

UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

MIANYANG BOE OPTOELECTRONICS TECHNOLOGY CO., LTD.; WUHAN
CHINA STAR OPTOELECTRONICS SEMICONDUCTOR DISPLAY
TECHNOLOGY CO., LTD.; TIANMA MICROELECTRONICS CO. LTD.; AND
VISIONOX TECHNOLOGY, INC.,

Petitioner,

v.

SAMSUNG DISPLAY CO., LTD.,
Patent Owner.

Case No. IPR2023-00987

U.S. Patent No. 9,818,803

Original Issue Date: Nov. 14, 2017

Title: PIXEL ARRANGEMENT STRUCTURE FOR ORGANIC LIGHT
EMITTING DISPLAY DEVICE

**PETITION FOR *INTER PARTES*
REVIEW OF U.S. PATENT NO. 9,818,803**

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LISTING OF EXHIBITS

Exhibit	Description
1001	U.S. Patent No. 9,818,803 to Lee
1002	File History of U.S. Patent No. 9,818,803 to Lee
1003	Declaration of P. Morgan Pattison, Ph.D.
1004	U.S. Patent No. 6,897,855 B1 to Matthies et al.
1005	U.S. Patent No. 7,091,986 B2 to Phan
1006	JP 4496852 B2 to Murai et al.
1007	Certified translation of JP 4496852 B2 to Murai et al. and associated translator's declaration
1008	U.S. Patent No. 6,366,025 B1 to Yamada
1009	U.S. Pub. 2009/0121983 A1 to Sung et al.
1010	U.S. Patent No. 3,971,065 to Bayer
1011	U.S. Pub. 2009/0302331 A1 to Smith et al.
1012	U.S. Patent No. 7,274,383 B1 to Brown Elliot
1013	U.S. Pub. 2010/0171440 A1 to Satou
1014	U.S. Pub. 2003/0128179 A1 to Credelle
1015	U.S. Patent No. 6,867,549 to Cok et al.

I. Introduction

Petitioner respectfully requests IPR of claims 1-5 and 19-21 of U.S. Patent No. 9,818,803 (“the ’803 patent”), which is assigned to Samsung Display Co., Ltd. (“Samsung” or “Patent Owner”). There is more than a reasonable likelihood that Petitioner will prevail with respect to at least one challenged claim.

The ’803 patent is directed to an organic light emitting diode (or OLED) display with green, blue, and red pixels—arbitrarily labeled as “first,” “second,” and “third” pixels—arranged in what the patent calls a “virtual square.” A green pixel is located at the square center. The red and blue pixels are located at the square vertices. Either the red or blue pixel (or both) can be made larger than the green pixel. According to the specification, sizing the pixels this way improves display life.

There is nothing new about what the ’803 patent claims. The prior art first taught displays with red, green, and blue pixels arranged in squares *forty years* before the ’803 patent. (*See, e.g.*, Ex. 1010, Figs. 1a-b, 6:18-20.) The prior art also taught that deterioration of an OLED display is avoided by making the blue pixels larger than the green pixels more than *ten years* before the ’803 patent. (*See* Exs. 1008, 1011, 1015).

Given that the ’803 patent does nothing more than claim well-known, long in the prior art concepts, it is unsurprising that it had a difficult path to allowance. The

claims were repeatedly rejected over multiple different references. While Patent Owner eventually obtained allowance by pointing to a grab-bag of minute and insubstantial design differences between the claims and the Examiner-cited art, this those arguments simply served to walk the claims squarely into other prior art that was not before the Examiner.

To show how pervasive the claimed subject matter is in the prior art, this Petition focuses on three exemplary references. These include: (1) U.S. Patent No. 6,897,855 B1 to Matthies et al. (Ex. 1004, “Matthies”), (2) US 7,091,986 to Phan (Ex. 1005, “Phan”), and (3) JP 4496852 B2 to Murai et al. (Exs. 1006, 1007, “Murai”).

Each of these—just as the ’803 patent requires—teaches an OLED display with red, green, and blue pixels arranged in a square. While Matthies is open to and allows the use of differently sized pixels, in its examples the red, green, and blue pixels are the same size. However, U.S. Patent No. 6,366,025 to Yamada (Ex. 1008, “Yamada”), like the ’803 patent, explains that OLED deterioration is avoided and display life improved by making the blue pixel largest and the green pixel smallest. Applying this teaching from Yamada to Matthies renders the claims obvious (Ground 1). Phan already teaches the use of larger red and smaller green and blue pixels. This alone renders most of the claims obvious (Ground 2). The rest of the claims are obvious when Yamada’s teachings regarding OLED pixel size ordering

are applied to Phan (Ground 3). Murai’s display also already includes smaller green pixels. While its example red and blue pixels are the same size, it is also open to different pixel sizes and shapes. Once again, applying Yamada’s teachings renders the claims obvious (Ground 4).

II. Mandatory Notices

A. Real Party-in-Interest

Mianyang BOE Optoelectronics Technology Co., Ltd. (“BOE”); Wuhan China Star Optoelectronics Semiconductor Display Technology Co., Ltd.; Tianma Microelectronics Co. Ltd.; and Visionox Technology, Inc. (collectively, the Petitioner) and their subsidiaries are the real parties-in-interest.

B. Related Matters

Patent Owner is asserting the ’803 patent in *Certain Active Matrix Organic Light-Emitting Diode Display Panels And Modules For Mobile Devices, And Components Thereof*, Inv. No. 337-TA-1351 (U.S. ITC). In addition to the ’803 patent, the ITC action asserts U.S. Patent Nos. 7,414,599; 9,330,593; 10,854,683; and 11,594,578. Petitioner BOE has intervened as a respondent in the ITC action.

C. Counsel, Service, and Fee Information

Petitioner designates the following counsel:

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Petitioner consents to service by electronic mail at the addresses listed in the table above. Petitioner's Power of Attorney is attached.

The USPTO is authorized to charge the filing fee and any other fees incurred by Petitioner to the deposit account of Orrick, Herrington, & Sutcliffe LLP: 15-0665.

III. Requirements for IPR

A. Grounds for Standing

Petitioner certifies that the '803 patent is available for IPR, and that Petitioner is not barred or estopped from requesting this IPR.

B. Identification of Challenge and Statement of Precise Relief Requested

Petitioner requests IPR of claims 1-5 and 19-21. This petition discusses claim construction, explains why the claims are unpatentable, provides details regarding

where the various claim limitations are found in the prior art, and is supported by the accompanying Declaration of P. Morgan Pattison, Ph.D. (Ex. 1003), a leading expert in the OLED field.

The application underlying the '803 patent—U.S. App. 13/614,197—was filed September 13, 2012. Further, the patent makes a facial claim of priority back to a March 6, 2012 foreign filing. (Ex. 1001, Cover.) For purposes of this petition only, it has been assumed that the claims of the '803 patent are entitled to the benefit of this March 2012 date.

Petitioner relies on the following references: (1) Matthies (Ex. 1004), (2) Phan (Ex. 1005), (3) Murai (Exs. 1006-1007); and (4) Yamada (Ex. 1008). These references are all prior art. (*See* Section VIII.) Murai was published in Japanese. A certified English translation and associated declaration is attached as Ex. 1007. Citations to Murai will refer to this translation.

Petitioner challenges the claims on the following grounds:

Ground 1: Claims 1-5 and 19-21 are obvious over Matthies and Yamada.

Ground 2: Claims 1-4 and 19-21 are obvious over Phan.

Ground 3: Claim 5 is obvious over Phan and Yamada.

Ground 4: Claims 1-5 and 19-21 are obvious over Murai and Yamada.

IV. Institution Should Be Granted

Petitioner has established a reasonable likelihood of success on the merits and

all other requirements for IPR have been met. The Board should institute IPR.

A. There Are No Grounds for a § 314 Discretionary Denial in this Case

There is a pending ITC matter relating to the '803 patent. This, however, has no bearing on the Board's decision to institute. *See* 6/21/22 Interim Procedure for Discretionary Denials, pp. 2-3.

B. Denial Under § 325(d) Would Be Inappropriate

The arguments set forth in this petition are different from those addressed by the Patent Office during prosecution. Yamada is among the many patent references cited on the face of the '803 patent. But, it was not specifically discussed or used by the Examiner to reject the claims. Instead, the Examiner focused on different references. (*See generally* Ex. 1002.) Matthies, Phan, and Murai were not cited by Patent Owner or considered by the Examiner. (*See generally id.*) Further, as explained in Section V.B below, the prior art references that were addressed by the Examiner purportedly failed to teach a variety of minor claim limitations, including squares centered around green pixels, larger blue pixels, and alternating green and blue/red pixels. In contrast, Matthies, Phan, and Murai all teach the very same “virtual square” arrangement required by the claims. Thus, this prior art is substantively different from and overcomes any purported deficiencies identified in connection with the art considered by the Examiner. For these reasons, and as further explained below, the Board should institute IPR.

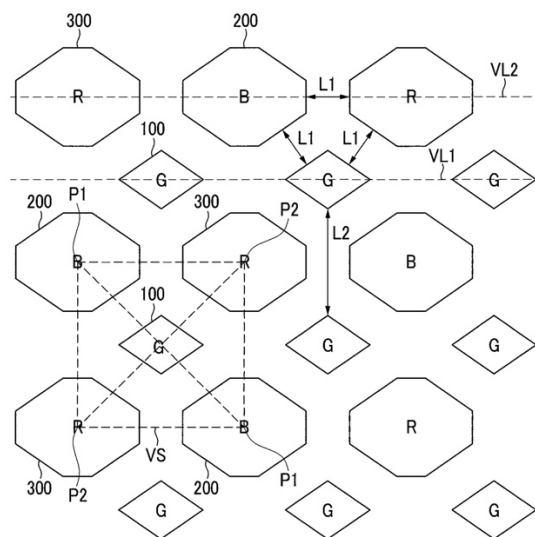
V. The '803 Patent

A. Overview

The '803 patent relates to “a pixel arrangement structure of an organic light emitting diode (OLED display).” (Ex. 1001, 1:16-18.) An “OLED display includes a plurality of pixels for emitting light of different colors.” (*Id.*, 1:29-31.) The pixels’ making up the display can be “deposited and formed” on a substrate “by using a ... fine metal mask (FMM).” (*Id.*, 1:38-40.) This purportedly leads to two countervailing considerations: “[w]hen reducing a gap between the neighboring pixels to obtain a high aperture ratio of the pixel, deposition reliability may be deteriorated.” (*Id.*, 1:40-42.) But, “when increasing the gap between the pixels to improve the deposition reliability, the aperture ratio of the pixel may be deteriorated.” (*Id.*, 1:43-45.)

The '803 patent then goes on to discuss “a pixel arrangement structure for an OLED display having an improved aperture ratio of a pixel while efficiently setting up a gap between the pixels.” (*Id.*, 1:59-62.) Figure 1 is reproduced below:

FIG.1



(*Id.*, Fig. 1.) This figure depicts an example “OLED display” including red, green, and blue pixels. (*Id.*, 3:52-55, 4:12-13, 4:30-31; 4:43-44.) The pixels are arranged in a “virtual square VS” (the dotted box) with a green pixel 100 “at a center point.” (*Id.*, 4:4-21.) The blue pixels 200 and red pixels 300 are located at “vertices” P1 and P2 of the “virtual square VS.” (*Id.*, 4:14-44.) As shown, the blue and red pixels are both the same size and have “a larger area” than the green pixels. (*Id.*, 4:24-26; 4:36-38.) The ’803 patent states that “by enclosing each of the” green pixels within “a pair” of red and blue pixels, “the aperture ratio” of all the pixels is somehow “improved.” (*Id.*, 5:20-23.) But, it does not explain why this is the case, or why it is important to use a “virtual square” instead of some other shape. (*See generally id.*) The patent also fails to explain how “aperture ratio” (*i.e.*, the ratio of light emitting area to total pixel area) can be improved when using the relatively small

pixel sizes and relatively large spaces between pixels shown in the '803 patent's figures. (*See generally id.*) Nor does the patent explain how it maintains an "improved aperture ratio" when it purposefully locates non-light emitting elements "such as a gate line, a data line, a driving power line, and the like" in the large spaces "among" the pixels. (*Id.*, 3:58-61.)

According to the '803 patent, in the pixel arrangement of Figure 1, there is also a "distance" L1 between the red, green, and blue pixels. (*See id.*, 4:64-5:5.) The "distance" L2 between different green pixels is "longer than" distance L1. (*Id.*, 5:13-16.) While the '803 patent states that use of these distances somehow "results in improved deposition reliability when using a fine metal mask to form the green, blue, and red" pixels, it does not explain why this is so. (*See id.*, 5:16-19.) Further, other, completely different pixel-to-pixel spacings can purportedly produce this same benefit. (*See, e.g., id.*, 6:31-35.) Indeed, the patent even explains that the dimensions and spacings in its figures are "arbitrar[y]" and are not meant to be "limit[ing]" in any way. (*Id.*, 3:32-46.) Consistent with this teaching, the claims at issue here make no mention and do not require use of any particular pixel-to-pixel "distance."

The '803 patent also goes on to explain that the pixel arrangement shown in Figure 1 can be varied. For instance, the pixels can have different shapes and sizes. (*See id.*, 3:41-46.) In Figure 2, the blue pixels are largest and the green pixels are

smallest. (*See id.*, Fig. 2.) According to the patent, relatively sizing the pixels in this way “suppress[es] the deterioration of the life span of the OLED display” by accounting for the fact that the blue pixels have “the shortest life span.” (*Id.*, 6:43-50; *see also* Ex. 1003, ¶¶ 44-64.)

B. Prosecution History

When the '803 patent's claims were originally filed, they simply required a “first pixel,” “second pixel,” and “third pixel” arranged in a “virtual square.” (Ex. 1002, p. 23.) The broadest independent claim was not limited to OLED displays, did not require the pixels be any particular color, and did not require the pixels to have any particular size or shape. (*See id.*)

These claims were repeatedly rejected over a series of prior art references, including: (1) U.S. Pub. 2009/03302331 A1 to Smith (Ex. 1011, “Smith”), (2) U.S. Patent No. 7,274,383 B1 to Brown Elliot (Ex. 1012, “Brown Elliot”), (3) U.S. Pub. 2010/0171440 A1 to Satou (Ex. 1013, “Satou”), and (4) U.S. Pub. 2003/0128179 A1 to Credelle (Ex. 1014, “Credelle”) either alone or in combination with other references. (*See, e.g.*, Ex. 1002, pp. 386-395, 433-443, 487-495, 525-535, 710-719, 777-787.)

This led to repeated narrowing of the claims. Among other things, limitations were interjected requiring the pixels to be certain colors, alternate with each other, and have certain relative sizes. (*See id.*, pp. 419 (adding limit requiring a larger

“second pixel” than “third pixel”), 511 (adding limit requiring alternating “first” and “second” pixels), 552 (limiting the “first pixel” to green), 728 (requiring an “OLED display”).) Then, in each response, Patent Owner relied on the minute design differences it had added in an effort distinguish whatever reference the Examiner was citing at the time.

For example, Patent Owner argued that in Smith, the “second” pixel was not larger than the “third” pixel. (*See id.*, pp. 424-425.) Further, while Smith taught arrangement of pixels in a square, a blue pixel (and not a green) was at the square center. (*Id.*, pp. 557-558.) With respect to Brown Elliot, Patent Owner similarly argued that the disclosed pixels did not have the right sizes. (*See id.*, p. 462.) It also pointed out that in Brown Elliot’s figures, “any line going through diagonally arranged blue emitters is going to go through two red or green emitters.” (*See id.*, p. 516.) So, Brown Elliot did not teach alternating first and second pixels. (*See id.*) Next, Patent Owner argued that Satou was different from the claims because it teaches an “illuminating device” (*i.e.*, a light) and not an “OLED display.” (*Id.*, p. 734.) Finally, Patent Owner argued that in Credelle, the red and green pixels were larger than the blue pixels. According to Patent Owner, if the green pixel were made smaller, the pixels would no longer be arranged in a “virtual square.” (*See id.*, p. 805.) After this response, the claims were allowed. (*See id.*, pp. 866-869; *see also* Ex. 1003, ¶¶ 65-77.)

The prior art discussed in this petition teaches everything purportedly lacking from all these prosecution references. This includes the use of a virtual square, larger blue pixels and smaller green pixels, and alternating first and second pixels.

VI. Claim Construction

The Board applies the same *Phillips* claim construction standard used by district courts. *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (*en banc*). For purposes of this petition, Petitioner submits that the terms of the '803 patent's claims do not require further construction and can be afforded their plain and ordinary meaning. (*See* Ex. 1003, ¶¶ 79-82.)

VII. Level of Ordinary Skill in the Art

A POSITA in the field of the '803 patent would have had a degree in electrical engineering, materials science, physics, or a similar discipline, along with 2 years of professional experience working with display design, including OLED displays, or an equivalent level of skill, knowledge, and experience. (Ex. 1003, ¶¶ 37-40.) This POSITA would have been aware of and generally knowledgeable about OLED materials, and display pixel design, layout, and operation. (*Id.*, ¶ 40.)

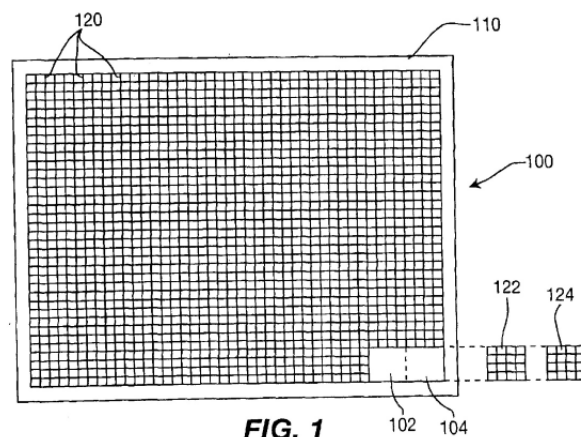
VIII. Prior Art Overview

A. Matthies

Matthies issued May 23, 2005. (*See* Ex. 1004, Cover.) It is prior art under § 102(b). Matthies is not cited by the '803 patent and was not considered during prosecution. (*See generally* Exs. 1001, 1002.)

Matthies relates to “tiled display devices.” (Ex. 1004, 1:8-10.) The display can employ “active matrix circuits.” (*Id.*, 8:21-26.) According to Matthies, by “[b]uilding a large-area display out of smaller tiles,” the display can be made larger while “reduc[ing] manufacturing costs.” (*Id.*, 1:48-65.) Matthies explains that existing tiled displays do not “allow a display to be constructed so that pixels can be brought up to the very edge ... while at the same time allowing for electronics to address each tile.” (*Id.*, 2:2-7.)

Figure 1 provides a “front plan view of a partially assembled large-area display 100.” (*Id.*, 5:35-36.) The display includes a large number of “emissive ... elements” (or sub-pixels) that are arranged in “arrays on tiles” like tiles 122 and 124 in Figure 1. (*Id.*, 5:37-55.) The example display includes tiles with “16 pixel forming elements in a four by four array.” (*Id.*, 5:56-61.)

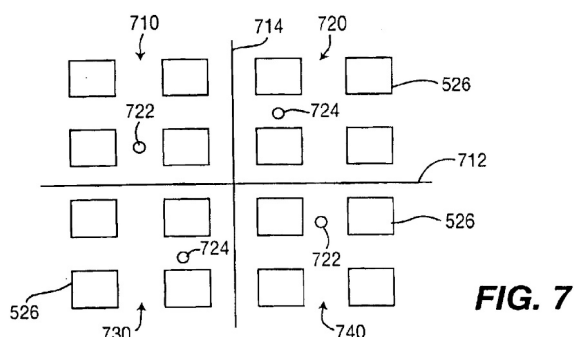


(*Id.*, Fig. 1.)

Each sub-pixel or “pixel forming element” can be made from “organic light emitting diode (OLED) material.” (*Id.*, 6:17-22; *see also* Abstract; 5:29-30.)

According to Matthies, “it is desirable for” the OLED sub-pixels “to occupy only a portion (e.g. about 25 percent) of the pixel area.” (*Id.*, 13:11-14.) Including space around the sub-pixels “leaves room” for the “vias 520 and 522 to connect to the row and column electrodes of the pixel without interfering with the regular spacing of the pixels across tile boundaries.” (*Id.*, 15:67-16:14; *see also id.*, 2:36-40.)

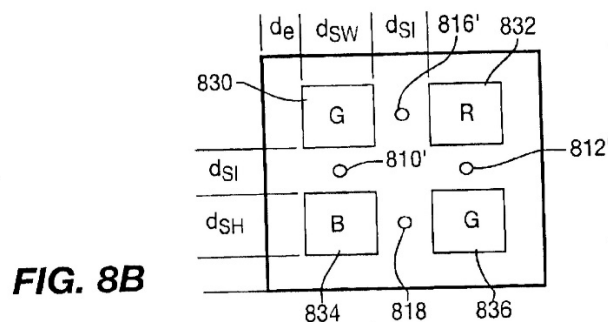
Matthies includes numerous examples of its sub-pixel arrangement and spacing. For instance, “FIG. 7” depicts a “layout” where “the active portions 526 of the pixels are centered in their respective regions.” (*Id.*, 16:21-26.) As shown, “[t]he distance between the edge of an active region 526” and adjoining structure “is equal on all sides.” (*Id.*, 16:26-30.)



(*Id.*, Fig. 7.)

Figure 8B provides an example of a “[c]olor pixel[.]” (*Id.*, 16:40-41.) “This structure is known as a quad sub-pixel....” (*Id.*, 16:62-67.) It includes “[t]wo ... sub-pixel elements, 830 and 836” that “emit green light” and “two pixel elements, 832 and 834” that “emit red and blue light, respectively.” (*Id.*) Matthies explains that “[t]he geometry of the quad sub-pixel structure is defined by the dimensions

d_{SH} , the height of the sub-pixel, d_{SW} , the width of the sub-pixel, d_e , the distance from the active sub-pixel areas to the edge of the pixel area, and d_{SI} , the distance adjacent sub-pixels.” (*Id.*, 17:16-20.)



(*Id.*, Fig. 8B.) Matthies includes a table providing example dimension values that lead to an array of equally spaced, square sub-pixels:

TABLE 2	
d_{SH}	.25P
d_{SW}	.25P
d_e	.125P
d_{SI}	.25P

(*Id.*, 17:24-29.)

Matthies also recognizes that OLED pixel “aging” and “decay” presents a problem. (*Id.*, 11:47-12:40.) It proposes various methods to address and account for these effects. (*Id.*) And, it also explains that “any other method” may be used “either as a check or to augment” display “performance.” (*Id.*, 12:41-47; *see also* Ex. 1003, ¶¶ 85-107.)

B. Phan

Phan issued August 15, 2006. (Ex. 1005, Cover.) It is prior art under § 102(b). Phan is not cited by the '803 patent and was not considered during prosecution. (*See generally* Exs. 1001, 1002.)

Phan teaches a “display comprising pixels and dots.” (Ex. 1005, 1:18-19.) This display can be an “Organic Light Emitting Diode (OLED)” display. (*Id.*, 1:18-29.) The dots 11 making up a display 10 are “arranged along horizontally and/or vertically extending lines” and “consist of ... the three basic colours of red, green and blue.” (Ex. 1005, 1:57-61.) Each dot is individually addressable. (*Id.*, 5:12-21.) This allows the dots to be grouped into “dynamic-generated ... pixels” to “give a perception of” a “higher resolution display.” (*Id.*, 2:63-3:18.)

According to Phan, the colored dots are arranged in “square” groups in “a well known grid pattern.” (*Id.*, 4:41-43.) Figure 2a provides an example:

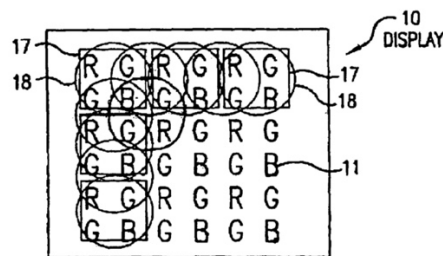


FIG. 2a

(*Id.*, Fig. 2a.) The dots can have different sizes. For instance, the red, green, and blue dots can form a “square quad pixel,” with all the dots having the same size. Alternatively, the blue dot can be made larger than the other colors:

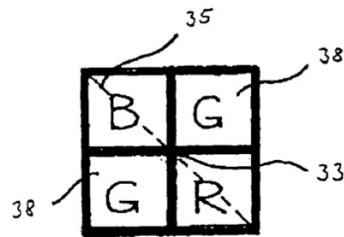


FIG. 11a

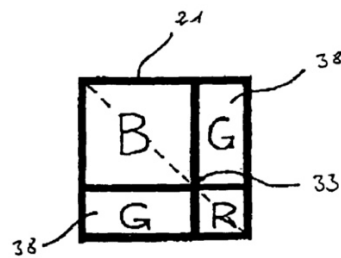


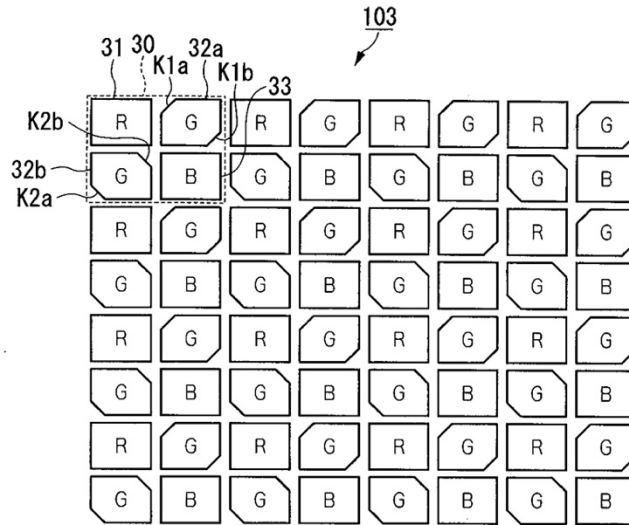
FIG 11b

(*Id.*, 5:47-54; Figs. 11a-b; *see also* Ex. 1003, ¶¶ 108-118.)

C. Murai

Murai published April 23, 2010. (*See* Ex. 1007, Cover.) It is prior art under § 102(b). Murai is not cited by the '803 patent and was not considered during prosecution. (*See generally* Exs. 1001, 1002.)

Murai relates to a “color image display device.” (Ex. 1007, ¶ [0001].) The display can be “an organic EL display device[.]” (*Id.*, ¶ [0058].) The display is formed from multiple “red (R),” “green (G),” and “blue (B)” dots 31, 32a, 32b, and 33. (*Id.*, ¶¶ [0028]-[0029].) The “dots” can be arranged in a “rectangle” or square at a “diagonal” from each other. (*Id.*, ¶ [0010].) In other words, the red, green, and blue dots “are disposed to surround one point, and make up a rectangle made up of four rectangles” (or a “square” of four squares). (*Id.*, ¶¶ [0017]; [0006]; [0032].) Figure 3 provides an example:



(*Id.*, Fig. 3.) Murai explains that arranging pixels in a square improves “the aperture ratio.” (*Id.*, ¶ [0010].)

Murai also teaches that its dots can have different sizes. This is accomplished by including a “cut-off portion[]” in the dot corner to adjust the dot area. (*Id.*, ¶¶ [0006], [0011], [0013], [0039]; Figs. 5(b), 6(a)-(b).) Including cut-offs improves the displayed image because it “prevents dots (pixels) of the same color from being placed next to each other in the vertical direction, the horizontal direction, and the diagonal direction of the screen.” (*Id.*, ¶ [0005]; *see also* Ex. 1003, ¶¶ 119-130.)

D. Yamada

Yamada issued April 2, 2002. (*See* Ex. 1008, Cover.) It is prior art under § 102(b). While Yamada is cited on the face of the ’803 patent, it was not discussed during prosecution. (*See* generally Exs. 1001, 1002.)

Yamada relates to an “electroluminescent display apparatus.” (Ex. 1008, 1:6-10.) According to Yamada, this type of display includes blue, red, and green “pixel[s] ... arranged in a matrix configuration.” (*Id.*, 2:55-60; *see also id.*, 6:44-7:2.) These differently colored pixels have different “emission efficienc[ies].” (*Id.*, 2:53-54.) To improve the display’s life and avoid premature deterioration, Yamada teaches that the pixels should be re-sized “in accordance with the emission efficiency of” each color’s “emissive element.” (*Id.*, 2:55-3:6, 3:16-27, 4:4-14, 10:61-11:3.) The “emissive element of a color with the highest emission efficiency” (green) is made “smaller,” while the “emissive element of a color with the lowest emission efficiency” (blue) is made “larger.” (*Id.*, 3:38-44, 3:51-57; 7:3-12, 8:19-28; 8:47-52; 10:52-55; 11:4-15.) Figure 4 provides an example:

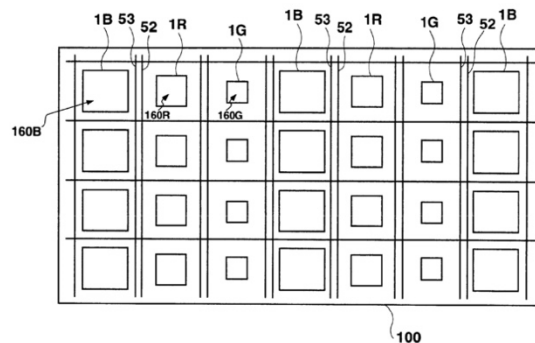


Fig. 4

(*Id.*, Fig. 4; *see also* Ex. 1003, ¶¶ 131-138.)

IX. Ground 1: Claims 1-5, and 19-21 Are Obvious Over Matthies and Yamada

Matthies (Ex. 1004) and Yamada (Ex. 1008), when considered in view of the knowledge of a POSITA, render claims 1-5 and 19-21 obvious.

Matthies teaches an OLED display that includes red, green, and blue pixels arranged in a square pattern. While Matthies' pixels are all equally sized in certain examples, a POSITA would have considered it obvious to resize the pixels in view of Yamada. Yamada explains that making the blue pixel largest, red pixel an intermediate size, and green pixel smallest improves OLED display life. Applying this to Matthies results in an OLED display with pixels that are arranged in the claimed "virtual square" shape and also sized in the way the '803 patent claims require.

A. Claim-By-Claim Analysis

1. Claim 1

[1-pre] "1. A pixel arrangement structure of an organic light emitting diode (OLED) display, comprising:"

To the extent this preamble language is limiting, Matthies teaches it. Matthies discloses a tiled "electronic display device." (Ex. 1004, 1:8-10.) The display can be an "OLED ... display" that includes OLED "pixel forming elements." (*Id.*, 5:29-30; 6:18-22, 16:40-43; *see also id.*, 3:6-7)

Matthies also discusses how the pixels making up its display device are arranged. In particular, the display includes "tiles ... constructed with" "evenly spaced" "pixel forming elements." (*Id.*, 5:47-53.) In one example, a "display 100" is "formed from tiles having 16 pixel forming elements in a four by four array." (*Id.*, 5:56-61; *see also id.*, Fig. 1; Ex. 1003, ¶¶ 144-150.)

[1-a] “a plurality of pixels for displaying an image on the OLED display and comprising:”

Again, Matthies relates to an “OLED ... display device.” (Ex. 1004, 3:6-7, 5:29-30; 6:18-22, 16:40-43.) This device is formed as a “tiled display” that includes a multitude of “picture element[s]” or “pixels.” (Ex. 1004, Abstract; *see also id.*, 2:35-37.) In one embodiment, the display pixels can be formed from “red (R) ..., green (G) ... and blue (B) ... sub-pixels,” each of which is formed from an “OLED material[.]” (Ex. 1004, 16:40-44; 13:1-2.)

The sub-pixels receive “image data for display.” (*Id.*, 2:58-63.) Each sub-pixel can “controlled by a single row and column electrode pair.” (*Id.*, 16:38-41; *see also id.*, 9:10-13; Fig. 2.) There can be a large number of sub-pixels in each of the display’s tiles (*i.e.*, from 16 to 896). (*Id.*, 5:54-61.)

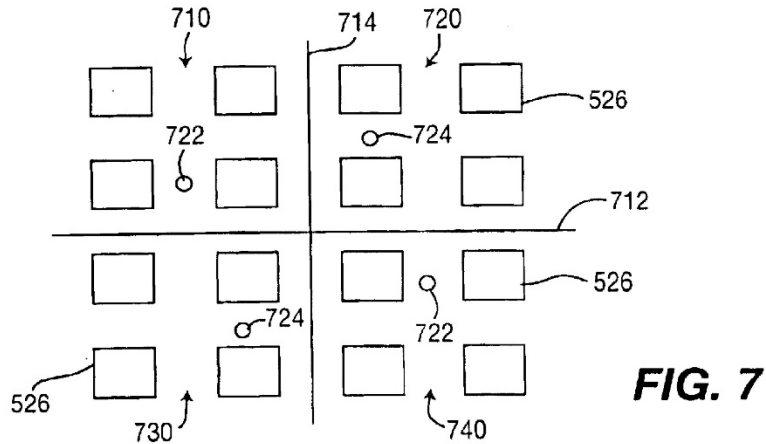
In the ’803 patent, the “term pixel refers to a minimum unit for displaying images.” (Ex. 1001, 1:31-32; 3:55-56.) Matthies includes such a “***plurality of pixels***” (its red, green, and blue OLED sub-pixels are its display’s minimum unit). And, Matthies’ sub-pixels together form an “***OLED display***” for “***displaying an image.***” (Ex. 1003, ¶¶ 151-159.)

[1-a(1)] “a first pixel having a center coinciding with a center of a virtual square;”

This claim requires three pixels—a “first,” “second,” and “third” pixel—arranged in a “virtual square” shape. The claim later specifies that the “first” pixel be green. Matthies teaches this pixel arrangement.

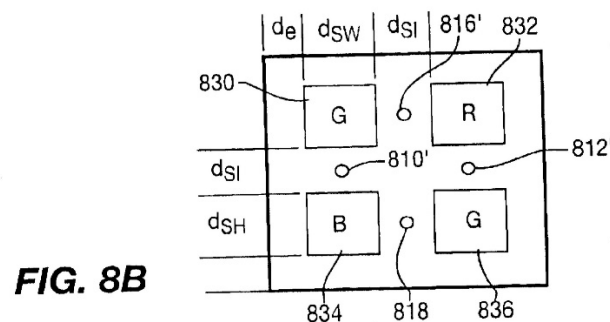
Matthies’ display includes tiled “pixel forming elements” (or “sub-pixels”) arranged in a “matrix.” (Ex. 1004, 5:56-62.) The sub-pixels are arranged “such that ... the inter-pixel distance between the edge pixels of two adjacent tiles is the same as the inter-pixel distance of adjacent pixels in the interior of a tile.” (*Id.*, 5:49-53; *see also id.*, 8:48-50 (explaining that the display is “tile[d]” “such that there is a continuity in the pixel spacing over the display”).) Each sub-pixel can be “centered in the pixel area.” (*Id.*, 2:46-47.)

Figure 7 provides an example: sub-pixel “active portions 526 ... are centered in their respective pixel regions.” (*Id.*, 16:21-25.) “The distance” between “the center of the active pixel region to the edge” of the tile that contains the pixel “is $\frac{1}{2}$ of the pixel pitch.” (*Id.*, 16:26-30.) Because of this, all 16 of the sub-pixels are equally spaced in a repeating square pattern:



(*Id.*, Fig. 7.)

Figure 8B provides another an example employing “[c]olor pixels.” (*Id.*, 16:40-41.) This figure shows “a quad sub-pixel structure” including two green, one red, and one blue “sub-pixel elements” 830, 832, 834, and 836. (*Id.*, 16:62-67.) “[V]ias” 810', 812', 816', and 818 are located between the “sub-pixels” to facilitate electrical interconnection to the display device’s “row” and “column electrodes.” (*Id.*, 17:10-17.) According to Matthies, “[t]he geometry of the quad sub-pixel structure is defined by the dimensions d_{SH} , the height of the sub-pixel, d_{SW} , the width of the sub-pixel, d_e , the distance from the active sub-pixel areas to the edge of the pixel area, and d_{SI} , the distance between the adjacent sub-pixels.” (*Id.*, 17:16-20.)

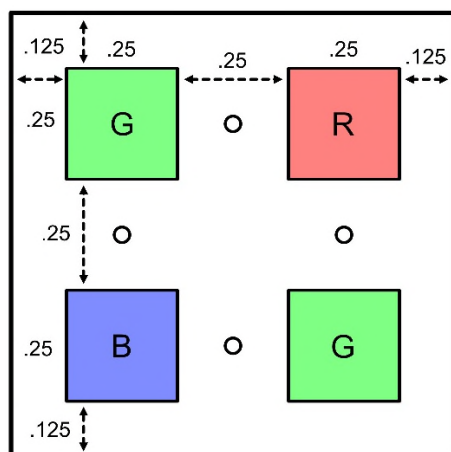


(*Id.*, Fig. 8B.) Table 2 provides an example of these pixel geometry defining values (the variable “P” refers to the total “pixel pitch”):

TABLE 2	
d_{SH}	.25P
d_{SW}	.25P
d_e	.125P
d_{S1}	.25P

(*Id.*, 16:53-55; 17:20-29.)

As can be seen, both the sub-pixel dimensions and spacing are “equal in the horizontal and vertical directions.” (*Id.*, 17:31-33.) This results in square sub-pixels arranged in an evenly spaced, square matrix. The below demonstrative is a scale drawing of the Figure 8B’s “quad sub-pixel structure” generated using the example dimensions of Table 2:

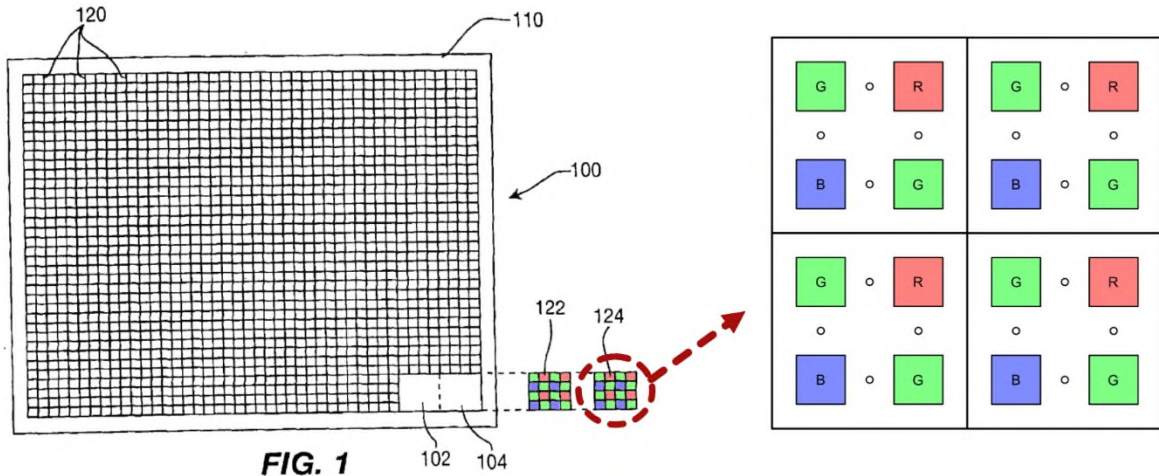


(Ex. 1003, ¶¶ 160-174.) Because the sub-pixels are equally sized and consistently spaced across the display, the center-to-center distance between adjacent green and red/blue sub-pixels will always be the same. (*See id.*, ¶ 175.) Further, the center-to-

center distance between sub-pixels located diagonally will also always be the same. (*See id.*, ¶ 176.) Thus, the sub-pixels are arranged in a square matrix. (*See id.*, ¶ 177.)

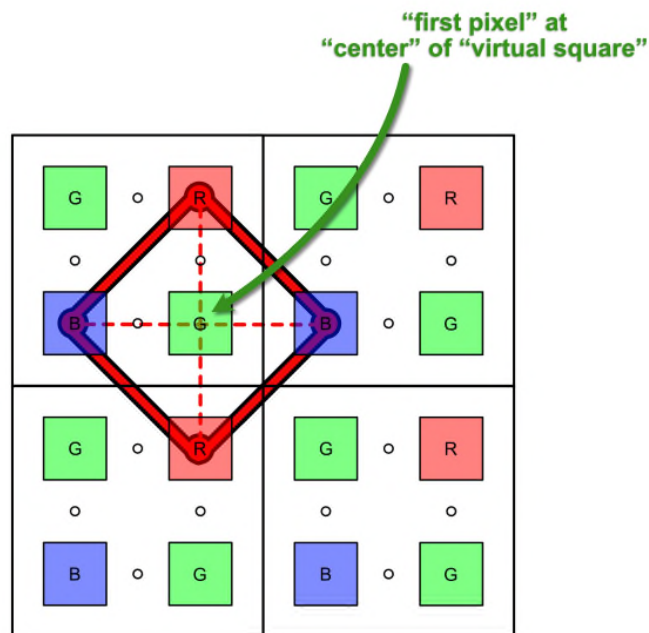
Matthies also teaches how this “quad sub-pixel structure” should be integrated into a display. “[D]isplay 100” can be “formed from tiles having 16 pixel forming elements in a four by four array.” (Ex. 1004, 5:56-61.) To obtain such a larger tile, the pixel geometry shown in Figure 8B and the above demonstrative is simply repeated. (*See, e.g., id.*, Fig. 7 (showing a 16 pixel tile with equal pixel spacing); *see also id.*, 5:38-55 (“[t]he tiles are constructed with pixel forming elements evenly spaced”).)

In the below demonstrative, tile 124 from Figure 1 has been expanded in size. Matthies’ “quad sub-pixel structure” (again drawn to scale using the dimensions of Table 2) has been applied to the tile. Because Matthies builds its “large-area display out of smaller tiles” that are “the basic unit of manufacture” and ensures a “continuity” of pixel spacing across its display (*id.*, 1:56-65; 8:48-50; *see also id.*, 5:36-46), a POSITA would have understood that the other tiles making up the display would have the same structure:



(Ex. 1003, ¶¶ 178-183.)

A display formed using Matthies red, green, blue “quad sub-pixel structure” satisfies this claim limitation. Because the colored pixels are arranged in a repeating square matrix, they form the claimed “*virtual square*” with a “*first pixel*” (the green sub-pixel) at its center:



(Ex 1004, Fig. 6 (annotated); Ex. 1003, ¶¶ 184-189.)

While the above-shown “virtual square” formed by Matthies’ sub-pixels is rotated 45°, it is still a square. (*See id.*, ¶¶ 190-192.) Again, due to Matthies’ arrangement of its sub-pixels in a square matrix with equal distances between pixel centers, the shape above has four equal sides (the pixel center-to-center distance is always the same) and four right angles. (*See id.*) Nothing about the ’803 patent requires the claimed “virtual square” to have any particular rotation relative to other display elements. (*See generally* Ex. 1001.) Instead, the patent simply requires pixels to be arranged in a square pattern. This is what Matthies teaches.

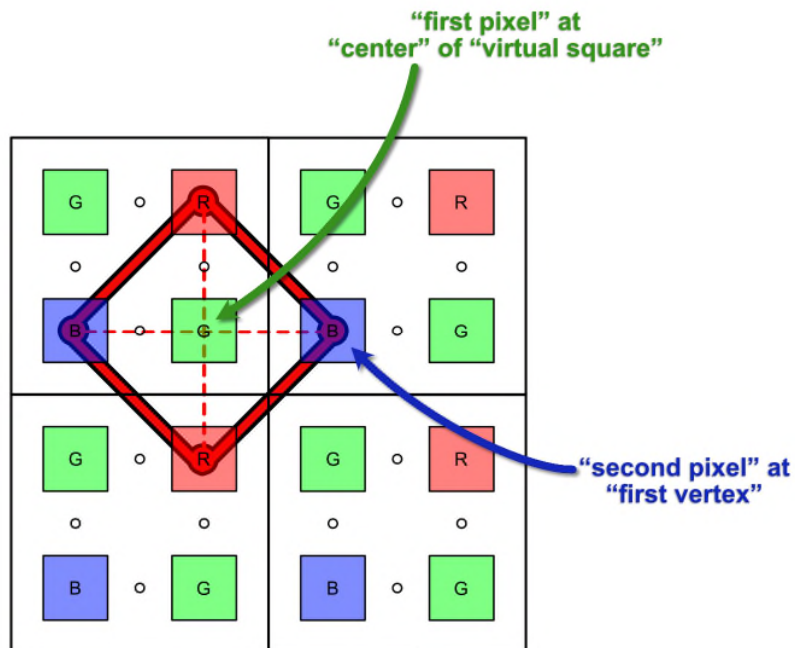
[1-a(2)] “a second pixel separated from the first pixel and having a center at a first vertex of the virtual square;”

Again, Matthies’ display includes red, green, and blue sub-pixels. (*See* Ex. 1004, 13:1-2; 16:40-44; 16:62-17:4; Fig. 8B.) The blue sub-pixels are the claimed “*second pixel*.” (Ex. 1003, ¶¶ 193-194.)

The sub-pixels are spaced apart. According to Matthies, “it is desirable” that the sub-pixels “occupy only a portion (e.g. about 25 percent) of the pixel area.” (Ex. 1004, 13:11-14; *see also id.*, 15:67-16:2.) This allows “an electrical via” to be included between the sub-pixels “without interfering with the active region of the pixel.” (*Id.*, 2:35-40; *see also id.*, 5:49-53 (referencing “inter-pixel distance” between “edge[s]”); 8:48-50 (referencing “pixel spacing”).) In figure 8B for instance, there is a “distance” “ d_{SI} ... between the adjacent sub-pixels.” (*Id.*, 17:16-

20.) Thus, the blue pixels are “*separated*” from the green pixels. (Ex. 1003, ¶¶ 195-200.)

Further, Matthies arranges its sub-pixels in a repeating, square matrix. (See *supra*, limitation [1-a(1)].) Because of this, the blue sub-pixels are located at a “*first vertex*” of the square formed around the green pixel:

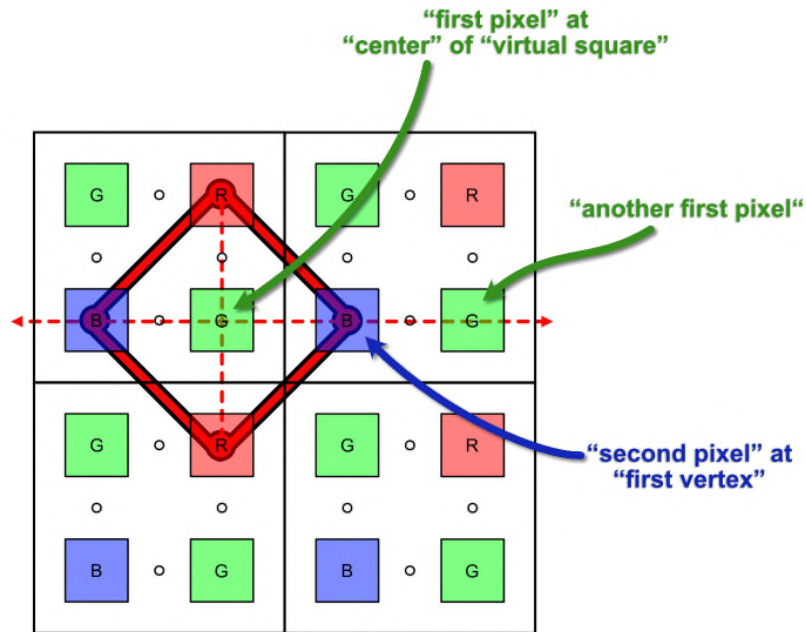


(Ex. 1003, ¶¶ 200-202.)

[1-a(3)] “another first pixel on a line defined by the center of the virtual square and the first vertex, the first pixel, the second pixel, and the other first pixel being consecutive pixels on the line from among the plurality of pixels; and”

Once again, Matthies arranges its sub-pixels in a repeating, square matrix. (See *supra*, limitation [1-a(1)].) Further, Matthies’ “quad sub-pixel structure” includes two green sub-pixels for every red/blue sub-pixel. (Ex. 1004, 16:62-67;

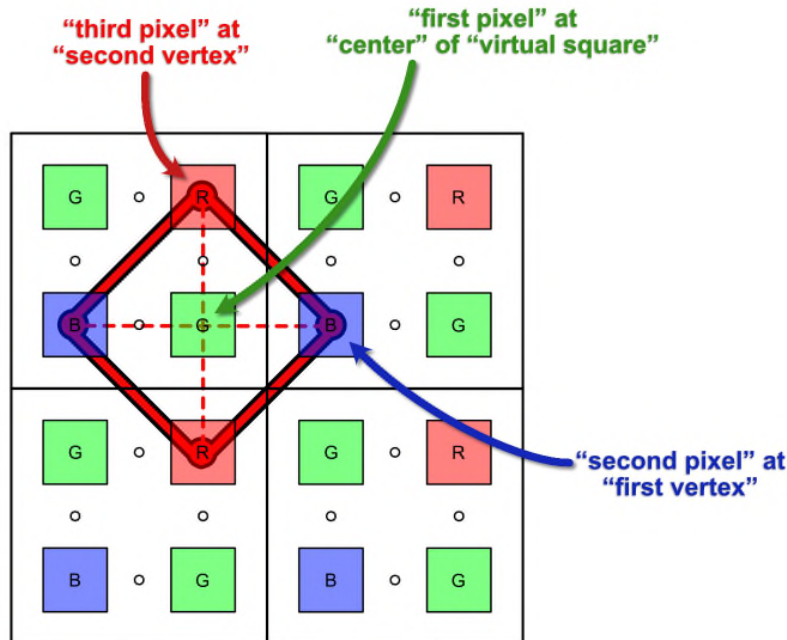
Fig. 8B.) This results in “*another first pixel*” being located “*consecutive[ly]*” after the “second pixel” on a “*line*” passing through the “first” and “second pixel[s]”:



(Ex. 1003, ¶¶ 203-206.)

[1-a(4)] “a third pixel separated from the first pixel and the second pixel, and having a center at a second vertex neighboring the first vertex of the virtual square,”

Once again, Matthies’ display includes red, blue, and green sub-pixels arranged in a repeating, square matrix. (*See supra*, limitation [1-a(1)].) The red sub-pixels are the claimed “*third pixel.*” These pixels are located on the “*second vertex*” of the square formed around the green pixel. They also “*neighbor[]*” the square’s “first vertex”:



(Ex. 1003, ¶¶ 207-209.)

[1-b] “wherein the second pixel has a larger area than that of the third pixel, and”

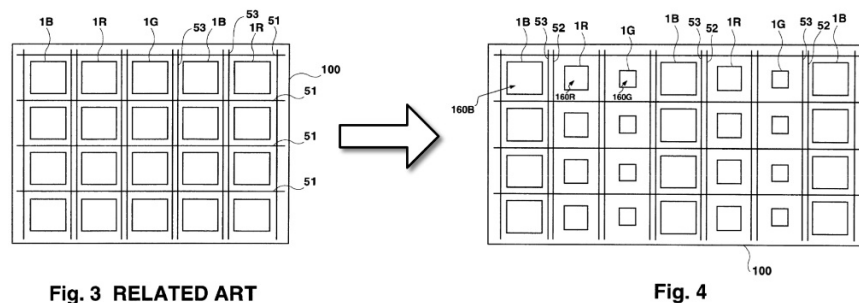
This is obvious in view of Matthies and Yamada. Matthies does provide an example of a display with equally sized sub-pixels. (*See, e.g.*, Ex. 1004, 16:62-17:29; Fig. 8B.) This, however, is not the extent of what it teaches.

Matthies explains that it also “contemplates both larger and smaller pixel apertures.” (*Id.*, 17:36-38.) Further, sub-pixel spacing can also be made “different” if needed. (*Id.*, 17:31-33; *see also id.*, 19:9-10 (referencing the use of “different pixel pitches”).)

Yamada provides an example of an array of red, green, and blue pixels that are differently sized and have different amounts of pixel-to-pixel spacing. Like

Matthies, Yamada relates to an “electroluminescent display apparatus.” (Ex. 1008, 1:6-10.) Also like Matthies, Yamada explains that such a display includes red, blue, and green “pixel[s] ... arranged in a matrix configuration.” (*Id.*, 2:55-60; *see also id.*, 6:44-7:2.) In such a display, the different colors’ “emission layer[s]” have different “emission efficienc[ies].” (*Id.*, 2:53-54.) To account for this, Yamada re-sizes the pixels “in accordance with ... emission efficiency.” (*Id.*, 2:55-60, 3:16-27.) Yamada explains that in a typical OLED display, the “green pixel” has the highest efficiency and is thus made smallest, while the “blue pixel” has the lowest efficiency and is made largest. (*Id.*, 7:3-12, 8:19-28; 8:47-52; 10:52-55; 11:4-15; *see also* 3:38-44, 3:51-57.)

Figures 3 and 4 of Yamada exemplify how a pixel array/matrix is to be modified using this relative sizing. The blue pixel’s size remains the same, while sizes of the red and green pixels are reduced. The same pixel spacing continues to be used—with the pixels centered on the same spots—and the intervening signal lines 51, 52, and 53 remain in place:

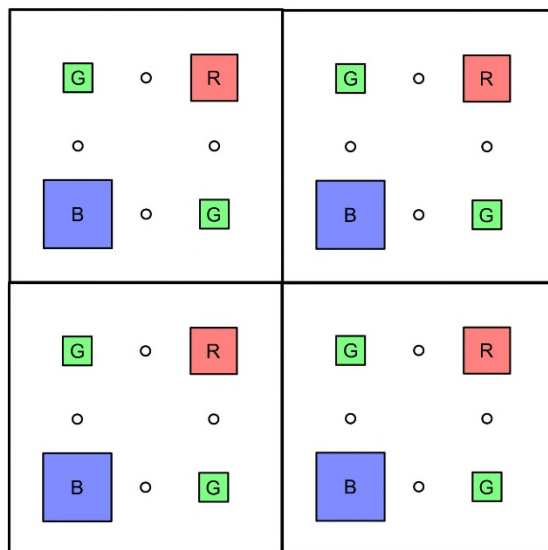


(*Id.*, Fig. 4; *see also id.*, 1:24-54.) Yamada explains that teachings also apply equally

to other pixel “layouts” besides the one in its figures. (*See id.*, 12:37-40.) It also provides a numerical example where the green:red:blue pixel area ratio is set to 1:2.6:5.6. (*See id.*, 11:8-10; *see also* Ex. 1003, ¶¶ 210-221.)

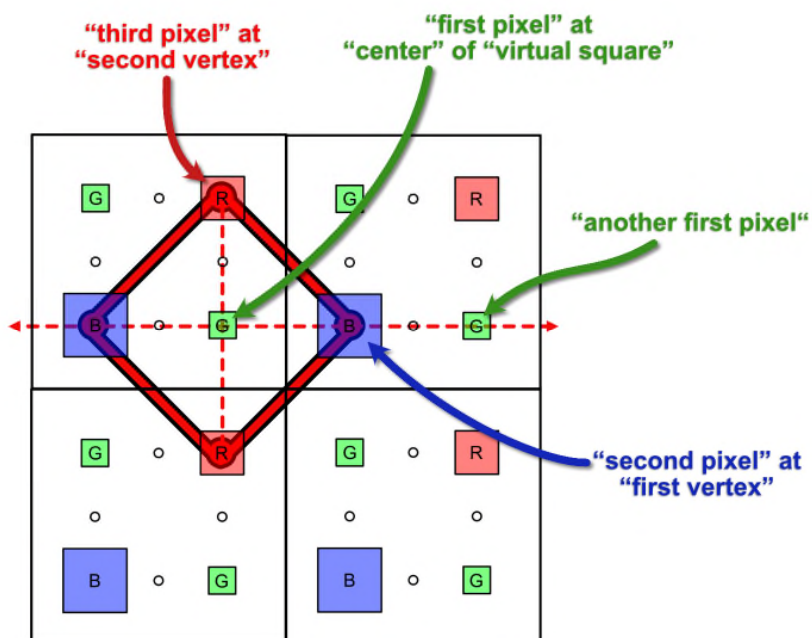
Following these teachings, rather than making all the sub-pixels all the same size, a POSITA would have understood that Matthies’ sub-pixels should be re-sized in accordance with their emission efficiencies such that the “first pixels” (the green sub-pixels) are smallest, the “second pixels” (the blue sub-pixels) are largest, and the “third pixels” (the red sub-pixels) have an intermediate size. The same “quad sub-pixel structure” taught by Matthies would continue to be used (just with re-sized pixels). (*See id.*, ¶¶ 222-224.)

The below demonstrative—again drawn to scale—applies Yamada’s example green:red:blue pixel area ratio of 1:2.6:5.6 to Matthies’ “quad sub-pixel structure.” Per Yamada, the blue pixel has kept its original size. The other pixels have been reduced in size in accordance with Yamada’s example ratio. The same regular sub-pixel spacing taught by Matthies continues to be employed. Each pixel is still “centered in the pixel area” as Matthies and Yamada both teach. (Ex. 1004, 2:46-47, 16:22-25, 16:62-17:30; Ex. 1008, Fig. 4.) And, consistent with Matthies’ teaching, it continues to be the case that no pixel occupies more than “¼ of the total pixel area.” (Ex. 1004, 15:67-16:2; *see also id.*, 13:11-14.)



(Ex. 1003, ¶¶ 225-229.)

When modified following Yamada, Matthies teaches exactly what this limitation requires. As shown below, Matthies “second pixel” (the blue sub-pixel) has a *“larger area”* than its “third pixel” (the red sub-pixel). The sub-pixels continue to form a *“virtual square”*:



(*Id.*, ¶¶ 230-231.)

[1-c] “wherein the first pixel is configured to emit green light.”

Again, Matthies’ display includes “green sub-pixels.” (Ex. 1004, 16:62-17:4; Fig. 8B.) And, as explained above, this green sub-pixel is located at the center of a “virtual square.” (*See supra*, limitation [1-a(1)]; *see also* Ex. 1003, ¶¶ 232-234.)

2. Claim 2

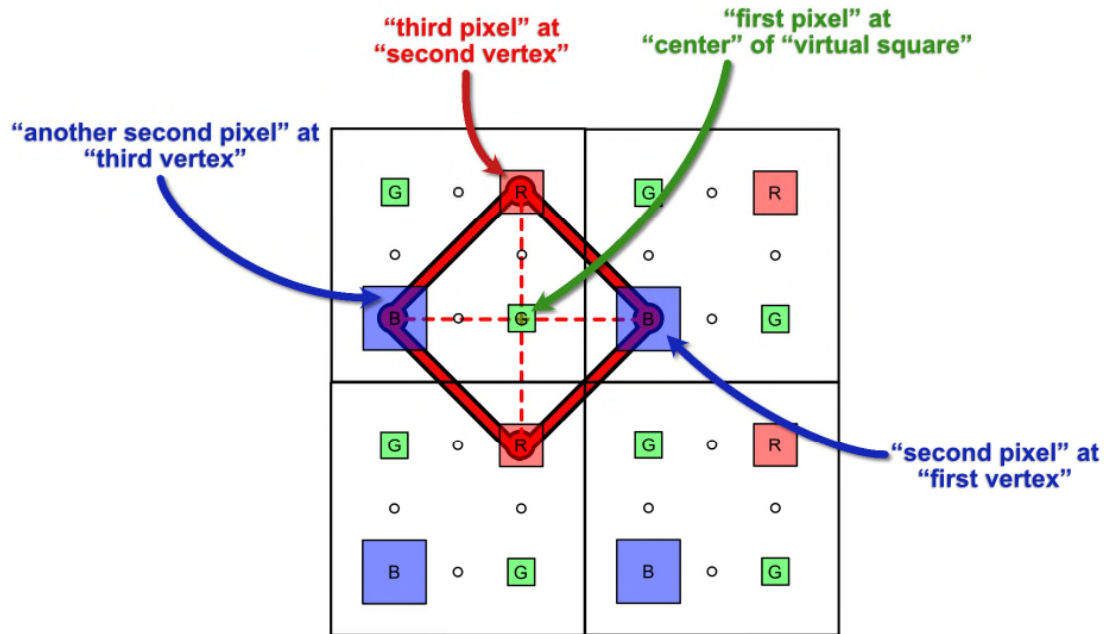
Claim 2 depends on claim 1 and further requires:

[2-a] “wherein the plurality of pixels further comprises another second pixel separated from the first pixel and having a center at a third vertex neighboring the second vertex of the virtual square, and”

[2-b] “wherein the second pixels are separated from each other by the first pixel.”

As explained, Matthies’ blue sub-pixels are the claimed “second pixel.” (*See supra*, limitation [1-a(2)].) Further, Matthies pixels are arranged in a repeating, square matrix. (*See supra*, limitation [1-a(1)].) And, there are two green sub-pixel pixels for each red and blue sub-pixel. (*See* Ex. 1004, 16:62-17:4; Fig. 8B.) Because of this, “*another second pixel*” is located at a “*third vertex*” of the same “virtual square” centered on the green sub-pixel. This “third vertex” “*neighbor[s]*” the square’s “second vertex.” The pixel at this vertex, like all of Matthies’ pixels, is spaced from the other pixels. (*See id.*, 17:16-20; Fig. 8B.) Moreover, as shown below, Matthies’ “first pixel” (the green sub-pixel) is located between and further

“*separate[s]*” Matthies’ “second pixel” and “another second pixel” (two blue sub-pixels):



(Ex. 1003, ¶¶ 235-241.)

3. Claim 3

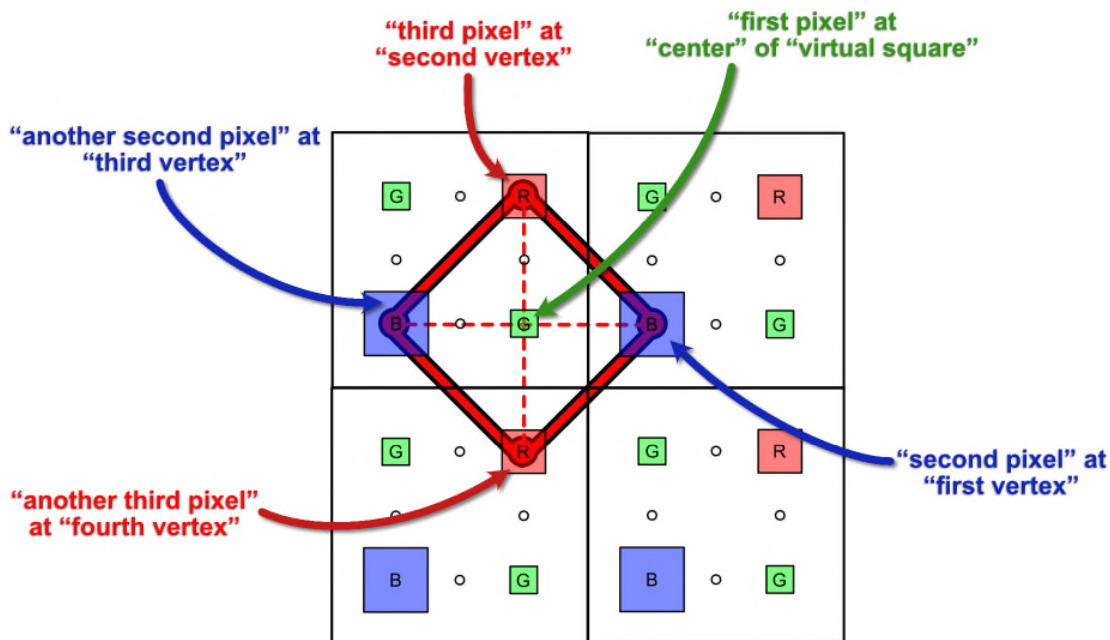
Claim 3 depends on claim 2 and further requires:

[3-a] “wherein the plurality of pixels further comprises another third pixel separated from the first pixel and having a center at a fourth vertex neighboring the third vertex of the virtual square, and”

[3-b] “wherein the third pixels are separated from each other by the first pixel.”

As explained, Matthies’ red pixels are the claimed “third pixel.” (*See supra*, limitation [1-a(2)].) The pixels are arranged in a repeating, square matrix. (*See supra*, limitation [1-a(1)].) Thus, “*another third pixel*” is located at a “*fourth vertex*” of the “virtual square” centered on the green sub-pixel. This “fourth vertex”

“*neighbor[s]*” the square’s “third vertex.” And, because Matthies includes two green sub-pixels for each red and blue sub-pixel (Ex. 1004, 16:67-17:4), Matthies’ “*first pixel*” (its green sub-pixel) is located between and “*separate[s]*” its “*third pixel*” and “*another third pixel*” (two red sub-pixels):



(Ex. 1003, ¶¶ 242-247.)

4. Claim 4

Claim 4 depends on claim 3 and further requires:

[4-a] “wherein the second pixels and the third pixels enclose the first pixel in the virtual square.”

Matthies’ pixels are arranged in repeating, square matrix. (See *supra*, limitation [1-a(1)].) Due to this use of this pixel arrangement, Matthies’ “*second pixels*” (the blue sub-pixels) and “*third pixels*” (the red sub-pixels) surround and “*enclose*” its “*first pixel*” (the green sub-pixels) in the center of a “*virtual square*”:

and the green pixel smallest. (See Ex. 1008, 3:38-44, 3:51-57; 7:3-12, 8:19-28; 8:47-52; 10:52-55; 11:4-15.) Applying this to Matthies results in what this claim requires: Matthies’ “*second pixels*” (the blue sub-pixels) and “*third pixels*” (the red sub-pixels) both have a “*larger area*” than its “*first pixels*” (the green sub-pixels). (Ex. 1003, ¶¶ 255-259.)

6. Claim 19

Claim 19 depends on claim 1 and further requires:

[19-a] “the first pixel, the second pixel, and the third pixel are configured to emit different color lights.”

Matthies’ display includes red, green, and blue pixels. (See Ex. 1004, 13:1-2; 16:40-44; 16:64-17:4; Ex. 1003, ¶¶ 260-262.)

7. Claim 20

[20-a] “the second pixel and the third pixel are configured to emit blue light and red light, respectively.”

This is taught by Matthies for the same reasons discussed for claim 1 above: Matthies’ blue sub-pixels are the claimed “*second pixel[s]*,” and its red sub-pixels are the claimed “*third pixel[s]*.” (See *supra*, limitations [1-a(2)], [1-a(4)]; Ex. 1003, ¶¶ 263-264.)

8. Claim 21

Claim 21 depends on claim 1 and further requires:

[21-a] “the second pixel has a larger area than that of the first pixel.”

This is obvious in view of Matthies and Yamada for the same reasons discussed for claims 1 and 5. (*See supra*, limitations [1-b], [5-b]; *see also* Ex.1003, ¶¶ 265-266.)

B. Motivation to Combine

A POSITA would have considered it obvious and would have been motivated to apply Yamada’s teaching to Matthies. (*See* Ex. 1003, ¶¶ 267-308.)

According to Yamada, in certain prior art OLED devices, the red, green, and blue pixels all have “identical emissive areas in size.” (Ex. 1008, 2:55-60.) This is problematic because the different OLED pixel colors have different “emission efficienc[ies].” (*Id.*, 2:60-63.) To achieve a consistent pixel luminance with same-sized pixels, the pixels with lower emission efficiencies (like blue) must be supplied with a larger current than the pixels with higher emission efficiencies (like green). (*See id.*) Supplying the blue pixels with a larger current, however, “causes” its “life ... to shorten” impacting the overall life of the display. (*Id.*, 2:64-66.) Further, these different emission efficiencies make display “color balance ... difficult to achieve” by requiring further adjustments to supplied current. (*Id.*, 3:1-6.) This not only adds design complication, but results in even further “deterioration.” (*Id.*)

To address this problem, Yamada teaches that the pixels with lower emission efficiencies (blue) should be made larger than pixels with higher emission

efficiencies (green). (*See id.*, 3:38-44, 3:51-57; 7:3-12, 8:19-28; 8:47-52; Figs. 4, 9.) Because the pixels have different sizes, luminance can be balanced while supplying each of the pixels with similar amounts of current or power. (*See id.*, 3:65-4:9.) This avoids the deterioration problem experienced in prior art OLED displays with same-sized pixels and “extend[s] the life of the display device.” (*See id.*, 4:5-14; *see also* 10:61-11:3.) As an added benefit, the overall display design becomes “simplified” and “extremely easy to control” as each pixel is supplied with “the same amount of power.” (*Id.*, 4:57-5:8; *see also id.*, 5:41-49; Ex. 1003, ¶¶ 268-273.)

This would have provided a POSITA with a strong motivation to apply Yamada to Matthies. Matthies teaches a display that employs OLED pixels. (Ex. 1004, 3:6-7; *see also id.*, Abstract; 6:17-22.) Matthies also provides an example of an OLED display with a “quad sub-pixel structure” where each of the red, green, and blue sub-pixels making up the display has an equal size. (*E.g., id.*, 16:62-17:31; Figs. 1; 8B; *see also id.*, 16:21-34; Fig. 7.) And, Matthies provides a different “magnitude of current” to a “OLED pixel” to “match the amount of light emitted by [a given] pixel to the amounts of light emitted by every other pixel in the display device.” (*Id.*, 10:14-18, 24-27.)

A POSITA would have understood that Matthies is subject to the very problem identified by Yamada: its OLED pixels are all the same size. (Ex. 1003, ¶¶

274-280.) And, they are supplied with different currents to achieve a consistent luminance across its display. (*Id.*, ¶ 280.) This will result in some pixels having shorter lives than others shortening the display's life. (*Id.*, ¶ 281.) Applying Yamada's teachings and re-sizing the pixels in accordance with their emission efficiencies—the blue pixels would be largest, the red would have an intermediate size, and the green the smallest—would allow each pixel to be supplied with a similar current increasing the display's life. (*Id.*, ¶ 282.)

Further, not only would the life of Matthies' display be improved after applying Yamada, but a POSITA would have recognized that its design would be simplified. Because its display employs similarly sized pixels, Matthies system includes a series of extra components to tailor the supplied current on a pixel-by-pixel basis. For instance, a “non-volatile memory 214” is included to store required current “value[s] for the pixel cell.” (Ex. 1004, 10:58-61.) This memory must be accessed to obtain the stored value each time a pixel is addressed. (*Id.*, 10:61-64.) The display also includes “programmable current sources 216” that allow the current provided to the display's pixels to vary. (*Id.*, 10:66-11:5; Fig. 2; *see also id.*, 2:63-65.) Because different OLED pixels age at different rates, Matthies “also include[s] circuitry” such as a “light sensor” or “circuitry 134” with an “electronic compensation system which continually adjusts the brightness of individual pixels” to “compensate for aging of the display material.” (*Id.*, 11:47-60.)

A POSITA would have recognized that Yamada is able to achieve a similar effect—more balanced pixel luminance and reduced aging effects—without the need for all the extra structure referenced in Matthies. (Ex. 1003, ¶¶ 283-288.) This would have simplified Matthies’ design and would have further motivated application of Yamada to Matthies. (*Id.*, ¶ 289.) It is also consistent with Matthies own expressed goal of “reduc[ing] manufacturing costs.” (Ex. 1004, 1:64-65.)

Next, Matthies itself repeatedly recognizes that OLED pixels are subject to “aging” and “decay.” (Ex. 1004, 11:47-49, 11:54-60, 12:3-8, 12:13-16.) While it proposes a number of methods to address these deleterious effects, it also explains that “other method” can also be used “either as a check or to augment the performance.” (*Id.*, 12:41-47.) This would have motivated a POSITA to consider applying other known methods for addressing OLED pixel aging and display, including those set forth in Yamada. (Ex. 1003, ¶¶ 290-292.) Bolstering this, Matthies explains that the “geometry of the pixels” plays a role in the “rate of decay,” and suggests that “suitable adjustments may be readily determined by one skilled in the art of designing OLED displays by monitoring the performance of an exemplary pixel over time.” (Ex. 1004, 12:3-13.) A POSITA would have considered this an invitation to apply the different pixel geometries set forth in Yamada to address the aging and decay problems Matthies references. (Ex. 1003, ¶¶ 293-294.)

Next, Yamada’s design—in particular, its use of larger blue pixels and smaller green pixels—is also referenced repeatedly in the prior art. For instance, one reference explains that “[i]t has been proposed to adjust the relative sizes of the different colored light emitting elements to compensate for color-dependent age-related degradation in luminous efficiencies.” (*See, e.g.*, Ex. 1015, 1:63-67.) Another similarly explains that the “blue colour-forming regions” of an OLED should be made “with a larger area” allowing them to be “driven at a lower voltage” and “increasing the lifetime” of the display. (Ex. 1011, ¶ [0062].) The fact that both the problem Yamada addresses and the solution it proposes were well-known as of the ’803 patent’s filing would have further motivated its application to Matthies. (Ex. 1003, ¶¶ 304-308.)

Additionally, a POSITA would have recognized that applying Yamada’s teachings would have provided Matthies with greater design flexibility. (*Id.*, ¶¶ 295-297.) This would also have motivated combination. (*Id.*) Matthies purposefully limits the “the active portions ... of the pixels” to “only about ¼ of the total pixel area” so as to “leave[] room along the edges of the display” for the “vias 520 and 522 to connect to the row and column electrodes of the pixel without interfering with the regular spacing of the pixels across tile boundaries.” (Ex. 1004, 15:67-16:4; *see also id.*, 2:36-40.) Reducing the size of the more luminant green and red pixels,

while leaving the blue pixels at their existing $\frac{1}{4}$ of total pixel area size, would create additional space for Matthies' vias. (Ex. 1003, ¶ 297.)

Next, “when a patent simply arranges old elements with each performing the same function it had been known to perform and yields no more than one would expect from such an arrangement, the combination is obvious.” *KSR Int’l Co. v. Teleflex Inc.*, 550 US 398, 406 (2007). This is all the ’803 patent does here. (See Ex. 1003, ¶¶ 298-303.) Matthies teaches an improved OLED display that is tiled (and thus can be made large), is easier to manufacture, and has improved performance (See, e.g., Ex. 1004, 1:56-65; 2:35-40; 2:62-65.) Yamada teaches an OLED display with improved life. (E.g., Ex. 1008, Abstract, 3:11-16.) The combined display of Matthies and Yamada would continue to exhibit these very same benefits and advantages. (Ex. 1003, ¶¶ 301-303.)

A POSITA would also have had a more than a reasonable expectation of success. (See *id.*, ¶¶ 309-318.) Again, it was routine in the art to resize OLED pixels to improve display lifetime. (*Id.*, ¶ 310.) Indeed, Matthies itself already contemplates that the sizes of and space between its pixels can adjusted. (E.g., Ex. 1004, 17:31-37; see also *id.*, 12:9 (referencing the possibility of different “geometry of the pixels”).) Further, Matthies also invites use of different “other methods” “to maintain a predetermined brightness level” of its pixels. (*Id.*, 12:41-46.) Thus, a POSITA would have considered application Yamada to amount to nothing more

than the use of known design option—that Matthies itself already allows for—to solve a known prior art problem. (Ex. 1003, ¶¶ 311-313.) Moreover, Yamada explains that the benefits of its invention—improved life and design simplification—are not limited to just the example pixel “arrangement[s]” shown in its figures, but also extend to other “layouts[.]” (Ex. 1008, 12:37-40.) This would not only have further motivated application of Yamada’s teachings, but would have emphasized to a POSITA that combination would be successful. (Ex. 1003, ¶¶ 314-316.) Finally, both Matthies and Yamada relate to pixel designs intended for use with OLED displays. (*Id.*, ¶¶ 317-318.) This similarity in purpose would have given a POSITA yet another reason to believe that the references’ teachings would be successfully used together. (*Id.*)

X. Ground 2: Claims 1-4 and 19-21 Are Obvious Over Phan

Phan (Ex. 1005), when considered in view of the knowledge of a POSITA, also renders claims 1-4 and 19-21 obvious.

Like the other references discussed in this Petition, Phan teaches an OLED display formed from a matrix of red, green, and blue pixels. The pixels are arranged in a repeating grid-pattern with a square shape. Phan also teaches that the blue pixel can be made larger than the other pixels.

A. Claim-By-Claim Analysis

1. Claim 1

[1-pre] “1. A pixel arrangement structure of an organic light emitting diode (OLED) display, comprising:”

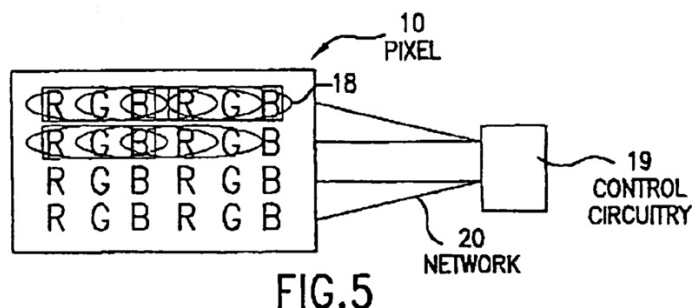
To the extent this preamble language is limiting, Phan teaches a “display comprising pixels and dots.” (Ex. 1005, 1:18-19.) These pixels and dots are grouped and arranged to “provide a display ... which has a higher optical resolution....” (*Id.*, 2:51-53.) Phan explains that its teachings can be employed with various “display technologies,” including “Organic Light Emitting Diode (OLED)” displays. (*Id.*, 1:18-29; *see also* Ex. 1003, ¶¶ 324-327.)

[1-a] “a plurality of pixels for displaying an image on the OLED display and comprising:”

Again, in the ’803 patent, a “pixel” is the “minimum unit for displaying images.” (Ex. 1001, 1:31-32; 3:55-56.) Phan teaches this claimed “*plurality of pixels.*”

According to Phan, a typical “display” includes “so-called pixels” that “consist of so-called dots representing the three basic colours of red, green and blue.” (Ex. 1005, 1:57-61.) The “[d]ots are sources of luminous radiation the light” for purposes of generating a display. (*Id.*, 1:61-64.) Each “dot” may be “surrounded by a black mask or black barrier ribs ... to obtain a higher contrast.” (*Id.*, 4:34-36.) Further, Phan’s display is a “dot-addressed display.” (*Id.*, 2:63-65; 5:13-15.) Thus, “each dot has a receiver of its own” that allows it to be addressed and controlled by

“control circuitry 19 through a network 20.” (*Id.*, 5:12;21.) This is shown in Figure 5:

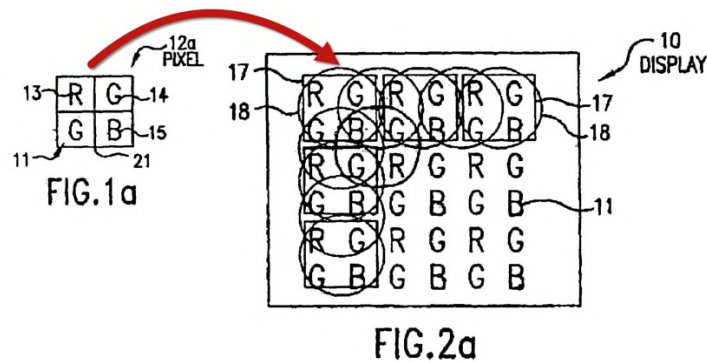


(*Id.*, Fig. 5.) Because the dots are individually addressable, Phan’s display allows for the use of what it calls “dynamic-generated ... pixels” formed by “grouping” different collections of dots to “give a perception of” a “higher resolution display.” (*Id.*, 2:63-3:18.) In other words, Phan’s dots—like the ’803 patent’s “pixels”—are its display’s minimum unit. (Ex. 1003, ¶¶ 328-335.)

Phan also teaches that its “pixels” are part of an “**OLED display**” for “**displaying an image.**” In particular, Phan explains that its “invention relates to a display comprising pixels and dots” that employs “display technologies” like “Organic Light Emitting Diode (OLED)....” (Ex. 1005, 1:18-29.) And, Phan’s display is intended to allow for generation of a “high resolution ... image.” (*Id.*, 4:19-24; *see also id.*, 2:51-3:25 (repeatedly explaining that Phan’s display generates a “higher optical resolution” image intended for viewing by the “human eye”); *see also* Ex. 1003, ¶¶ 336-338.)

[1-a(1)] “a first pixel having a center coinciding with a center of a virtual square;”

Phan teaches the claimed pixels and pixel arrangement. According to Phan, the “[p]ixels” that make up its display “comprise regularly disposed dots 11 radiating the basic colours red (red dot 13), green (green dot 14) and blue (blue dot 15).” (Ex. 1005, 4:29-32.) Phan explains that “the arrangement of the different dots 13, 14, and 15 should be identical in each static pixel 17 within a display 10.” (*Id.*, 4:38-40.) Moreover, the pixels may be “square” and arranged in “a well known grid pattern.” (*Id.*, 4:41-43.) Figure 2a provides an example of a “display with square pixels” (like that shown in Figure 1a) “with well-known static pixels being shown within squares, and the dynamic pixels of the invention within circles.” (*Id.*, 3:33-36; 4:41-47.)



(*Id.*, Figs. 1a, 2a.)

Phan also provides other examples of how individual pixels—and the colored dots those pixels contain—are structured. For instance, “FIG. 11a shows a square quad pixel” like that of Fig. 1a “where the crosspoint 33 is in the center of the four

dots (individual elements) of equal light emitting area and space, contoured by black mask or black barrier ribs 21 with the same structure.” (*Id.*, 5:47-50.) And, “FIG. 11b” shows a variation of this “square quad pixel” where the “crosspoint 33” has “mov[ed] along the diagonal line 35” to “form[] two dots (individual elements) of equal light emitting area and space 38 of green color (G).” (*Id.*, 5:51-54)

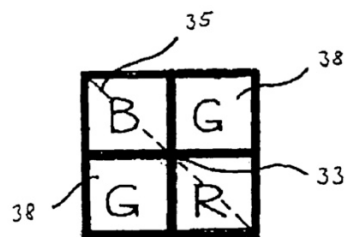


FIG. 11a

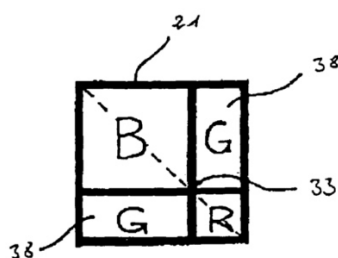


FIG 11b

(*Id.*, Figs. 11a, 11b.) Either example “quad pixel” is intended for use in, for instance, the “quad pixel display” of Fig. 12. (*Id.*, 5:47-60; Fig. 12.)

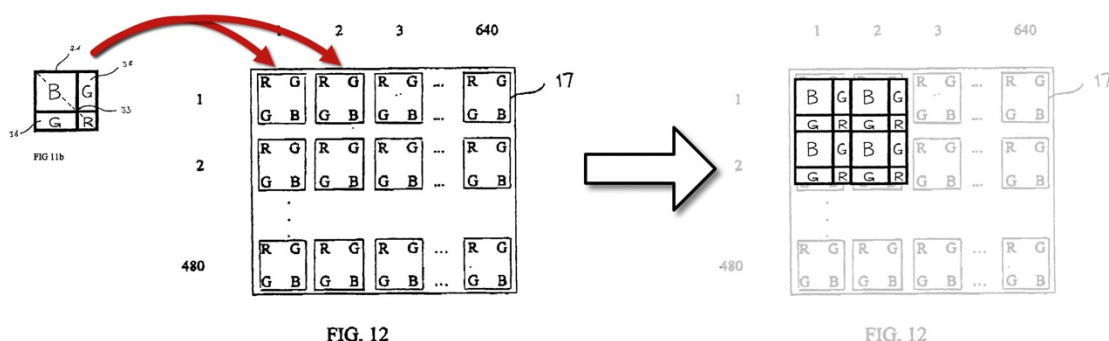


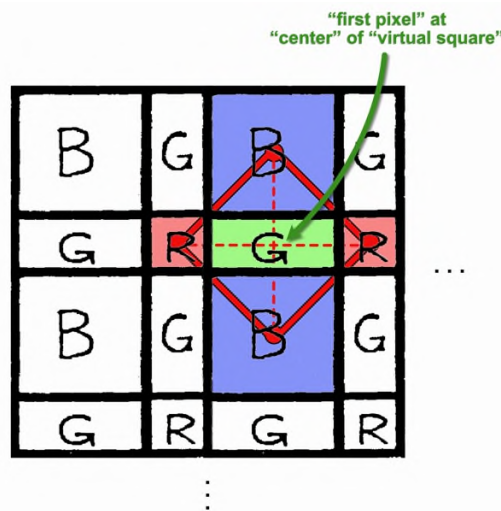
FIG. 12

FIG. 12

(*Id.*, Figs. 11b, 12 (annotated); *see also* Figs. 13aa, 13bb, 13cc, 13dd (depicting the arrangement of R, G, and B pixels in Phan’s “[i]nvented display”).)

Use of the pixel structure shown in Fig. 11b in a grid or matrix to produce Phan’s display results in what this limitation requires. Phan’s green dots are the

claimed “*first pixel.*” Again, Phan teaches that its pixel dots are “regularly disposed” and arranged in a “square.” The square pixels are then arranged in a grid or matrix where every pixel is “identical” shaped. (See, e.g., *id.*, 4:29-32; 4:41-43; 5:47-54.) Due to the use of a square pixel shape that is regularly arranged in an identically repeating matrix, Phan’s dots form a “*virtual square*” with a green dot at its “*center*”:

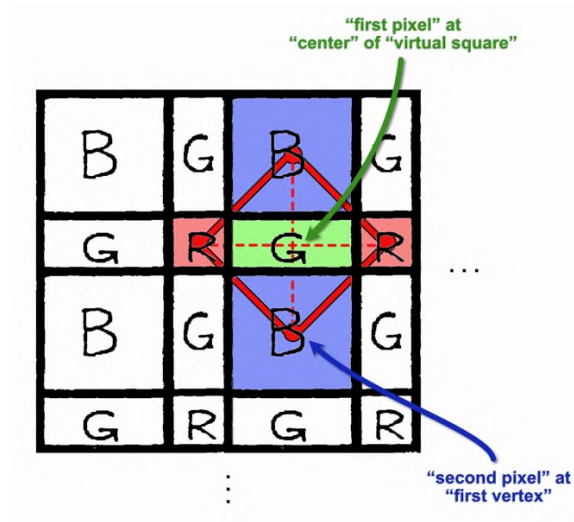


(Ex. 1003, ¶¶ 339-356.)

[1-a(2)] “a second pixel separated from the first pixel and having a center at a first vertex of the virtual square;”

Again, Phan’s pixels also include “red” and “blue” dots. (Ex. 1005, 4:29-32: Fig. 11b.) The blue dots are the claimed “*second pixel.*” Phan also explains that its dots are “surrounded by a black mask or black barrier ribs 21 to obtain a higher contrast.” (*Id.*, 4:33-37.) This serves to “*separate[]*” adjacent dots. (See, e.g., *id.*, Figs. 1a-c; 10a-11b.) Moreover, due to the use of square pixels arrange in a matrix

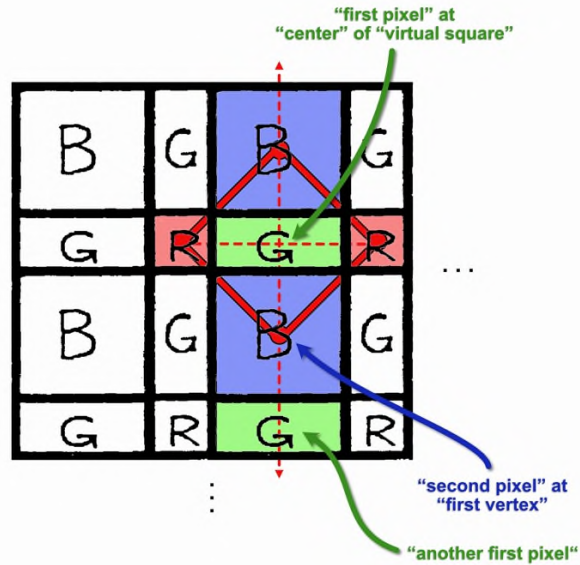
or grid, Phan’s blue dots are located at a “*first vertex*” of the square formed around the green dot:



(Ex. 1003, ¶¶ 357-361.)

[1-a(3)] “another first pixel on a line defined by the center of the virtual square and the first vertex, the first pixel, the second pixel, and the other first pixel being consecutive pixels on the line from among the plurality of pixels; and”

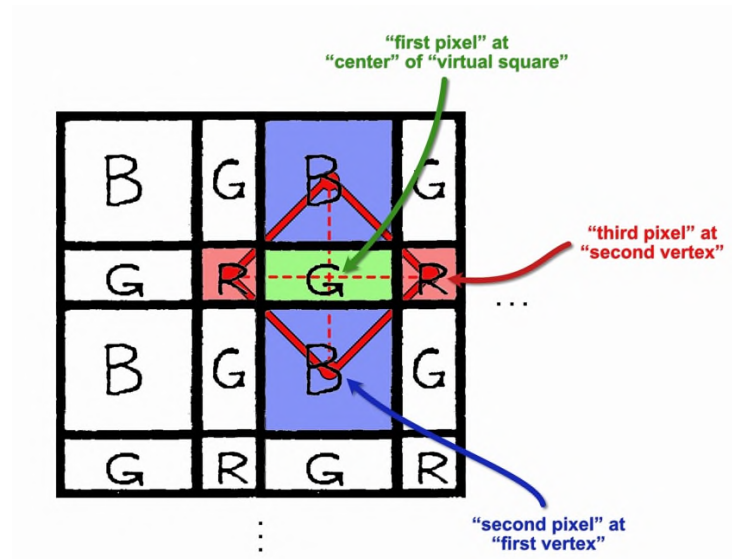
Phan teaches that its pixels are all “identical” and “regularly disposed” in a repeating matrix. (Ex. 1005, 4:29-32; Fig. 11b.) This results in “*another first pixel*” being located “*consecutive[ly]*” after the “second pixel” on a “*line*” passing through the “first” and “second pixel[s]”:



(Ex. 1003, ¶ 362-364.)

[1-a(4)] “a third pixel separated from the first pixel and the second pixel, and having a center at a second vertex neighboring the first vertex of the virtual square,”

Again, Phan’s pixels include red, blue, and green dots. (Ex. 1005, 4:29-32; Fig. 11b.) The red dots are the claimed “*third pixel*.” These dots are located on the “*second vertex*” of the square formed around the green dot. They also “*neighbor[]*” the square’s “first vertex”:



(Ex. 1003, ¶ 365-367.)

[1-b] “wherein the second pixel has a larger area than that of the third pixel, and”

As explained, Phan’s blue dots are the claimed “second pixel.” Its red dots are the claims “third pixel.” In Fig. 11b, the central “crosspoint” of the pixel has been shifted “along diagonal line 35” resulting in dots with non-equal areas. (Ex. 1005, 5:47-54.) The blue dots have a larger area than the red dots:

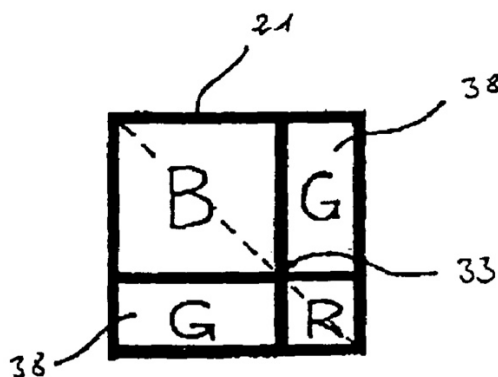


FIG 11b

(*Id.*, Fig. 11b; *see also* Ex. 1003, ¶¶ 368-370.)

[1-c] “wherein the first pixel is configured to emit green light.”

Again, each of Phan’s pixels includes a “green dot 14.” (Ex. 1005, 4:29-32; Fig. 11b.) And, as explained above, this green dot is located at the center of a “virtual square.” (*See supra*, limitation [1-a(1)]; *see also* Ex. 1003, ¶¶ 371-373.)

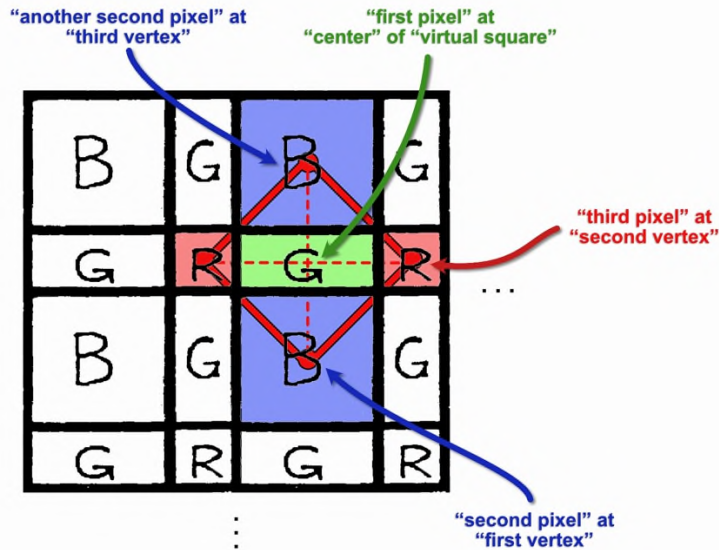
2. Claim 2

Claim 2 depends on claim 1 and further requires:

[2-a] “wherein the plurality of pixels further comprises another second pixel separated from the first pixel and having a center at a third vertex neighboring the second vertex of the virtual square, and”

[2-b] “wherein the second pixels are separated from each other by the first pixel.”

Again, Phan’s blue dots are the claimed “second pixel.” (*See supra*, limitation [1-a(2)].) Further, Phan teaches that its pixels are all “identical” and “regularly disposed” in a repeating matrix. (Ex. 1005, 4:29-32; Fig. 11b.) Because of this, “*another second pixel*” is located at a “*third vertex*” of the same “virtual square” centered on the green dot. This “third vertex” “*neighbor[s]*” the square’s “second vertex.” The dots are “surrounded by a black mask or black barrier ribs 21 to obtain a higher contrast.” (*Id.*, 4:33-36.) Again, this “*separate[s]*” adjacent dots. (*See, e.g., id.*, Figs. 1a-c; 10a-11b.) As shown below, a “*first pixel*” (Phan’s green dot) is located between and further “*separate[s]*” the “*second pixel*” and “*another second pixel*” (two of Phan’s blue dots):



(Ex. 1003, ¶¶ 374-380.)

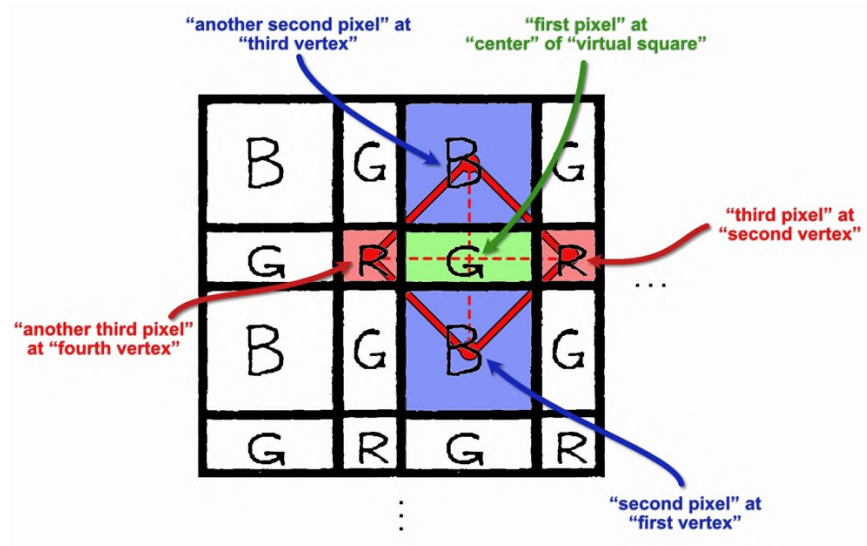
3. Claim 3

Claim 3 depends on claim 2 and further requires:

[3-a] “wherein the plurality of pixels further comprises another third pixel separated from the first pixel and having a center at a fourth vertex neighboring the third vertex of the virtual square, and”

[3-b] “wherein the third pixels are separated from each other by the first pixel.”

As explained, Phan’s red dots are the claimed “third pixel.” (*See supra*, limitation [1-a(2)].) Once again, Phan’s pixels are all “identical” and “regularly disposed” in a repeating matrix. (Ex. 1005, 4:29-32; Fig. 11b.) Thus, “*another third pixel*” is located at a “*fourth vertex*” of the “virtual square” centered on the green dot. This “fourth vertex” “*neighbor[s]*” the square’s “third vertex.” And, a “*first pixel*” (Phan’s green dot) is located between and “*separate[s]*” the “*third pixel*” and “*another third pixel*” (two Phan’s red dots):



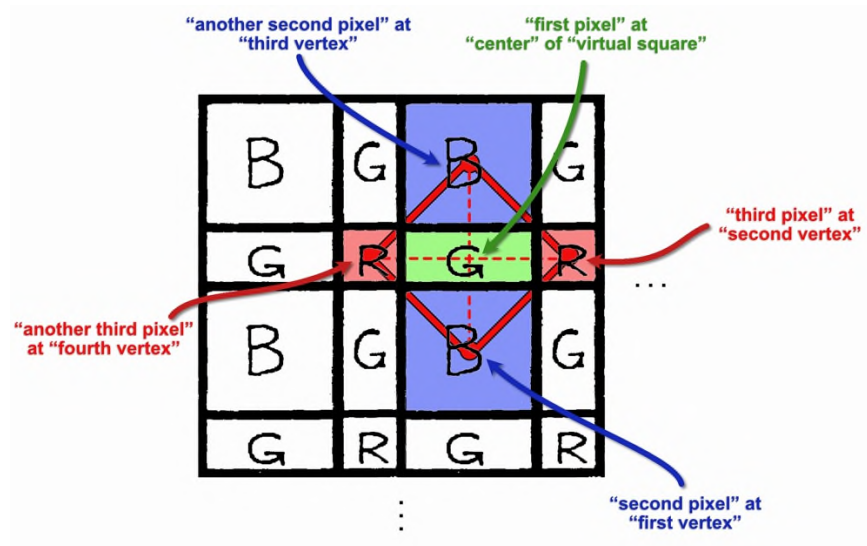
(Ex. 1003, ¶¶ 381-385.)

4. Claim 4

Claim 4 depends on claim 3 and further requires:

[4-a] “wherein the second pixels and the third pixels enclose the first pixel in the virtual square.”

Phan employs pixels with dots arranged in a “square” shape. (Ex. 1005, 3:65-4:4; 4:29-30, 4:54-55, 5:47-54; Figs. 2a-b; 11b, 12.) As shown below, Phan’s “*second pixels*” (the blue dots) and “*third pixels*” (the red dots) surround and “*enclose*” its “*first pixel*” (the green dot) in the center of a “*virtual square*”:



(Ex. 1003, ¶¶ 386-389.)

5. Claim 19

Claim 19 depends on claim 1 and further requires:

[19-a] “the first pixel, the second pixel, and the third pixel are configured to emit different color lights.”

As explained, Phan’s “[p]ixels” “comprise regularly disposed dots 11 radiating the basic colours red (red dot 13), green (green dot 14) and blue (blue dot 15).” (Ex. 1005, 4:29-32; *see also id.*, Figs. 11b, 12.) Phan’s green dot is the claimed “*first pixel*,” its blue dot is the claimed “*second pixel*,” and its red dot is the claimed “*third pixel*.” (*See supra*, limitations [1-a(1)] through [1-a(4)]; Ex. 1003, ¶¶ 390-393.)

6. Claim 20

Claim 20 depends on claim 19 and further requires:

[20-a] “the second pixel and the third pixel are configured to emit blue light and red light, respectively.”

This is taught by Phan for the same reasons discussed for limitations [1-a(1)] through [1-a(4)] and [19-a]. (Ex. 1003, ¶¶ 394-395.)

7. Claim 21

Claim 21 depends on claim 1 and further requires:

[21-a] “the second pixel has a larger area than that of the first pixel.”

As shown below, Phan’s “*second pixel*” (the blue dot) has a “*larger area*” than its “*first pixel*” (the green dot):

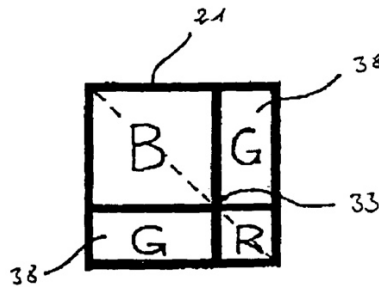


FIG 11b

(Ex. 1005, Fig. 11b; *see also* Ex. 1003, ¶¶ 396-398.)

B. Motivation to Combine

A POSITA would have considered it obvious and would have been motivated to employ Phan’s teachings together. (Ex. 1003, ¶¶ 399-403.) Phan includes two sets of example pixel designs. A POSITA would have considered these an obvious starting place when implementing the rest of what Phan teaches. (*Id.*, ¶ 400.) The “quad pixel” designs of Figures 11a and 11b are also characterized as “typical.” (Ex.

1005, 5:47-54.) This would have both further motivated a POSITA to use and give a POSITA every reason to believe that those pixels can be successfully employed with the displays referenced elsewhere in Phan. (Ex. 1003, ¶¶ 401-403; *see also* Ex. 1005, 7:12-17 (explaining that Phan’s examples are not meant to be limited and are instead intended to be “varied”).)

XI. Ground 3: Claim 5 Is Obvious Over Phan and Yamada

Phan (Ex. 1005) also renders claim 5 obvious when considered in view of the teachings of Yamada (Ex. 1008.)

Claim 5 depends on claim 4 and further requires:

[5-a] “the first pixel, the second pixels, and the third pixels have polygonal shapes, and”

Phan explains that the dots making up its pixels can be formed as a “square quad.” (Ex. 1005, 5:47-54.) For instance, in Fig. 11a, each dot is an “equal” part of the “square” pixel (and thus is also square). (*Id.*, 5:47-50.) And, in Fig. 11b, while the overall pixel still has a square shape, the “crosspoint” that separates the dots has “mov[ed]” along a “diagonal line” resulting in square and rectangular shaped dots. (*Id.*, 5:51-54.) These square and rectangular shaped dots are all “*polygonal*” as this limitation requires:

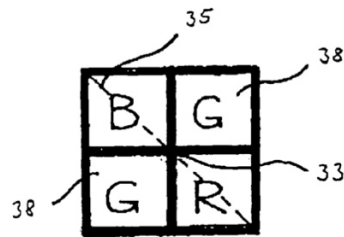


FIG. 11a

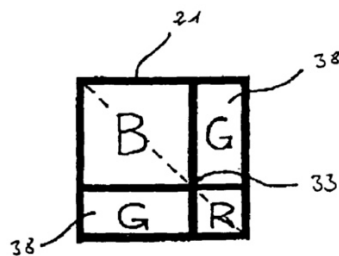


FIG 11b

(*Id.*, Figs. 11a, 11b; Ex. 1003, ¶¶ 407-411.)

Claim 5 also requires:

[5-b] “each of the second pixels and each of the third pixels has a larger area than the first pixel.”

Phan teaches that its “*second pixel*” (the blue pixel) can be made larger than its “*first pixel*” (the green pixel). (*See* Ex. 1005, Fig. 11b.) It does not, however, provide an example where its “third pixel” (the red pixel) is also larger than the green pixel. Regardless, a POSITA would have considered this obvious.

Specifically, Yamada teaches an OLED display with red, green, and blue pixels re-sized “in accordance with the emission efficiency of” each color’s “emissive element.” (*Id.*, 2:55-60, 3:16-27.) In one OLED-specific example, the “green pixel” has the highest efficiency and is thus made smallest, while the “blue pixel” has the lowest efficiency and is made largest. (*Id.*, 7:3-12, 8:19-28; 8:47-52; 10:52-55; 11:4-15; *see also id.*, 3:38-44, 3:51-57.) This is shown in Figures 3 and 4 of Yamada:

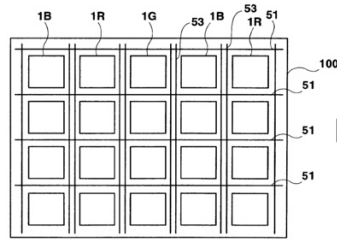


Fig. 3 RELATED ART

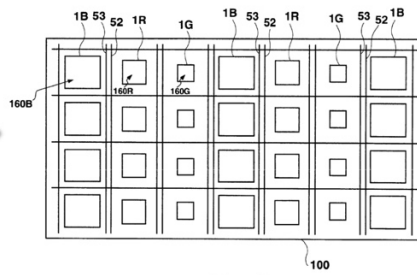
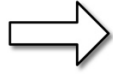
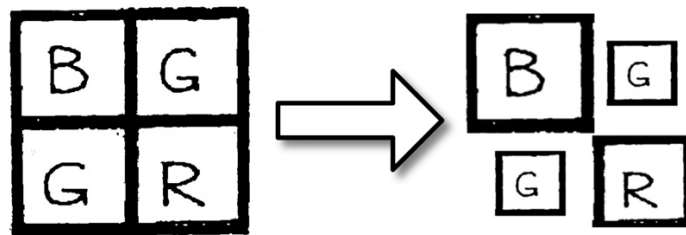


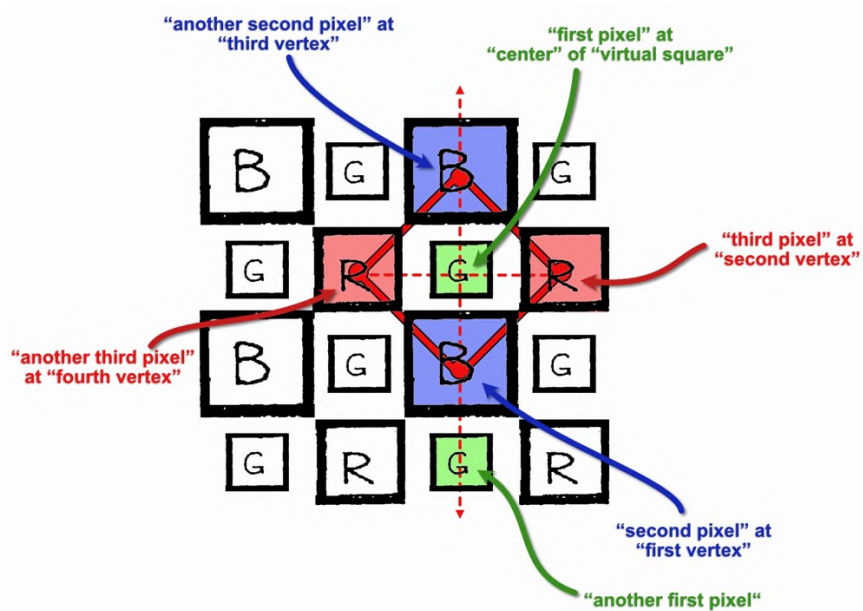
Fig. 4

(*Id.*, Figs. 3, 4.) As shown, when re-sizing the pixels, Yamada maintains its display matrix geometry: the now smaller pixels are centered on the same point they were previously. (*See id.*; *see also supra*, Section IX.A.1; Ex. 1003, ¶¶ 412-420.)

As discussed, Phan provides numerous examples of “square” pixels and pixels with “square quad” shapes. (*See* Ex. 1005, 4:29-30; 5:47-54; Figs. 1a-c, 11a-b.) Each pixel includes two green, one blue, and one red dot. (*See id.*) Following Yamada’s teachings, while maintaining the square pixel shape and matrix geometry Phan already employs, results in the following. The figure on the left is derived from Figure 11a of Phan. The modified figure on the right employs the same overall square pixel size and shape as Figure 11a. But, while the blue dot maintains its original size (making it relatively larger), the green dots have been made smallest and the red dot an intermediate size as Yamada instructs:



(Ex. 1003, ¶¶ 421-430 .) Following Yamada’s example, the dots remain centered on the same points so as to maintain the same overall geometry. (See *id.*, ¶ 425.) When this Yamada-modified square pixel design used in a display matrix like that shown in Figure 12 of Phan, the following results:



(Ex. 1003, ¶ 431.) This is exactly what claim 5 requires: both the “*second pixel*” (Phan’s blue pixel) and the “*third pixel*” (Phan’s red pixel) have a “*larger area*” than the “*first pixel*” (Phan’s green pixel). (See *id.*, ¶ 432.)

A POSITA would have been motivated to apply Yamada to Phan in the manner discussed above for the same reasons it would have been obvious to apply Yamada to Matthies. (Ex. 1003, ¶¶ 433-442.) As explained, it was well-known that adjusting pixel size—and making pixels with lower emission efficiencies (like blue pixels) larger and pixels with higher emission efficiencies (like green pixels)

smaller—reduces deterioration and improves display life. *See supra*, Section IX.B. Numerous references apply this approach to their pixels for purposes of improving display lifetime. *See id.* A POSITA would have recognized that applying Yamada to Phan would have similarly improved the life of Phan’s display. (Ex. 1003, ¶¶ 434-437.) By making the blue pixels largest and the green pixels smallest, display deterioration and dot failure would have been reduced. (*Id.*)

Further, re-sizing pixels in accordance with their emission efficiency was also known to simplify display design. *See supra*, Section IX.B. This is because each pixel can be supplied with the same current or power. *See id.* This also would have motivated application of Yamada to Phan: a POSITA would have understood that Phan’s display, like others in the prior art, would be simplified because the same current could be supplied to all of Phan’s dots. (Ex. 1003, ¶¶ 438-439; *see also supra*, Section IX.B.)

Moreover, Phan already teaches that differently sized red, green, and blue dots can be used. (*E.g.*, Ex. 1005, Fig. 11b.) Given this, a POSITA would consider application of Yamada’s teachings, where the blue dots are made largest and the green dots the smallest, to be nothing more than a routine, minor design variation. (Ex. 1003, ¶¶ 440-441.) A POSITA would also consider the combination of Phan and Yamada to constitute a simple “arrange[ment of] old elements with each performing the same function it had been known to perform” producing expected

results. *KSR Int'l*, 550 US at 406. Because the dots would still be individually controllable, the combined display would still allow for Phan's dynamic pixels (providing for improved resolution), while also having improved life and design simplicity due to Yamada's teachings. (Ex. 1003, ¶¶ 442-443.)

A POSITA also would have had a reasonable expectation of success. While Phan provides examples of certain pixel shapes, it also explains that "[o]ther ... shapes are contemplated" and can be used. (Ex. 1005, 5:29-32.) A POSITA would have understood that this could of course include variations on the differently sized pixels that Phan already teaches. (Ex. 1003, ¶¶ 444-446.) Likewise, Yamada explains that its pixel-resizing teachings can be applied to a variety of different display layouts. (Ex. 1008, 12:37-40.) This would have further motivated application of Yamada's teachings and emphasized to a POSITA that Phan and Yamada would be successfully combined. (Ex. 1003, ¶¶ 447-449.) Finally, both Phan and Yamada relate to pixel designs intended for use with, among other things, OLED displays. (*Id.*, ¶ 450.) This similarity in purpose would have given a POSITA yet another reason to believe that the references' teachings can be successfully used together. (*Id.*, ¶ 451.)

XII. Ground 4: Claims 1-5 and 19-21 Are Obvious Over Murai in View of Yamada

Murai (Ex. 1007) and Yamada (Ex. 1008), when considered in view of the knowledge of a POSITA, render claims 1-5 and 19-21 obvious.

Murai teaches an OLED display with red, green, and blue pixels arranged in a square or cross pattern. The pixels include corner cut-outs resulting in different pixel sizes. In one embodiment, the green pixels are smallest. It also would have been obvious to make the blue pixels larger than the red pixels in view of Yamada.

A. Claim-By-Claim Analysis

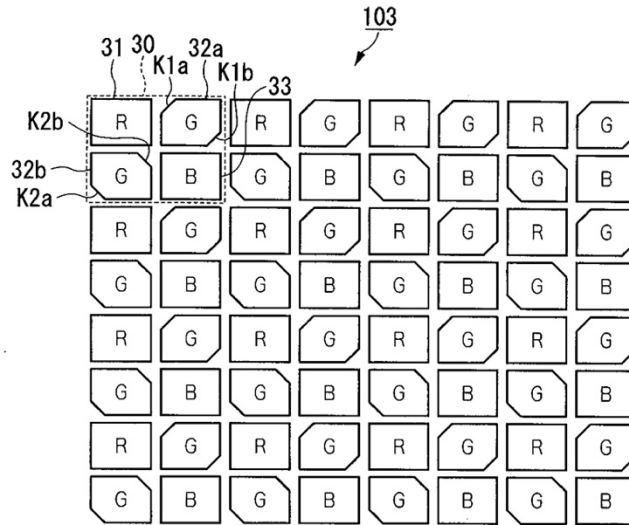
1. Claim 1

[1-pre] “1. A pixel arrangement structure of an organic light emitting diode (OLED) display, comprising:”

To the extent this preamble language is limiting, Murai teaches “a color image display device[.]” (Ex. 1007, ¶ [0001].) The device includes colored “dots” arranged into “unit pixel[s].” (*Id.*, ¶ [0006].) Murai discusses the “dot arrangement” used by its “color image display device” at length. (*Id.*, ¶ [0015].) Further, Murai explains that the display can be “an organic EL display device.” (*Id.*, ¶ [0058]; *see also* Ex. 1003, ¶¶ 457-460.)

[1-a] “a plurality of pixels for displaying an image on the OLED display and comprising:”

According to Murai, “FIG. 3 is a plane view showing a dot shape and dot arrangement in a color image display device.” (Ex. 1007, ¶ [0027].) As shown, the device includes multiple “red (R),” “green (G),” and “blue (B)” dots 31, 32a, 32b, and 33 arranged into “unit pixels 30.” (*Id.*, ¶¶ [0028]-[0029].)



(*Id.*, Fig. 3.) “[A] scanning line may be disposed in each gap” between rows of dots. (*Id.*, ¶ [0041].) Similarly, “a signal wire may be disposed in each gap” between columns of dots. (*Id.*) Each dot may include a “TFT: thin film transistor” that drives/activates the dot. (*Id.*) While most of Murai refers to dots 31, 32a, 32b, and 33 as “dots,” it also characterizes them as “pixel[s].” (*E.g.*, *id.*, ¶ [0016].)

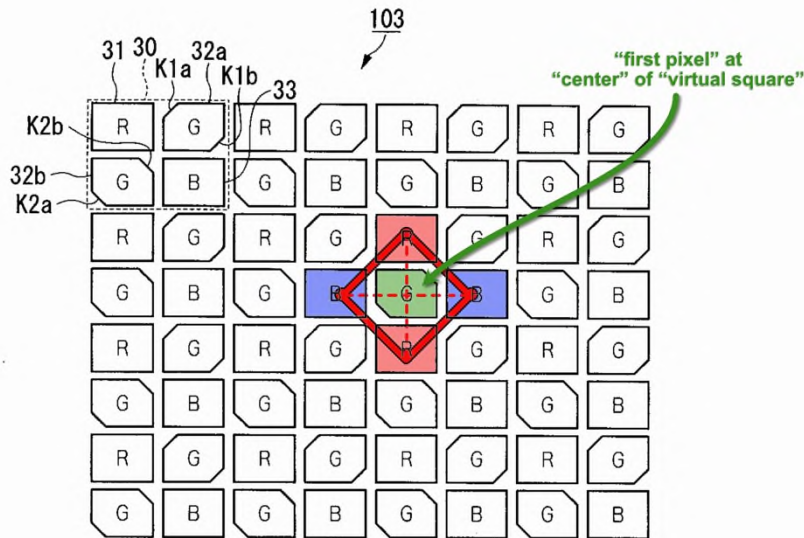
Again, in the ’803 patent, a “pixel” is the “minimum unit for displaying images.” (Ex. 1001, 1:31-32, 34-37; 3:55-56.) This is what Murai teaches: its colored dots/pixels are the claimed “*plurality of pixels*” because they are the minimum unit of Murai’s display. (Ex. 1003, ¶¶ 461-466.)

[1-a(1)] “a first pixel having a center coinciding with a center of a virtual square;”

Murai’s “color image display device” includes “unit pixels ... made up of four dots disposed as a grid in the vertical and horizontal direction.” (Ex. 1007, ¶ [0015].) Each unit pixel includes two “dots” that “are pixels that display green (G),” one

“dot” that “is a pixel that displays red (R),” and one “dot” that “is a pixel that displays blue (B).” (*Id.*, ¶ [0016]; *see also id.*, ¶ [0018] (“R and B may be displayed by one dot and G may displayed by two dots”); ¶¶ [0028]-[0029], [0031] (similar).) The dots “are respectively rectangular, and have substantially the same shape. It is preferable for the rectangular shape ... to be a square.” (*Id.*, ¶ [0017]; *see also id.*, ¶ [0030] (again referencing “substantially the same” pixels shaped as a “square”).) Further, the “four dots ... are respectively disposed to surround one point, and make up a rectangle made up of four rectangles.” (*Id.*, ¶ [0017]; *see also id.*, ¶ [0006] (dots are “disposed on a diagonal” of a “rectangular shape”); ¶ [0010] (similar); ¶ [0032] (similar).) The two green dots/pixels “are disposed on a diagonal of the unit pixel....” (*Id.*, ¶ [0019].) All of the dots are “accurately” and “regularly disposed” for purposes of “improv[ing]” “the aperture ratio.” (*Id.*, ¶ [0010].)

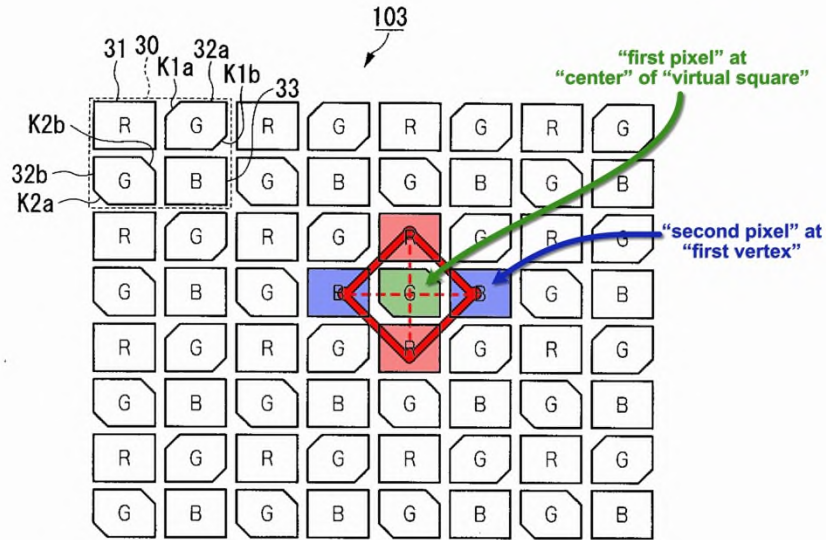
Figure 3 provides an example. Due to the use of a square dot shape, with dots arranged in a grid with a square shape, Murai’s dots form a “*virtual square*” with a green dot at its “*center*”:



(*Id.*, Fig. 3 (annotated); Ex. 1003, ¶¶ 467-480.)

[1-a(2)] “a second pixel separated from the first pixel and having a center at a first vertex of the virtual square;”

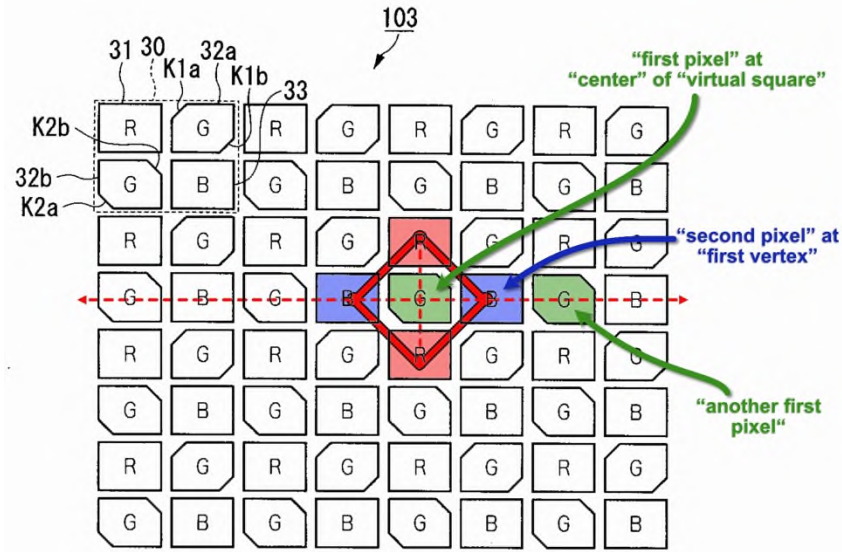
Again, Murai’s pixels also include “red (R)” and “blue (B)” dots/pixels. (Ex. 1007, ¶¶ [0016]; [0018]; [0028]-[0029], [0031].) The blue dots are the claimed “*second pixel*.” Murai also explains that there are “gaps” between its dots that accommodate “scanning” and “signal” lines. (*Id.*, ¶ [0041]; *see also* Fig. 3.) Thus, the dots are “*separated*” from each other. Moreover, due to the use of square dot shapes, with the dots “accurately” and “regularly disposed” in a “grid” with groups of dots located at “diagonals” in a rectangular/square pattern (*see id.*, ¶¶ [0006], [0010], [0015], [0017], [0019], [0030], [0032]), Murai’s blue dots are located at a “*first vertex*” of the square formed around the green dot:



(*Id.*, Fig. 3 (annotated); Ex. 1003, ¶¶ 481-484.)

[1-a(3)] “another first pixel on a line defined by the center of the virtual square and the first vertex, the first pixel, the second pixel, and the other first pixel being consecutive pixels on the line from among the plurality of pixels; and”

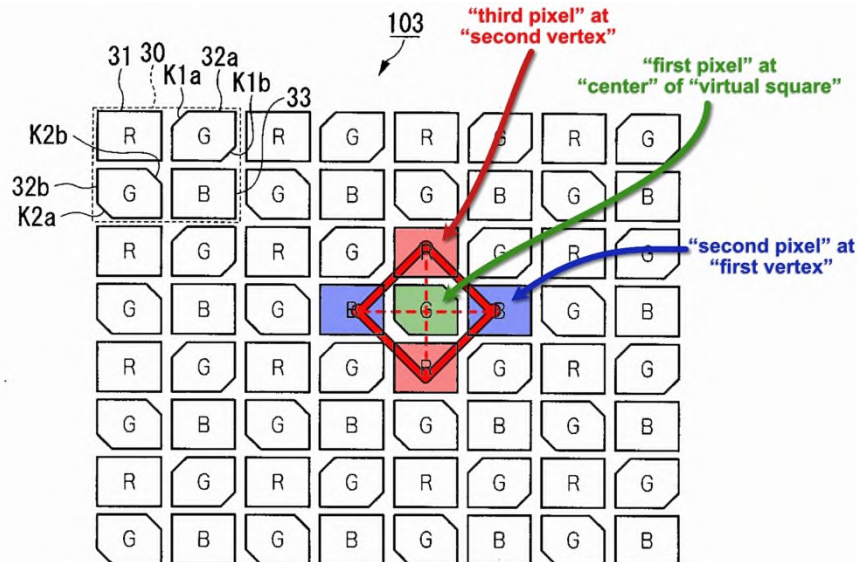
Murai’s display device is formed from “substantially identical” “square” dots “accurately” and “regularly disposed” in a “grid.” (Ex. 1007, ¶¶ [0010], [0015], [0017], [0019], [0030], [0032].) Further, the dots are grouped into units, each of which includes two green dots for every red and blue dot. (*Id.*, ¶¶ [0016]; [0018]; [0031].) The green dots “disposed on a diagonal of the unit pixel...” (*Id.*, ¶ [0019].) This results in “*another first pixel*” (a green dot) being located “*consecutive[ly]*” after the “second pixel” on a “*line*” passing through the “*first*” and “*second pixel[s]*”:



(*Id.*, Fig. 3 (annotated); Ex. 1003, ¶¶ 485-488.)

[1-a(4)] “a third pixel separated from the first pixel and the second pixel, and having a center at a second vertex neighboring the first vertex of the virtual square,”

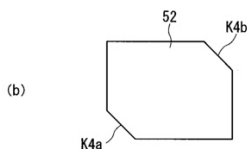
Again, Murai’s display includes red, blue, and green dots/pixels arranged in a matrix. (Ex. 1007, ¶¶ [0016]; [0018]; [0028]-[0029], [0031].) The red dots are the claimed “*third pixel*.” These dots are located on the “*second vertex*” of the square formed around the green dots. They also “*neighbor[]*” the square’s “first vertex”:



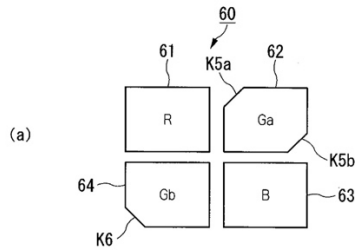
(*Id.*, Fig. 3 (annotated); Ex. 1003, ¶¶ 489-492 .)

[1-b] “wherein the second pixel has a larger area than that of the third pixel, and”

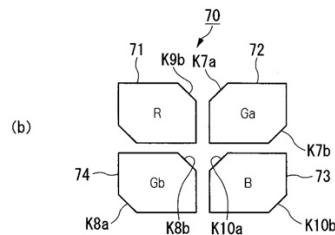
A POSITA would have considered this obvious in view of Murai and Yamada. Murai already teaches that the sizes of its dots can be adjusted. According to Murai, the dots/pixels can include a “cut-off portion” that adjusts the dot area. (Ex. 1007, ¶ [0006]; ¶ [0011] (“[A]t least one corner of the rectangular shape” can be “cut off[.]”)) Figure 5(b) provides an example:



(*Id.*, Fig. 5(b).) As shown, the example “dot 52” includes “cut-off portions K4a and K4b.” (*Id.*, ¶ [0039].) Murai applies similar “cut-offs” to various dots. (*See id.*, Figs. 3, 5, 6.)



(*Id.*, Fig. 6(a).) Alternatively, as shown in Fig. 6(b), all four dots can include cutouts:



(*Id.*, Figs. 6(b); Ex. 1003, ¶¶ 493-506.)

Yamada teaches an OLED display with red, green, and blue pixels re-sized “in accordance with the emission efficiency of” each color’s “emissive element.” (Ex. 1008, 2:55-60, 3:16-27.) In one OLED-specific example, the “green pixel” has the highest efficiency and is thus made smallest, while the “blue pixel” has the lowest efficiency and is made largest. (*Id.*, 7:3-12, 8:19-28; 8:47-52; 10:52-55; 11:4-15; *see also id.*, 3:38-44, 3:51-57.) This is shown in Figure 4 of Yamada:

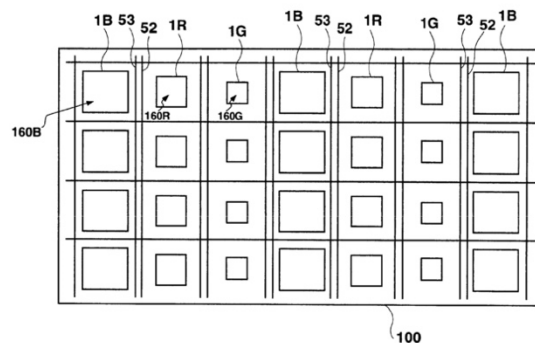
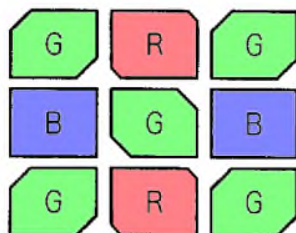


Fig. 4

(*Id.*, Fig. 4.)

Applying this to Murai results in what the claim requires: Murai's dots would be relatively re-sized per Yamada using the method Murai already teaches—different numbers and sizes of cutouts—such that the “*second pixels*” (the blue dots) have a “*larger area*” than both of the other “*pixel[s]*” (the green and red dots). (Ex. 1003, ¶¶ 507-510.) The below demonstrative provides one example of how a POSITA would have obviously accomplished this. The green dots are made smallest via the inclusion of two larger cutouts. The red dots have an intermediate size with two smaller cutouts. The blue dots are largest because they include no cutouts:



(*Id.*, ¶ 511.)

[1-c] “wherein the first pixel is configured to emit green light.”

Again, Murai's display includes “green (G)” dots/pixels. (Ex. 1007, ¶¶ [0016]; [0018]; [0028]-[0029], [0031]; Fig. 3.) And, as explained above, this green dot is located at the center of a “*virtual square*.” (See *supra*, limitation [1-a(1)]; see also Ex. 1003, ¶¶ 512-514.)

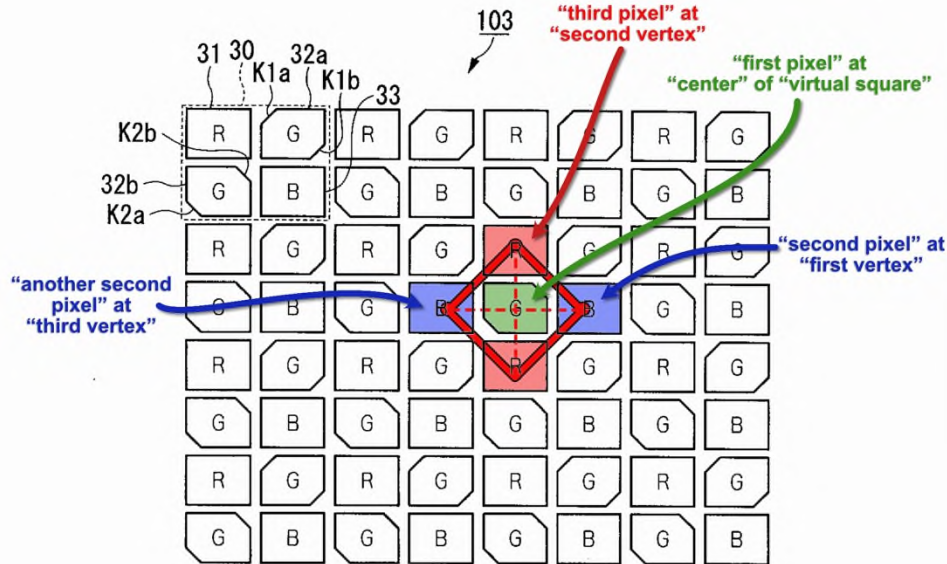
2. Claim 2

Claim 2 depends on claim 1 and further requires:

[2-a] “wherein the plurality of pixels further comprises another second pixel separated from the first pixel and having a center at a third vertex neighboring the second vertex of the virtual square, and”

[2-b] “wherein the second pixels are separated from each other by the first pixel.”

Again, Murai’s blue dots/pixels are the claimed “second pixel.” (*See supra*, limitation [1-a(2)].) Further, Murai explains that it employs square dot shapes, with the dots “accurately” and “regularly disposed” in a “grid” with groups of dots located at “diagonals” in a rectangular/square pattern. (*See* Ex. 1007, ¶¶ [0006], [0010], [0015], [0017], [0019], [0030], [0032].) And, there are two green dots/pixels—located at a diagonal—for every red dot/pixel and blue dot/pixel. (*See id.* ¶¶ [0016], [0018], [0028]-[0029], [0031].) Because of both the dot arrangement and the relative number of green, red, and blue dots, in Murai “*another second pixel*” is located at a “*third vertex*” of the same “virtual square” centered on the green dot. This “*third vertex*” “*neighbor[s]*” the square’s “*second vertex*.” The dot at this vertex, like all of Murai’s dots, is physically separated from the other dots by a “gap.” (*See, e.g., id.*, ¶ [0041]; Fig. 3.) Moreover, as shown below, Murai’s “first pixel” (the green dot) is located between and further “*separate[s]*” Murai’s “*second pixel*” and “*another second pixel*” (two blue dots):



(*Id.*, Fig. 3 (annotated); Ex. 1003, ¶¶ 515-522.)

3. Claim 3

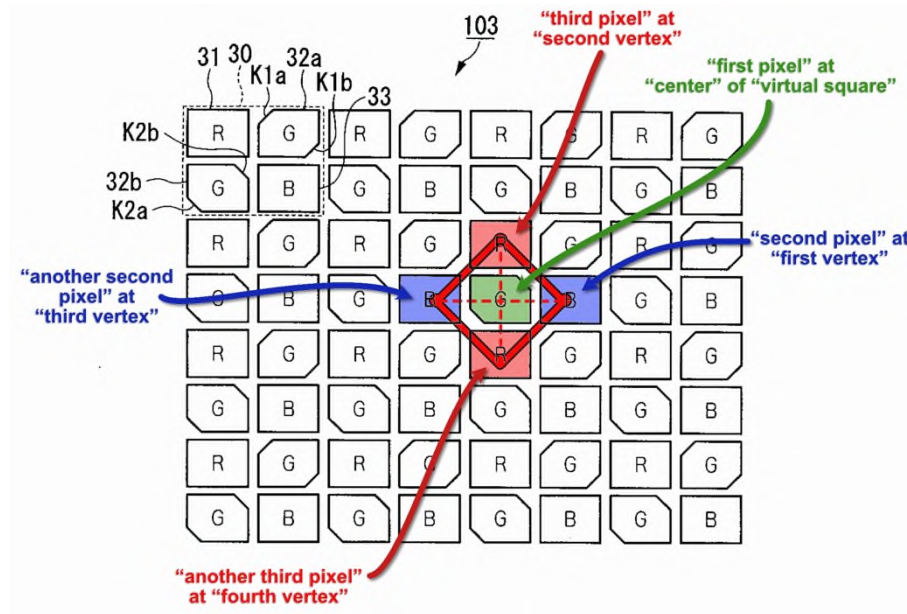
Claim 3 depends on claim 2 and further requires:

[3-a] “wherein the plurality of pixels further comprises another third pixel separated from the first pixel and having a center at a fourth vertex neighboring the third vertex of the virtual square, and”

[3-b] “wherein the third pixels are separated from each other by the first pixel.”

Again, Murai’s red dots/pixels are the claimed “third pixel.” (*See supra*, limitation [1-a(2)].) The dots are arranged in a regular grid, with dots located at the diagonals of a rectangle/square pattern. (Ex. 1007, ¶¶ [0006], [0010], [0015], [0017], [0019], [0030], [0032].) Thus, “*another third pixel*” is located at a “*fourth vertex*” of the “*virtual square*” centered on the green dot. This “fourth vertex” “*neighbor[s]*” the square’s “third vertex.” And, because Murai’s display device includes two green dots (located diagonally) for every red and blue dot (*id.*, ¶¶

[0016], [0018], [0028]-[0029], [0031]), Murai's "*first pixel*" (its green dot) is located between and "*separate[s]*" its "*third pixel*" and "*another third pixel*" (two red dots):



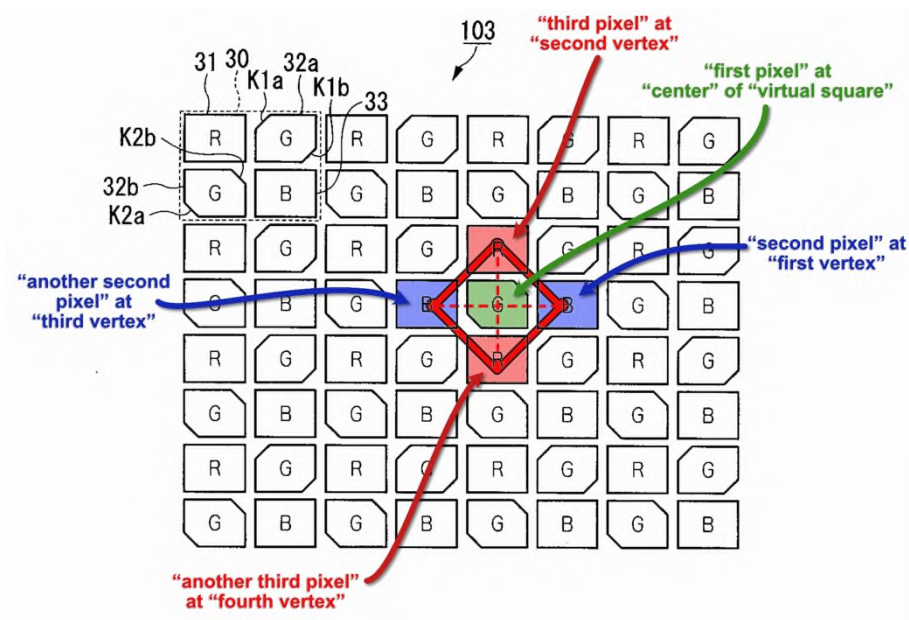
(*Id.*, Fig. 3 (annotated); Ex. 1003, ¶¶ 523-529.)

4. Claim 4

Claim 4 depends on claim 3 and further requires:

[4-a] "wherein the second pixels and the third pixels enclose the first pixel in the virtual square."

Murai's dots/pixels are square shaped and arranged in a "grid" with the individual dots located at the "diagonals" of a rectangle/square pattern. (Ex. 1005, ¶¶ [0006], [0010], [0015], [0017], [0019], [0030], [0032].) Because of this, its "*second pixels*" (the blue dots) and "*third pixels*" (the red dots) surround and "*enclose*" Murai's "*first pixel*" (the green dots) in the center of a "*virtual square*":



(*Id.*, Fig. 3 (annotated); Ex. 1003, ¶¶ 530-532.)

5. Claim 5

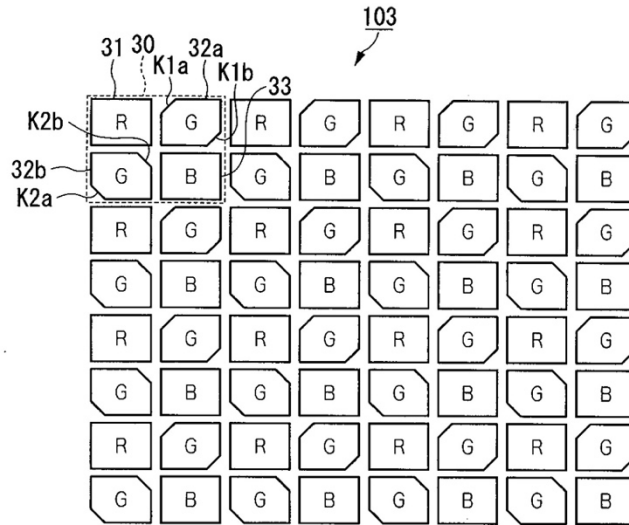
Claim 5 depends on claim 4 and further requires:

[5-a] “the first pixel, the second pixels, and the third pixels have polygonal shapes, and”

[5-b] “each of the second pixels and each of the third pixels has a larger area than the first pixel.”

Murai explains that its of its dots/pixels have a “rectangular shape” that is preferably “a square.” (Ex. 1007, ¶¶ [0017]; [0024]; [0030]; Fig. 3.) Thus, the dots are “*polygonal*.”

Further, Murai explains that its green dots can include two corner “cut-offs.” (See *id.*, ¶¶ [0031]-[0032].) As shown in Figure 3 below, the presence of these corner cut-offs makes Murai’s “*first pixel*” (the green dots) smaller than both its “*second pixels*” (the blue dots) and its “*third pixels*” (the red dots):



(*Id.*, Fig. 3; *see also* Ex. 1003, ¶¶ 533-537.)

6. Claim 19

Claim 19 depends on claim 1 and further requires:

[19-a] “the first pixel, the second pixel, and the third pixel are configured to emit different color lights.”

As explained, Murai’s pixels emit “red (R),” “green (G),” and “blue (B)” light.

(Ex. 1007, ¶¶ [0002], [0006]-[0007], [0009], [0016], [0028]-[0029]; *see also* Ex. 1003, ¶¶ 538-540.)

7. Claim 20

Claim 20 depends on claim 19 and further requires:

[20-a] “the second pixel and the third pixel are configured to emit blue light and red light, respectively.”

This is taught by Murai for the same reasons discussed for limitations [1-a(1)] through [1-a(4)] and [19-a]. (Ex. 1003, ¶¶ 541-542.)

8. Claim 21

Claim 21 depends on claim 1 and further requires:

[21-a] “the second pixel has a larger area than that of the first pixel.”

This is taught by Murai for the same reasons discussed in connection with limitation [5-b]: Murai’s “*second pixel[s]*” (its blue dots) have a “*larger area*” than its “*first pixel[s]*” (its green dots). In Figure 3, the green dots include corner cut-offs making them smaller. (*See supra*, limitation [5-b]; *see also* Ex. 1003, ¶¶ 543-546.) This would continue to the case even after application of Yamada’s teachings (as Yamada explains that the green dots should be made smallest). *See supra*, Section XII.A.1.[1-b].

B. Motivation to Combine

A POSITA would have been motivated to apply Yamada to Murai in the manner discussed above for the same reasons it would have been obvious to apply Yamada to both Matthies and Phan. (Ex. 1003, ¶¶ 547-562.) Once again, it was well-known that adjusting pixel size—and making pixels with lower emission efficiencies (like blue pixels) larger and pixels with higher emission efficiencies (like green pixels) smaller—reduces deterioration and improves display life. *See supra*, Section IX.B. Numerous references apply this very approach to their pixels for purposes of improving display lifetime. *See id.* A POSITA would have recognized that applying Yamada to Murai would have similarly improved the life of Murai’s display. (Ex. 1003, ¶¶ 548-551.) By making the blue pixels largest and

the green pixels smallest, display deterioration and pixel failure would have been reduced. (*Id.*, ¶ 552.)

Further, re-sizing pixels in accordance with their emission efficiency was also known to simplify display design. *See supra*, Section IX.B. This is because each pixel can be supplied with the same current or power. *See id.* This also would have motivated application of Yamada to Murai: a POSITA would have understood that Murai's display, like other prior art displays, would be simplified because the same current could be supplied to all of Murai's pixels. (Ex. 1003, ¶¶ 553-555; *see also supra*, Section IX.B.)

Moreover, Murai already teaches a display with differently sized pixels. *See supra*, Section XII.A.1.[1-b]. While Murai does so for purposes of improving image quality by preventing continuous bands of color, POSITA would have understood that this existing design feature could also be used to improve pixel life. (Ex. 1003, ¶¶ 556-557.) Given this, a POSITA would consider application of Yamada's teachings, where the blue pixels are made largest and the green pixels the smallest, to be nothing more than a routine, minor design variation. (*Id.*, ¶ 558.)

A POSITA would also have recognized that the combined display of Murai and Yamada would exhibit the benefits referenced in both references. Due to its use of Murai's pixel layout and notches, the display would exhibit improved color. (Ex. 1003, ¶¶ 559-560.) And, because the dots would be resized in accordance with their

emission efficiencies, the display would be simpler and have improved life. (*Id.*, ¶¶ 561-562.) Thus, once again, the combination is nothing more than a simple “arrange[ment of] old elements with each performing the same function it had been known to perform” producing expected results. *KSR Int’l*, 550 US at 406.

A POSITA also would have had a reasonable expectation of success. Again, Murai is already open to the re-sizing of its pixels. (Ex. 1003, ¶¶ 563-564.) Likewise, Yamada explains that its pixel-resizing teachings can be applied to a variety of different display layouts. (Ex. 1008, 12:37-40.) This would have further motivated application of Yamada’s teachings and emphasized to a POSITA that Murai and Yamada would be successfully combined. (Ex. 1003, ¶¶ 565-566.) Finally, both Murai and Yamada relate to pixel designs intended for use with, among other things, OLED displays. (*Id.*, ¶ 567.) This similarity in purpose would have given a POSITA yet another reason to believe that the references’ teachings can be successfully combined. (*Id.*, ¶ 568.)

XIII. Conclusion

For the foregoing reasons, Petitioner respectfully requests institution of IPR and cancellation of claims 1-5 and 19-21.

Respectfully submitted,

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Dated: 6/21/2023

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CERTIFICATE OF WORD COUNT

The undersigned certifies that the foregoing PETITION FOR *INTER PARTES* REVIEW complies with the type volume limitation in 37 C.F.R. § 42.24(a). According to the utilized word-processing system's word count, the petition—excluding the caption, table of contents, table of exhibits, mandatory notices, certificate of word count, and certificate of service—contains 13,983 words.

Dated: 6/21/2023

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CERTIFICATE OF SERVICE

The undersigned hereby confirms that the foregoing PETITION FOR IPR and associated exhibits were caused to be served on June 21, 2023 via overnight courier upon the following counsel of record for Patent Owner:

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