order of the energizing time periods. Shteynberg, [0047] and [0054]. Shteynberg stresses that “[e]ach *energizing time period* may be provided *in any order or combination*.” Shteynberg, [0054].

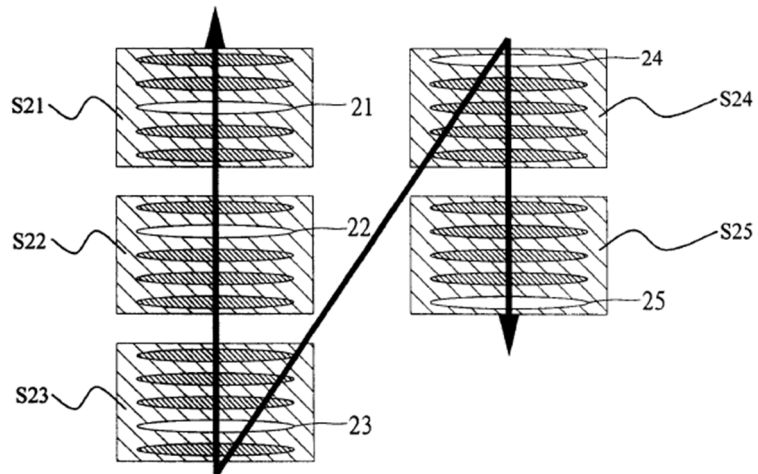
Zhang discloses a non-spatially-sequential firing order. For instance, the firing order shown in Fig. 1B is as follows: the *third* backlight module from the top, the *fourth* backlight module from the top, the *second* backlight module from the top, the *fifth* backlight module from the top, the *first* backlight module from the top, and the *sixth* backlight module from the top (i.e., a simplified illustration being *III→IV→II→V→I→VI*). Zhang, 5:14-23. The resultant display image is shown in Figs. 4A-4F,

which clearly show that the firing order is not spatially-sequential (i.e., one-by-one from the top to the bottom).



Zhang, Fig. 1B.

Similarly, in another embodiment shown in Fig. 2B, the simplified illustration of the lighting sequence is $III \rightarrow II \rightarrow IV \rightarrow I \rightarrow V$, which is not spatially-sequential. Zhang, p. 5:30-37.



Zhang, Fig. 2B.

IX. Shteynberg, Arai, Zhang, and Kobori in View of the Knowledge of a Person of Ordinary Skill in the Art Renders Obvious Claim 11 of the '710 Patent.

108. In my opinion, a person of ordinary skill in the art would have been motivated to modify the lighting system disclosed in the Shteynberg-Arai-Zhang combination to introduce the random logic that randomizes the firing order described in Kobori.

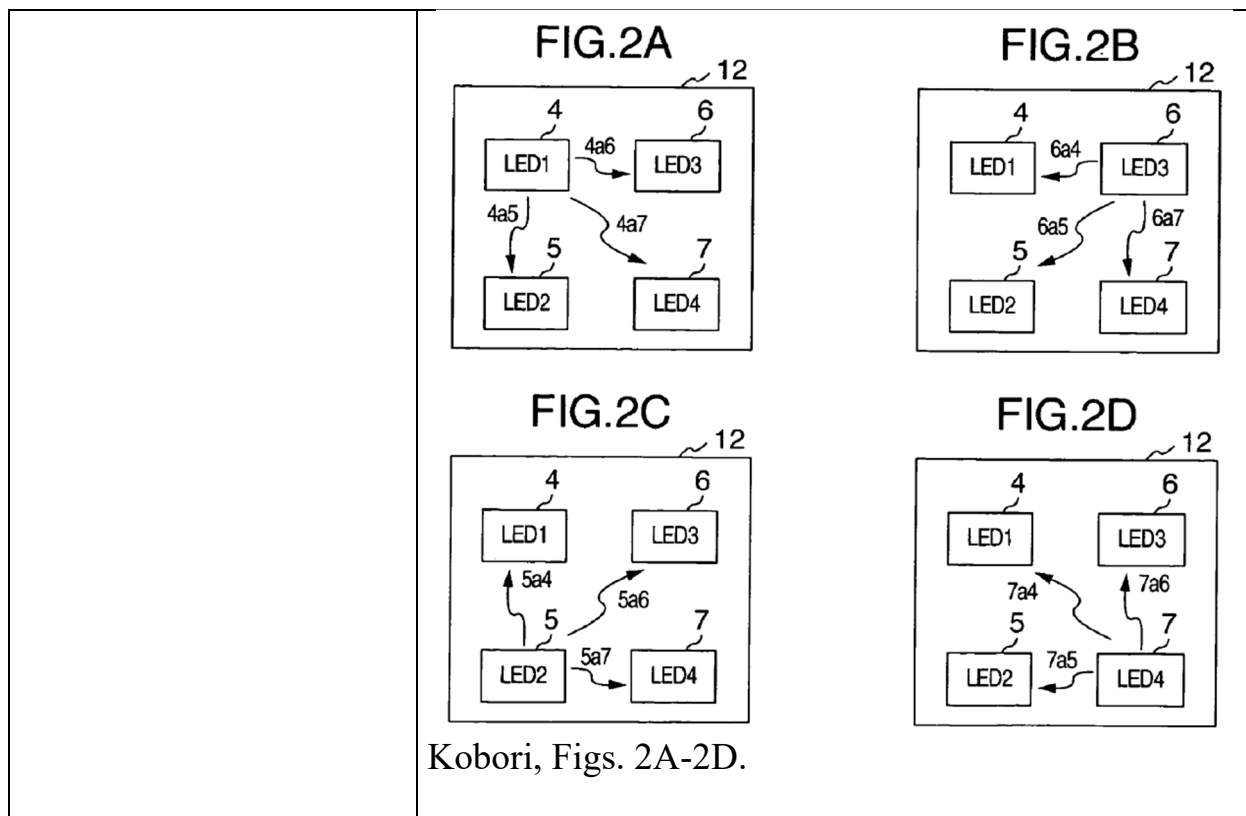
109. *First*, both the Shteynberg-Arai-Zhang combination and Kobori are in the same field of endeavor, i.e., achieving the emission of light perceived as white light. Consequently, a person of ordinary skill in the art would have had a reasonable expectation of success in combining their various disclosures to achieve emission of light perceived as white light. Furthermore, it was well within the technical ability of a person of ordinary skill in the art at the time to incorporate the improvements to a ***uniform luminiferous characteristic*** by incorporating the random logic that randomizes the firing order described in Kobori into the lighting system disclosed by the Shteynberg-Arai-Zhang combination.

110. *Second*, a primary motivation of one of ordinary skill in the art would have been to ***improve uniformity in the luminiferous characteristic***, as described in Kobori. Modifying the Shteynberg-Arai-Zhang combination to include the random logic that randomizes the firing order, as disclosed by Kobori, would meet this goal.

111. Thus, in my opinion, combining these four references—Shteynberg, Arai, Zhang, and Kobori—that use the same components to achieve the same goal would have been obvious to a person of ordinary skill in the art.

112. In my opinion, a person of ordinary skill in the art would have recognized that each element of claim 11 was obvious in view of the combination of Shteynberg, Arai, Zhang, and Kobori. This is further demonstrated by the claim chart below.

Claims of the '710 Patent	Prior Art
[’710 Claim 11] The system of claim 1, wherein the firing logic comprises random logic operative to generate the firing order.	Kobori admits the need to “obtain highly-accurate <i>uniform luminiferous characteristics</i> at a low cost.” Kobori, [0007]. Kobori describes, with reference to Figs. 2A-2D, it is possible to realize the variety of the LED layout relationship to calculate the luminiferous level by “ <i>arbitrarily changing</i> the PWM interval, the number of times, the phase for each LED so as to diversify the ON/OFF relationship.” Kobori, [0035]. Kobori further explains: “That is, by <i>[arbitrarily] changing the LED ON/OFF combination in the time sequence</i> , the [luminiferous] state of the LED at a particular position is detected.” <i>Id.</i> The LED ON/OFF combination in the time sequence is <i>equivalent to the firing order</i> under the definition of “firing order” in the ’710 Patent. Therefore, arbitrarily changing the ON/OFF combination in the time sequence is <i>equivalent to the random logic</i> that randomizes the firing order.



X. Shteynberg, Arai, and Lee in View of the Knowledge of a Person of Ordinary Skill in the Art Renders Obvious Claims 47-48 of the '710 Patent.

113. A person of ordinary skill in the art would be motivated to combine the Shteynberg-Arai combination and Lee. In my opinion, a person of ordinary skill in the art would have been motivated to modify the lighting system disclosed in the Shteynberg-Arai combination to introduce the string groups described in Lee.

114. *First*, both the Shteynberg-Arai combination and Lee are in the same field of endeavor, i.e., achieving the emission of light perceived as white light. Consequently, a person of ordinary skill in the art would have had a reasonable

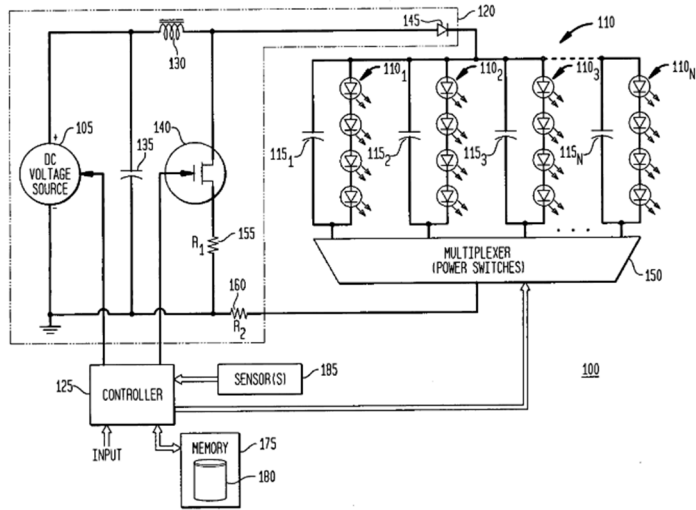
expectation of success in combining their various disclosures to achieve the emission of light perceived as white light. Furthermore, it was well within the technical ability of a person of ordinary skill in the art at the time to incorporate string groups described in Lee into the lighting system disclosed by the Shteynberg-Arai combination to achieve benefits, such as emitting “the ***uniform white light without reddish or bluish light ... even from the edge portions***” and ***avoiding “excessive driving voltage or current,”*** can be achieved. Lee, [0036] and [0040].

115. *Second*, a primary motivation of one of ordinary skill in the art would have been to ***achieve uniform white light*** and ***avoid excessive driving voltage or current***, as described in Lee. Modifying the Shteynberg-Arai combination to include the string groups, as disclosed by Lee, would meet this goal. For example, Lee describes solving “the problems of the conventional LED connection structure requiring an ***excessive driving voltage or current***.” Lee, [0036]. Lee describes that “the ***uniform white light*** without reddish or bluish light can be emitted even from the edge portions.” *Id.*, [0040].

116. Thus, in my opinion, combining these three references—Shteynberg, Arai, and Lee—that use the same components to achieve the same goal would have been obvious to a person of ordinary skill in the art.

117. In my opinion, a person of ordinary skill in the art would have recognized that each element of claims 47-48 was obvious in view of the combination of Shteynberg, Arai, and Lee. This is further demonstrated by the claim chart below.

Claims of the '710 Patent	Prior Art
[’710 Claim 47 Preamble] A method for controlling a plurality of strings of solid state lighting devices configured to extend in a first direction and arranged substantially adjacent to one another,	Shteynberg discusses, with reference to Figs. 14A and 14B, a method of time-division modulation for “separately and independently energizing” a selected LED string of the LED strings. Shteynberg, [0110]. Shteynberg describes that a parallel array of LEDs 110 includes a plurality of LED strings 110₁, 110₂, 110₃, ... , 110_N. Shteynberg, [0044]. Shteynberg discloses that the LEDs are organized in an “array,” i.e., the LEDs being organized in columns (each column corresponding to one LED string) and rows (multiple LED strings are distributed to form a row, i.e., arranged in substantially adjacent positions relative to one another), as shown in Fig. 3. The LEDs in each LED string are arranged in a first direction (from top to bottom, as shown in Fig. 3), and these strings of LEDs are arranged substantially adjacent to one another (the LED strings are arranged substantially adjacent to one another, as shown in Fig. 3).

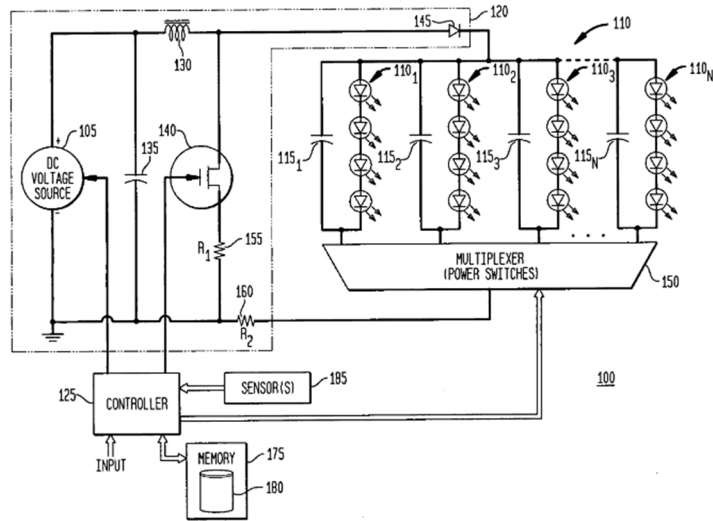


Id., Fig. 3.

Arai discloses that the LEDs 12 extend in a first direction (from left to right, as shown in Fig. 5) to be arranged in substantially adjacent positions relative to one another in a second direction (from top to bottom, as shown in Fig. 5).

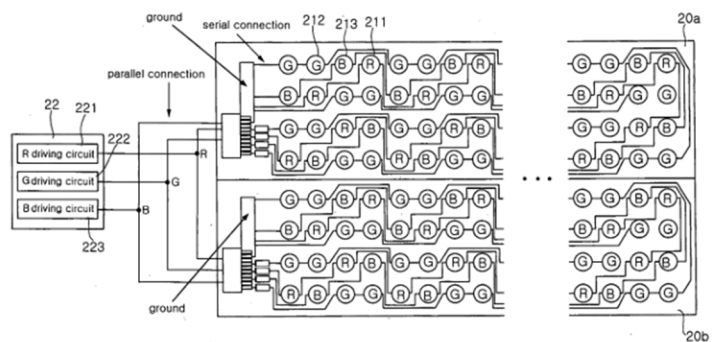
[’710 Claim 47A] the method comprising supplying a plurality of pulsed drive currents to a plurality of groups of the plurality of strings.

Shteynberg describes that the power converter 120 is operable to “deliver a controlled current level to” the LED strings 110₁, 110₂, 110₃, ... , 110_N. Shteynberg, [0048]. Under the control of the controller 125, the multiplexer 150 is configured to “*individually and selectively*” allow current through one or more of the LED strings in any combination, and for any selected duration.” Shteynberg, [0047].



Id., Fig. 3.

Lee describes that each driving unit 22 has red, green, and blue LED driving circuits 221, 222, and 223 for respectively driving the red, green, and blue LEDs 211, 212, and 213. Lee, [0029]. As shown in Fig. 3, which is an enlarged view of a part of Fig. 2, the series connection structure of the identical color LEDs in the divided region 20a is connected to the series connection structure of the identical color LEDs in the divided region 20b. *Id.*, [0034].



Lee, Fig. 3.

The parallel connection structure is electrically connected to the corresponding color LED driving circuit (i.e., the red driving circuit 221, the green driving circuit 222, or the blue driving circuit

	223). Lee, [0034]. As a result, the parallel connection structure between the series connection structures of the identical color LEDs in the different divided regions 20a and 20b is connected to the corresponding driving circuit 221, 222, or 223. <i>Id.</i>, [0035]. Therefore, the LEDs are electrically connected to each other by the combination of the series (<i>strings</i>) and parallel connections (<i>string groups</i>). <i>Id.</i>
[’710 Claim 48] The method of claim 47, further comprising receiving a user input, wherein supplying the plurality of pulsed drive currents is based on the user input.	Shteynberg describes that controller 125 may “receive input from <i>a wide variety of sources</i>, including open or closed-loop feedback of various signals and measurements from within the LED array driver circuit 100.” <i>Id.</i>, [0049]. Shteynberg describes receiving, by the controller 125, <i>input</i> coming from “<i>a wide variety of sources</i>.” Shteynberg describes that under the control of the controller 125, the multiplexer 150 is configured to “<i>individually and selectively</i>” allow current through one or more of the LED strings 110₁, 110₂, 110₃, through 110_N in any combination, and for any selected duration.” Shteynberg, [0047]. Shteynberg describes that the controller 125 receives input coming from a larger system, which includes <i>input from the user</i>. Shteynberg, [0049]. Under the control of the controller 125, the multiplexer 150 “provides for individually and selectively allowing current to flow through” each of the LED strings 110₁, 110₂, 110₃, through 110_N. <i>Id.</i>

XI. Shteynberg, Arai, and Kawabata in View of the Knowledge of a Person of Ordinary Skill in the Art Renders Obvious Claims 1-2, 5, 12, and 16-17 of the ’710 Patent.

118. In my opinion, a person of ordinary skill in the art would have been motivated to modify the display system in the Shteynberg-Arai combination to introduce the non-spatially-sequential firing order described in Kawabata.

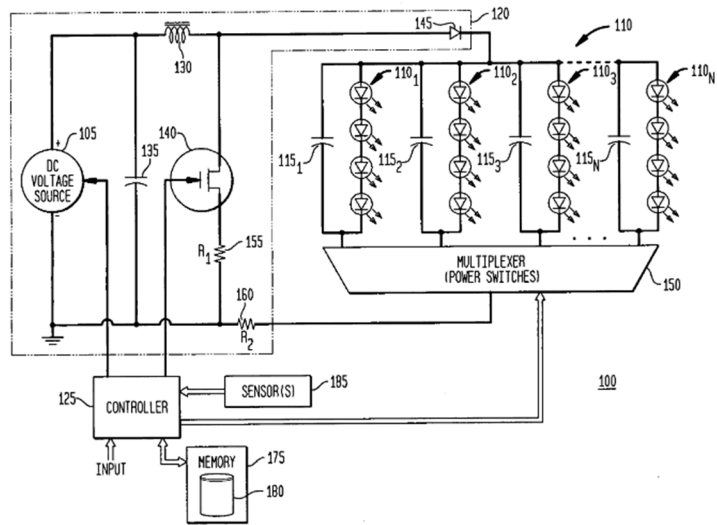
119. *First*, both the Shteynberg-Arai combination and Kawabata are in the same field of endeavor, i.e., achieving the emission of light perceived as white light. Consequently, a person of ordinary skill in the art would have had a reasonable expectation of success in combining their various disclosures to achieve the emission of light perceived as white light. Furthermore, it was well within the technical ability of a person of ordinary skill in the art at the time to incorporate the improvements to the display system described in Kawabata into the independent control of an array of LEDs disclosed by the Shteynberg-Arai combination.

120. *Second*, in my opinion, a primary motivation of one of ordinary skill in the art would have been to ***reduce a variation in luminance***, as described in Kawabata. Modifying the Shteynberg-Arai to include the non-spatially-sequential firing order, as disclosed by Kawabata, would meet this goal. For example, Kawabata states that “some of the light-emitting elements 2 for some of the light-emitting regions 4 may be turned ON in a different percentage of one vertical scanning period” to reduce such a variation in luminance. Kawabata, [0073].

121. Thus, in my opinion, combining these three references—Shteynberg, Arai, and Kawabata—that use the same components to achieve the same goal would have been obvious to a person of ordinary skill in the art.

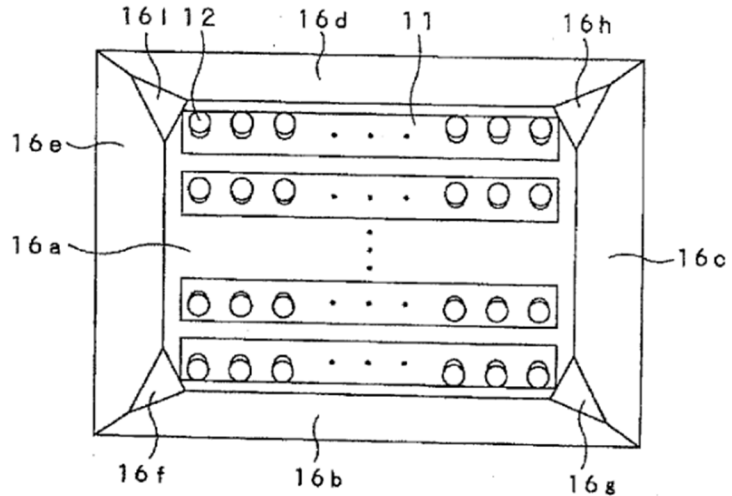
122. In my opinion, a person of ordinary skill in the art would have recognized that each element of claims 1-2, 5, 12, and 16-17 was obvious in view of the combination of Shteynberg, Arai, and Kawabata. This is further demonstrated by the claim chart below.

Claims of the '710 Patent	Prior Art
[’710 Claim 1 Preamble] A lighting panel system, comprising:	Shteynberg discloses a lighting system, which “comprises a plurality of series of light-emitting diodes, a power converter, a first multiplexer, and a controller.” Shteynberg, [0021].
[’710 Claim 1A] a plurality of strings of solid state lighting devices arranged in a first direction and positioned at intervals in at least one second direction;	Shteynberg discusses, with reference to Fig. 3, the lighting system includes a parallel array of LEDs 110, which includes a plurality of series-connected LEDs, and these independent series or strings (or channels) of LEDs are illustrated as “N” individual series of LEDs 110 ₁ , 110 ₂ , 110 ₃ , ... , 110 _N . Shteynberg, [0043]-[0044]. As shown in Fig. 3, LEDs in each LED string are arranged in a first direction (from top to bottom, as shown in Fig. 3), and these strings of LEDs are positioned at intervals in a second direction (from left to right, as shown in Fig. 3). Since the LEDs are organized in an “array,” the LEDs are organized in columns (each column corresponding to one LED string) and rows (multiple LED strings are distributed to form a row, i.e., positioned at intervals), as shown in Fig. 3.



Id., Fig. 3.

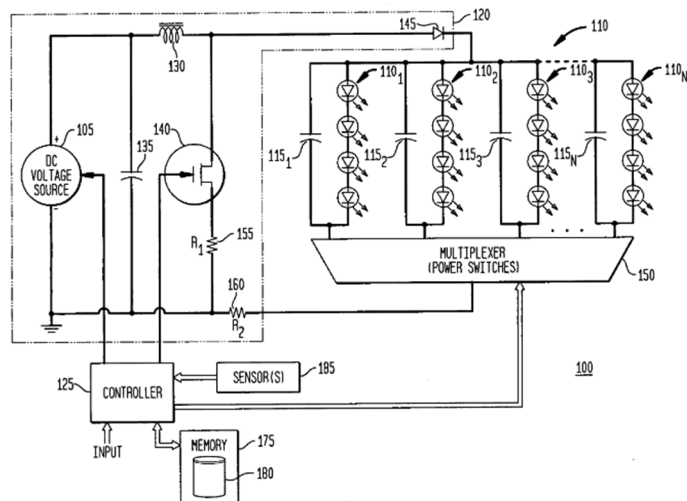
To the extent that someone would argue that Fig. 3 fails to show LED strings “arranged in a first direction and positioned at intervals in at least one second direction,” Arai discloses a backlight unit 3 of a transmission type liquid crystal display panel 1, having LEDs 12 that are “two-dimensionally arranged.” Arai, [0006] and [0024]. As shown in Fig. 5, the LEDs 12 are arranged in a first direction (from left to right, as shown in Fig. 5) to form LED strings and positioned at intervals in a second direction (from top to bottom, as shown in Fig. 5). Arai explains that such a two-dimensional arrangement could permit “display of high luminance on large-sized liquid crystal panel by low power consumption.” Arai, [0006].



Arai, Fig. 5.

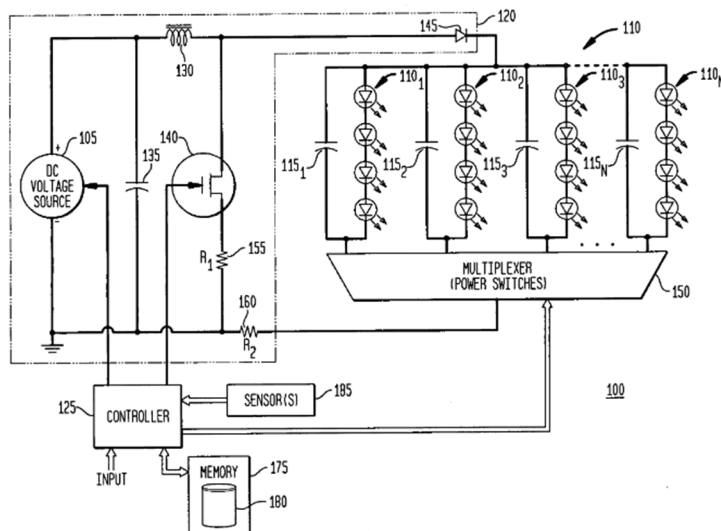
[710 Claim 1B] a current supply circuit configured to selectively supply a plurality of on-state drive currents to the plurality of strings responsive to a plurality of control signals; and

As discussed in paragraph [0048] of Shteynberg, with reference to Fig. 3, the lighting system includes a power converter 120, which includes “a DC voltage source 105, a filter capacitor 135, an inductor 130, a switch 140, and a peak current sense resistor (R1) 155.” Shteynberg, [0048]. The power converter 120 is operable to “*deliver a controlled current level* to a load.” *Id.* In the example shown in Fig. 3, the load is the LED strings 110₁, 110₂, 110₃, ... , 110_N. The DC voltage source 105 may be an AC/DC converter in some embodiments or an AC/DC converter connected to a phase modulation AC device. *Id.*



Id., Fig. 3.

	On the other hand, the lighting system further includes a multiplexer 150, which “provides for <i>individually and selectively allowing current to flow through</i> each of the series of LEDs 110₁, 110₂, 110₃, through 110_N.” Shteynberg, [0047]. As a result, any selected one of the LED strings 110₁, 110₂, 110₃, through 110_N is turned on or off accordingly. <i>Id.</i> The LED strings 110₁, 110₂, 110₃, through 110_N are energized using time-division modulation. Shteynberg, [0044]. “<i>Under the control of the controller 125,</i>” the multiplexer 150 is configured to “allow current through one or more of the series of LEDs 110₁, 110₂, 110₃, through 110_N <i>in any combination, and for any selected duration.</i>” Shteynberg, [0047]. Importantly, the multiplexer 150 may be implemented as <i>multiple</i> power switches, as shown in Fig. 3. Shteynberg, [0043]. Moreover, Shteynberg further states that the controller 125 “may be embodied as” <i>multiple controllers</i>, “adapted to perform the functionality.” <i>Id.</i>, [0051].
[’710 Claim 1C] a control system configured to receive a user input and to selectively provide control signals to the current supply circuit responsive to the user input to selectively drive the plurality of strings,	Shteynberg describes that the lighting system includes a controller 125. Shteynberg, [0043]. The controller may “receive input from a wide variety of sources.” <i>Id.</i>, [0049]. The controller 230 may “be coupled within a larger system, such as a computer-controlled lighting system in a building, and may interface with other computing elements.” Shteynberg, [0049]. Therefore, Shteynberg describes a variety of sources where the input for the controller 125 comes from. More importantly, Shteynberg suggests input coming from “a larger system” (as illustrated by the arrow in Fig. 3).



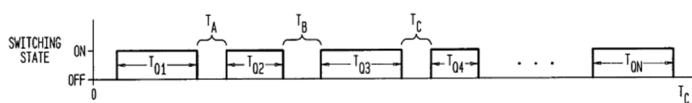
Id., Fig. 3.

The multiplexer 150 “provides for *individually and selectively allowing current to flow through* each of the series of LEDs 110₁, 110₂, 110₃, through 110_N ... *[u]nder the control of the controller 125.*” Shteynberg, [0047].

[’710 Claim 1D] the control system further including firing logic configured to determine a firing order of the plurality of strings.

Shteynberg describes that the multiplexer 150 is configured to “allow current through one or more of the series of LEDs 110₁, 110₂, 110₃, through 110_N *in any combination*, and *for any selected duration*” under the control of the controller 125. Shteynberg, [0047].

Shteynberg further describes, with reference to Fig. 4, that each of the LED strings 110₁, 110₂, 110₃, through 110_N is provided with a selected and independent current level, “*through control (by controller 125) of the switching state of each channel (via multiplexer 150),*” for a selected time period (or duration).” Shteynberg, [0054].

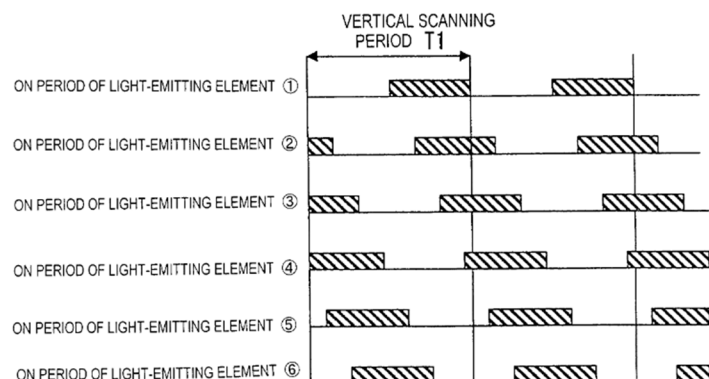


Id., Fig. 4.

Importantly, Shteynberg stresses that “[e]ach **energizing time period** may be provided **in any order or combination**.” Shteynberg, [0054]. As one example, and as illustrated in the annotated Fig. 4, **LED string 1103** is provided with current for third time period T_{Q3} , **followed by LED string 1102** being provided with current for second time period T_{Q4} .”

Kawabata describes, with reference to Figure 5, “scan lighting.” Kawabata, [0070]. Specifically, Kawabata states: “In this case, the drive signal supplied to one of the light-emitting elements 2 should **have its phase shifted** from that of the drive signal supplied to adjacent one of the light-emitting elements 2.” *Id.*

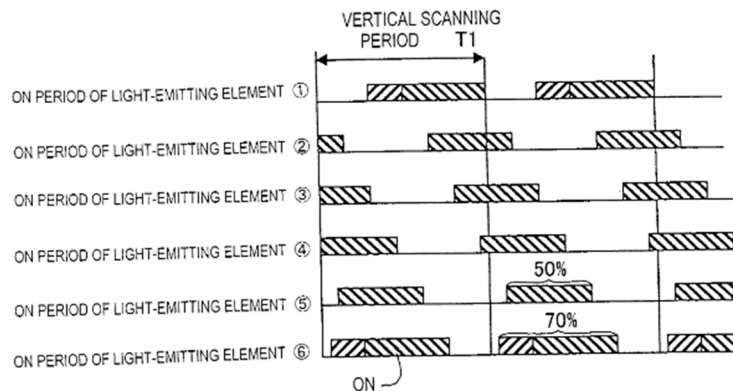
Therefore, Kawabata expressly discloses a firing order, according to the definition stated in the ’710 Patent. ’710 Patent, 10:30-33. As shown in Fig. 5 of Kawabata, each of the six light emitting elements 2 are turned on at different times. The **timing rule** in this example is the “adjacent one” of the light emitting elements 2 is turned next. According to the specification of the ’710 Patent, the firing logic 802 can include rule-based logic. ’710 Patent, 10:51-53. In other words, **rule-based logic** is viewed as the firing logic. Therefore, Kawabata discloses the firing logic because the timing rule discussed in paragraph [0070] is a rule-based logic.



Kawabata, Fig. 5.

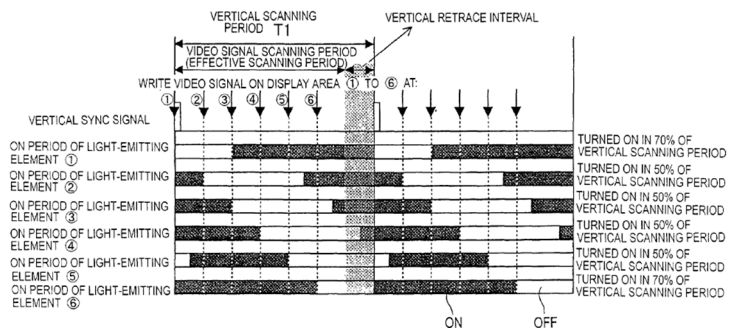
[’710 Claim 2] The system of claim 1, wherein the firing logic comprises rule-based logic operative to generate a non-spatially-sequential firing order.

As shown in Fig. 7, the light emitting element corresponding to region ⑥ is turned on *before, not after*, the light emitting element corresponding to region ⑤. Therefore, the light emitting elements are turned on according to a *non-spatially-sequential firing order*.



Kawabata, Fig. 7.

Additionally, as shown in Fig. 8, the firing order is ①→②→③→④→⑥→⑤→①, instead of ①→②→③→④→⑤→⑥→①. *Id.*, [0076]. The flipping order of ⑤ and ⑥ makes the firing order non-spatially-sequential (i.e., the temporally sequential strings are not spatially sequential/adjacent).



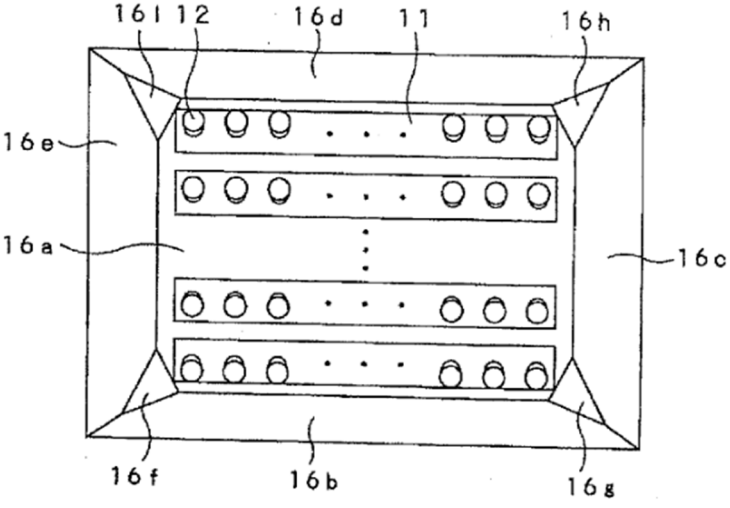
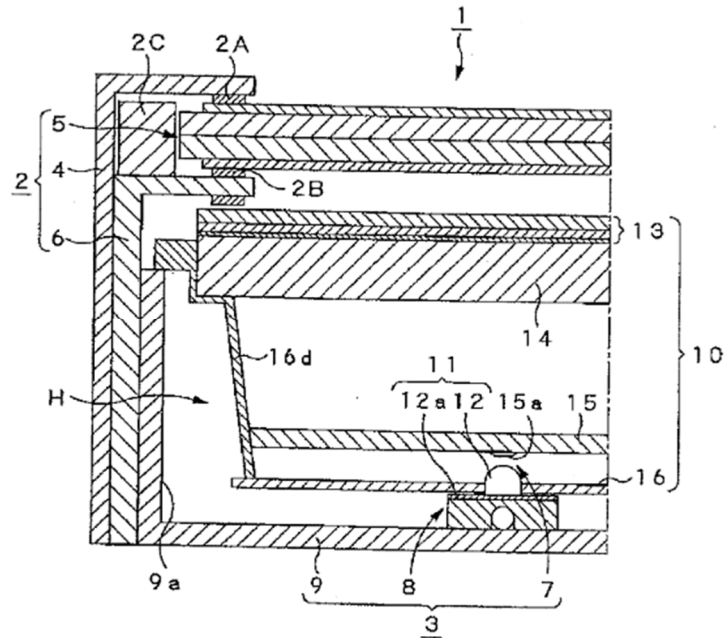
	Kawabata, Fig. 8. As shown in Fig. 23, the firing order is ①→②→④→③→⑤→⑥ and ⑧ (simultaneous)→⑦→①, which is non-spatially-sequential. Kawabata, [0113].
[’710 Claim 5] The system of claim 1, wherein ones of the plurality of strings are arranged corresponding to a plurality of bars that include portions of the plurality of strings, wherein the plurality of bars extend in the first direction and are positioned adjacent one another in a substantially parallel arrangement.	Arai describes that a light emitting block 11 is composed of LEDs 12 and a “<i>laterally elongated rectangular wiring board 12a</i> on which these LEDs 12 are mounted <i>in a predetermined order</i>.” Arai, [0029]. Fig. 5 shows that the laterally elongated rectangular wiring boards 12a extend in the first direction (from left to right, as shown in Fig. 5) and are positioned adjacent to one another in substantially parallel arrangement (parallel to each other in the first direction, as shown in Fig. 5).  Arai, Fig. 5. Additionally, as shown in Fig. 4, the LEDs 12 are arranged corresponding to the laterally elongated rectangular wiring boards 12a as the LEDs 12 are “mounted <i>in a predetermined order</i>” on the laterally elongated rectangular wiring boards 12a. Arai, [0029]. Thus, Arai discloses that ones of the plurality of strings (a series of LEDs as shown in

Fig. 5) are arranged corresponding (arranged, in a predetermined order, on) to a plurality of bars (the laterally elongated rectangular wiring boards 12a).



Arai, Fig. 4.

[’710 Claim 12] The system of claim 1, further comprising a means for generating a feedback signal configured to provide display performance information to the control system.

Shteynberg describes that the controller 125 “may receive input from a wide variety of sources, including *open or closed-loop feedback* of various signals and measurements from within the LED array driver circuit 100.” *Id.* In one embodiment, the sensor 185 is used to measure, for example, the actual output voltage across each of the LED strings 110₁, 110₂, 110₃, through 110_N. Shteynberg, [0072].

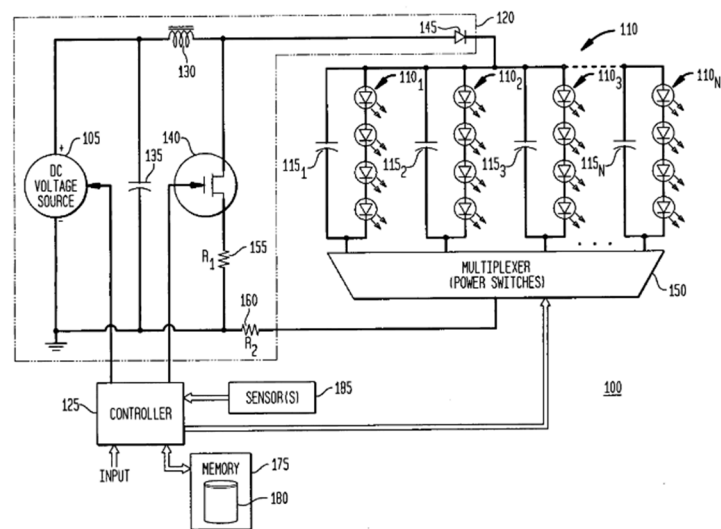
Shteynberg further states: “Corresponding to such measurements, compensation coefficients are introduced, stored in memory 175, and *utilized* for subsequent output voltage prediction *by the controller 125.*” *Id.* Also, Fig. 3 shows that the sensor 185 provides (illustrated as an arrow in Fig. 3) display performance information (e.g., the actual

	output voltage across each of the LED strings 110 ₁ , 110 ₂ , 110 ₃ , through 110 _N) to the controller 125.
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[’710 Claim 16] The system of claim 1, wherein the second direction is substantially orthogonal to the first direction.	Shteynberg discloses that the LEDs are organized in an “array,” i.e., the LEDs being organized in columns (each column corresponding to one LED string) and rows (multiple LED strings are distributed to form a row, i.e., positioned at intervals), as shown in Fig. 3. Shteynberg, therefore, discloses that LEDs in each LED string are arranged in a first direction (from top to bottom, as shown in Fig. 3), and these strings of LEDs are positioned at intervals in a second direction (from left to right, as shown in Fig. 3). Therefore, the second direction (from left to right, as shown in Fig. 3) is substantially orthogonal to the first direction (from top to bottom, as shown in Fig. 3). <i>Id.</i>, Fig. 3. Arai describes that the LEDs 12 are arranged in a first direction (from left to right, as shown in Fig. 5) to form LED strings and positioned at intervals in a second direction (from top to bottom, as shown in Fig. 5). Therefore, Arai discloses that the second
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	direction (from top to bottom) is substantially orthogonal to the first direction (from left to right).
[’710 Claim 17 Preamble] A method for controlling a plurality of strings of solid state lighting devices configured to extend in a first direction and to be arranged in substantially adjacent positions relative to one another in a second direction that is different from the first direction, the method comprising:	Shteynberg discusses, with reference to Figs. 14A and 14B, a method of time-division modulation for “separately and independently energizing” a selected LED string of the LED strings 110₁, 110₂, 110₃, through 110_N. Shteynberg, [0110]. Shteynberg describes, with reference to Fig. 3, that a parallel array of LEDs 110 includes a plurality of LED strings 110₁, 110₂, 110₃, ... , 110_N. Shteynberg, [0044]. As shown in Fig. 3, Shteynberg discloses that the LEDs are organized in an “array,” i.e., the LEDs being organized in columns (each column corresponding to one LED string) and rows (multiple LED strings are distributed to form a row, i.e., arranged in substantially adjacent positions relative to one another), as shown in Fig. 3. LEDs in each LED string are arranged in a first direction (from top to bottom, as shown in Fig. 3), and these strings of LEDs are arranged in substantially adjacent positions relative to one another in a second direction (from left to right, as shown in Fig. 3). As shown in Fig. 3, the second direction is substantially orthogonal to, therefore, different from the first direction. Arai discloses that the LEDs 12 extend in a first direction (from left to right, as shown in Fig. 5) to be arranged in substantially adjacent positions relative to one another in a second direction (from top to bottom, as shown in Fig. 5).
	[’710 Claim 17A] receiving an input from a user; and Shteynberg describes that controller 125 may “receive input from <i>a wide variety of sources</i>, including open or closed-loop feedback of various signals and measurements from within the LED

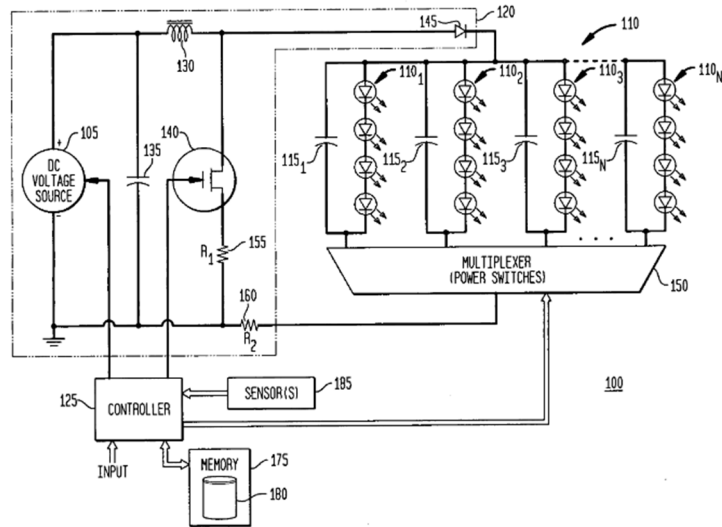
array driver circuit 100.” *Id.* As shown in Fig. 3, the controller 230 may receive input from one or more sensors 185. Alternatively, the controller 230 may “be *coupled within a larger system*, such as a computer-controlled lighting system in a building, and may interface with other computing elements.” Shteynberg, [0049]. Therefore, Shteynberg describes receiving, by the controller 125, *input* coming from “*a wide variety of sources.*”



Id., Fig. 3.

[’710 Claim 17B]
supplying, based in part on the input from the user, a plurality of pulsed drive currents to the plurality of strings in a non-spatially-sequential firing order.

Shteynberg describes that the power converter 120 is operable to “deliver a controlled current level to” the LED strings 110₁, 110₂, 110₃, ... , 110_N. Shteynberg, [0048]. Under the control of the controller 125, the multiplexer 150 is configured to “*individually and selectively*” allow current through one or more of the LED strings 110₁, 110₂, 110₃, through 110_N *in any combination*, and *for any selected duration.*” Shteynberg, [0047].

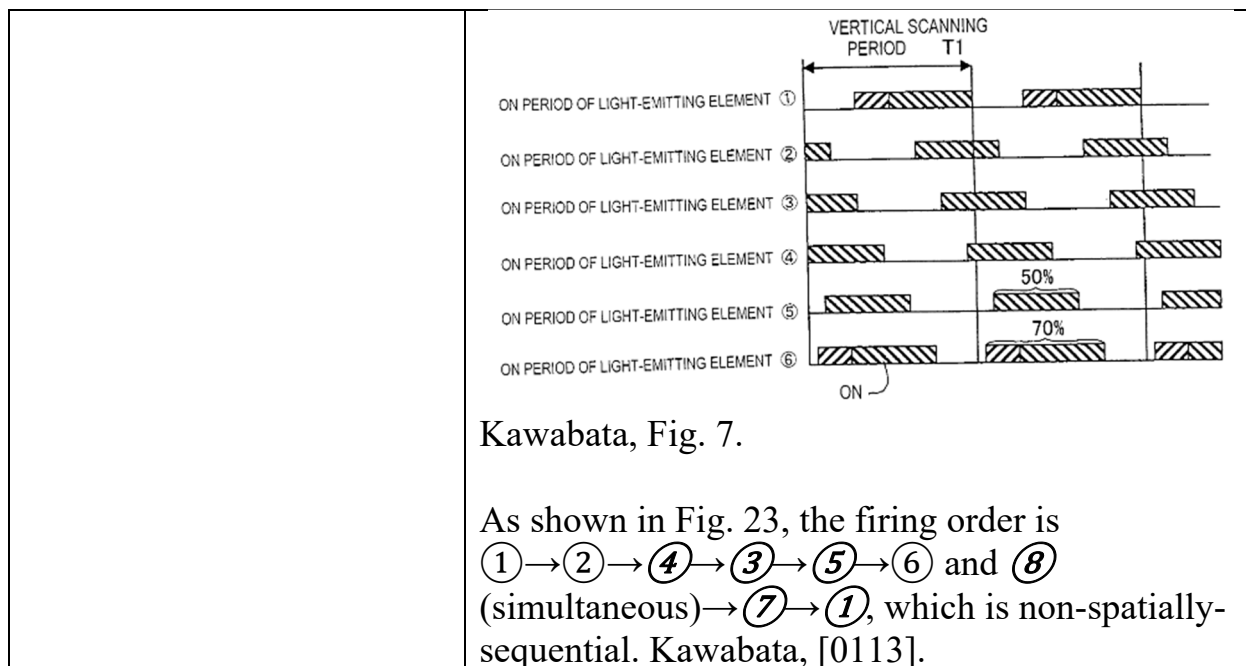


Id., Fig. 3.

Shteynberg describes that the controller 125 receives input coming from a larger system, which includes *input from the user*. Shteynberg, [0049]. *Under the control of the controller 125*, the multiplexer 150 “provides for *individually and selectively allowing current to flow through* each of the LED strings 110₁, 110₂, 110₃, through 110_N.

Shteynberg discloses that the controller 125 determines the order of the energizing time periods. Shteynberg, [0047] and [0054]. Shteynberg stresses that “[e]ach *energizing time period* may be provided *in any order or combination*.” Shteynberg, [0054].

As shown in Fig. 7 of Kawabata, the light emitting element corresponding to region ⑥ is turned on *before, not after*, the light emitting element corresponding to region ⑤. Therefore, the light emitting elements are turned on according to a *non-spatially-sequential firing order*.



XII. Shteynberg, Arai, Kawabata, and Kobori in View of the Knowledge of a Person of Ordinary Skill in the Art Renders Obvious Claim 11 of the '710 Patent.

123. In my opinion a person of ordinary skill in the art would be motivated to combine the Shteynberg-Arai-Kawabata combination and Kobori.

124. *First*, both the Shteynberg-Arai-Kawabata combination and Kobori are in the same field of endeavor, i.e., achieving the emission of light perceived as white light. Consequently, a person of ordinary skill in the art would have had a reasonable expectation of success in combining their various disclosures to achieve emission of light perceived as white light. Furthermore, it was well within the technical ability of a person of ordinary skill in the art at the time to incorporate the improvements to a *uniform luminiferous characteristic* by incorporating the

random logic described in Kobori into the lighting system disclosed by the Shteynberg-Arai-Kawabata combination.

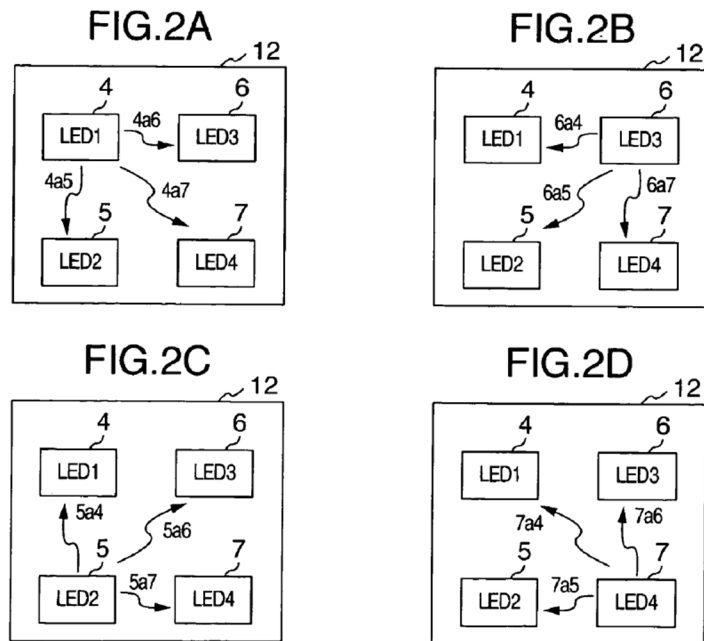
125. *Second*, a primary motivation of one of ordinary skill in the art would have been to ***improve uniformity in the luminiferous characteristic***, as described in Kobori. Modifying the Shteynberg-Arai-Kawabata combination to include the random logic disclosed by Kobori would meet this goal.

126. Thus, in my opinion, combining these four references—Shteynberg, Arai, Kawabata, and Lee—that use the same components to achieve the same goal would have been obvious to a person of ordinary skill in the art.

127. In my opinion, a person of ordinary skill in the art would have recognized that each element of claim 11 was obvious in view of the combination of Shteynberg, Arai, Kawabata, and Lee. This is further demonstrated by the claim chart below.

Claims of the '710 Patent	Prior Art
['710 Claim 11] The system of claim 1, wherein the firing logic comprises random logic operative to generate the firing order.	Kobori admits the need to “obtain highly-accurate <i>uniform luminiferous characteristics</i> at a low cost.” Kobori, [0007]. Kobori describes, with reference to Figs. 2A-2D, it is possible to realize the variety of the LED layout relationship to calculate the luminiferous level by “ <i>arbitrarily changing</i> the PWM interval, the number of times, the phase for each LED so as to diversify the ON/OFF relationship.” Kobori, [0035]. Kobori further explains: “That is, by <i>[arbitrarily] changing the LED ON/OFF combination in the time sequence</i> , the [luminiferous] state of the LED at a particular position is detected.” <i>Id.</i> The LED

ON/OFF combination in the time sequence is *equivalent to the firing order* under the definition of “firing order” in the ’710 Patent. Therefore, arbitrarily changing the ON/OFF combination in the time sequence is *equivalent to the random logic* that randomizes the firing order.



Kobori, Figs. 2A-2D.

XIII. Shteynberg, Arai, Kawabata, and Lee in View of the Knowledge of a Person of Ordinary Skill in the Art Renders Obvious Claims 13 of the ’710 Patent.

128. A person of ordinary skill in the art would have been motivated to modify the Shteynberg-Arai-Kawabata combination to include features such as multiple drive circuits and string groups described in Lee.

129. *First*, both the Shteynberg-Arai-Kawabata combination and Lee are in the same field of endeavor, i.e., achieving the emission of light perceived as white light. Consequently, a person of ordinary skill in the art would have had a

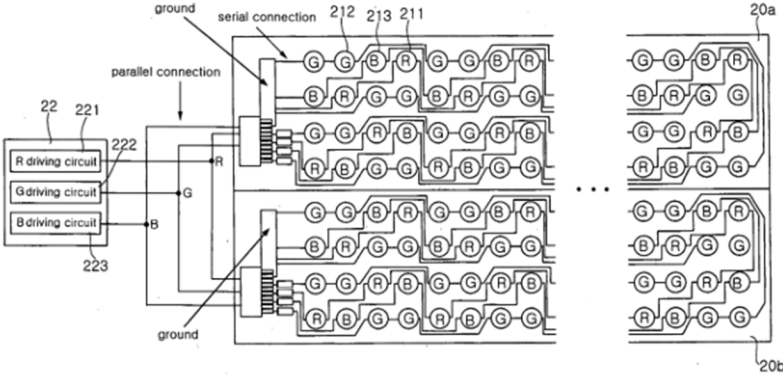
reasonable expectation of success in combining their various disclosures to achieve the emission of light perceived as white light. Furthermore, it was well within the technical ability of a person of ordinary skill in the art at the time to incorporate the improvements to *excessive driving voltage or current* by incorporating the multiple driving circuits described in Lee into the lighting system disclosed by the Shteynberg-Arai-Kawabata combination.

130. *Second*, a primary motivation of one of ordinary skill in the art would have been to *reduce excessive driving voltage or current*, as described in Lee. Modifying the Shteynberg-Arai-Kawabata combination to include the multiple driving circuits, as disclosed by Lee, would meet this goal. Lee describes solving “the problems of the conventional LED connection structure requiring an excessive driving voltage or current.” Lee, [0036]. Lee describes that “the uniform white light without reddish or bluish light can be emitted even from the edge portions.” *Id.*, [0040].

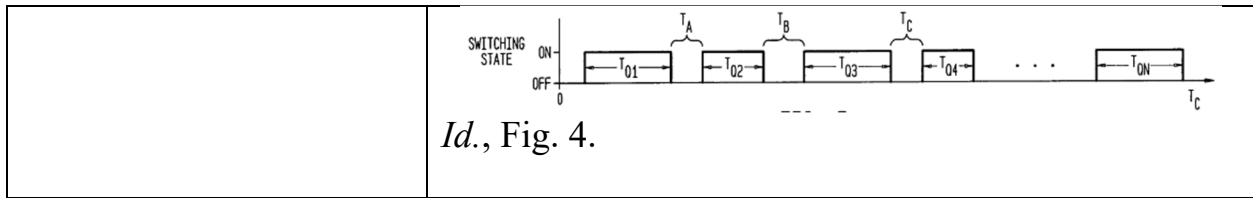
131. Thus, in my opinion, combining these four references—Shteynberg, Arai, Kawabata, and Lee—that use the same components to achieve the same goal would have been obvious to a person of ordinary skill in the art.

132. In my opinion, a person of ordinary skill in the art would have recognized that each element of claim 13 was obvious in view of the combination

of Shteynberg, Arai, Kawabata, and Lee. This is further demonstrated by the claim chart below.

Claims of the '710 Patent	Prior Art
[’710 Claim 13A] The system of claim 1, wherein the current supply circuit comprises a plurality of phase drivers configured to supply a plurality of on-state drive currents at a plurality of times in a firing cycle.	Lee describes that each driving unit 22 has red, green, and blue LED driving circuits 221, 222, and 223 for respectively driving the red, green, and blue LEDs 211, 212, and 213. Lee, [0029]. As shown in Fig. 3, which is an enlarged view of a part of Fig. 2, the series connection structure of the identical color LEDs in the divided region 20a is connected to the series connection structure of the identical color LEDs in the divided region 20b. <i>Id.</i>, [0034]. The parallel connection structure is electrically connected to the corresponding color LED driving circuit (i.e., the red driving circuit 221, the green driving circuit 222, or the blue driving circuit 223). Lee, [0034]. As a result, the parallel connection structure between the series connection structures of the identical color LEDs in the different divided regions 20a and 20b is connected to the corresponding driving circuit 221, 222, or 223. <i>Id.</i>, [0035]. Therefore, the LEDs are electrically connected to each other by the combination of the series and parallel connections. <i>Id.</i>  Lee, Fig. 3. Lee further describes that the red LED driving circuit 221, the green LED driving circuit 222, and the

	blue LED driving circuit 223 function to <i>apply electric power or current</i> to the LEDs “while properly controlling a luminance, a color coordinate, or a color temperature to drive the LEDs under a desired condition.” Lee, [0041]. Kawabata states: “In this case, the drive signal supplied to one of the light-emitting elements 2 should <i>have its phase shifted from that of the drive signal supplied to adjacent one</i> of the light-emitting elements 2.” Kawabata, [0070]. In other words, Kawabata discloses phase drivers configured to supply a plurality of on-state drive currents at a plurality of times in a firing cycle (have its phase shifted from the phase of the drive signal supplied to an adjacent LED string).
[’710 Claim 13B] wherein the plurality of strings of solid state lighting devices comprise a plurality of string groups, each configured to receive current from one of the plurality of phase drivers, and	Lee further discloses that the series connection structure of the identical color LEDs in the divided region 20a is connected to the series connection structure of the identical color LEDs in the divided region 20b. Lee, [0034]. The parallel connection structure is electrically connected to the corresponding color LED driving circuit (i.e., the red driving circuit 221, the green driving circuit 222, or the blue driving circuit 223). Lee, [0034]. Therefore, the LEDs are electrically connected to each other by the combination of the series (<i>strings</i>) and parallel connections (<i>string groups</i>). <i>Id.</i>
[’710 Claim 13C] wherein the control system is further configured to determine the plurality of times that each of the plurality of phase drivers begin to supply current to the plurality of string groups.	Shteynberg describes that the multiplexer 150 is configured to “allow current through one or more of the series of LEDs 110₁, 110₂, 110₃, through 110_N in any combination, and <i>for any selected duration</i>” under the control of the controller 125. Shteynberg, [0047]. Importantly, Shteynberg stresses that “[e]ach <i>energizing time period</i> may be provided <i>in any order or combination.</i>” Shteynberg, [0054].



I hereby declare that statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true.

Should further information become available to me as this matter proceeds, I may revise my opinions accordingly as necessary. I declare under penalty of perjury that the foregoing Declaration is true and correct.

<u>09/15/2023</u> Date	 Rafael J. Betancourt
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