

**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 Nos. IPR2023-00987, -00988, -01075

U.S. Patent Nos.

9,818,803

10,8454,683

11,594,578

**PETITIONER'S JOINT HEARING DEMONSTRATIVES
October 9, 2024**

EX 1024

Overview of Argument

Introduction

Matthies is not limited to passive-matrix displays

Motivation to apply Yamada's teachings

Phan's teaching of OLED display pixel arrangements

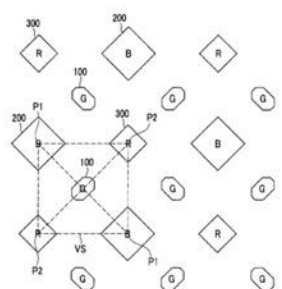
Murai's teaching of OLED display pixel arrangements

'578 patent-specific issues

Secondary considerations

Pending motions to strike

The '803, '683, and '578 Patents

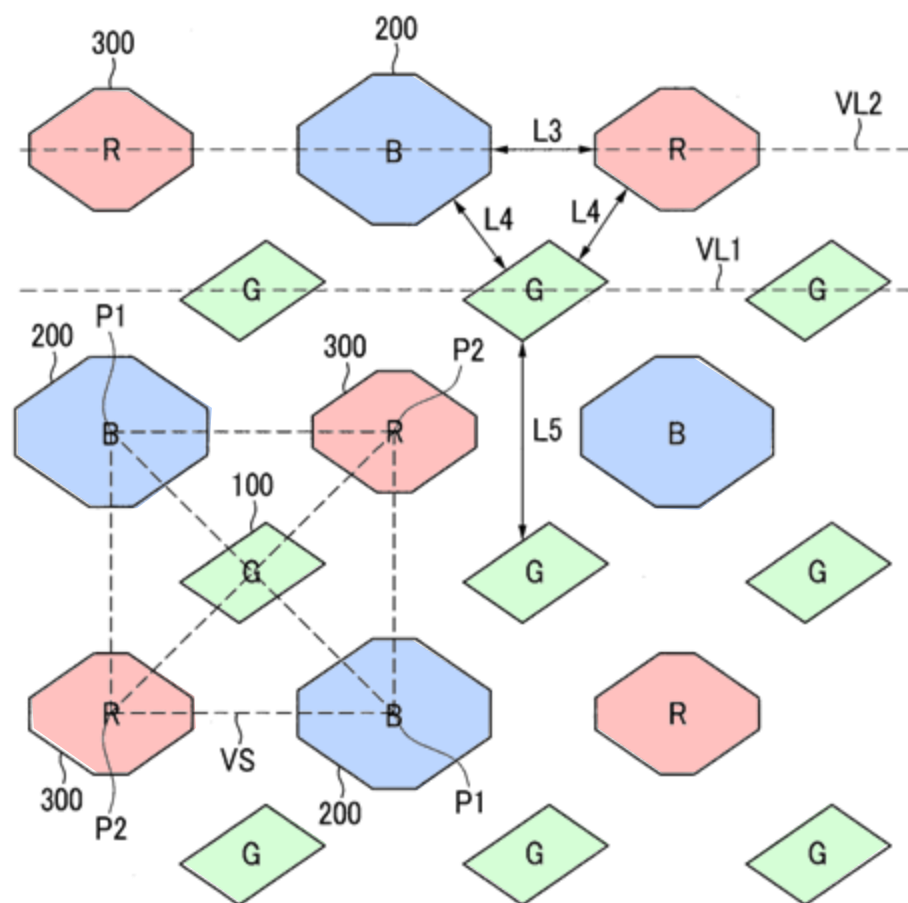
 US009818803B2	
(12) United States Patent Lee	(10) Patent No.: US 9,818,803 B2 (45) Date of Patent: Nov. 14, 2017
(54) PIXEL ARRANGEMENT STRUCTURE FOR ORGANIC LIGHT EMITTING DISPLAY DEVICE	
(75) Inventor: Sang-Shin Lee, Yongin-si (KR)	
(73) Assignee: Samsung Display Co., Ltd., Yongin-si (KR)	
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 199 days.	
(21) Appl. No.: 13/614,197	
(22) Filed: Sep. 13, 2012	
(65) Prior Publication Data US 2013/0234917 A1 Sep. 12, 2013	
(30) Foreign Application Priority Data Mar. 6, 2012 (KR) 10-2012-0022967	
(51) Int. Cl. G09G 3/32 (2016.01) H01L 27/32 (2006.01)	
(52) U.S. Cl. CPC H01L 27/3216 (2013.01); H01L 27/3218 (2013.01)	
(58) Field of Classification Search USPC 345/82, 419 See application file for complete search history.	
(56) References Cited U.S. PATENT DOCUMENTS 6,366,025 B1 4/2002 Yamada 6,867,549 B2 * 3/2005 Cok et al. 315/169.3 6,882,364 B1 4/2005 Inouya et al.	
(57) ABSTRACT A pixel arrangement structure of an OLED display is provided. The pixel arrangement structure includes: a first pixel having a center coinciding with a center of a virtual square; a second pixel separated from the first pixel and having a center at a first vertex of the virtual square; and 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.	
(74) Attorney, Agent, or Firm — Lewis Roca Rothgerber Christie LLP	
(20) Foreign Patent Documents GB 2 437 110 A 10/2007 JP 10-39791 2/1998 (Continued)	
(20) Other Publications EPO Search Report dated Jul. 8, 2013, for corresponding European Patent application 13157562.3, (6 pages). (Continued)	
(21) Claims 21 Claims, 5 Drawing Sheets	
	
Petitioner Ex 1001, p. 1 BOE et al. v. Samsung, IPR2023-00987	

- Claim priority back to the same March 2012 foreign filing
- Share a common specification
- All relate to a “***pixel arrangement structure*** of an organic light emitting diode (OLED display)”

Ex. 1001 (803 Patent), Cover, 1:16-18;
 see also IPR2023-00987, Paper 1 (Petition) at 4-5, 7

'803 Patent – Claim 1

FIG.2



1. A pixel arrangement structure of an organic light emitting diode (OLED) display, comprising:
a plurality of pixels for displaying an image on the OLED display and comprising:
a first pixel having a center coinciding with a center of a virtual square;
a second pixel separated from the first pixel and having a center at a first vertex of the virtual square;
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
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,
wherein the second pixel has a larger area than that of the third pixel, and
wherein the first pixel is configured to emit green light.

Ex. 1001 (803 Patent), Fig. 2, Claim 1;
see also IPR2023-00987, Paper 1 (Petition) at 1, 7

'683 Patent – Claim 1

1. A pixel arrangement structure of an organic light emitting diode (OLED) display comprising:

- a plurality of pixels for displaying an image on the OLED display and comprising:

- a first pixel;

- a pair of second pixels separated from the first pixel, the second pixels being located at opposite sides of the first pixel along a first line on which the first pixel, the second pixels, and another first pixel are consecutively arranged such that the first line passes through respective centers of the first pixel, the second pixels, and the other first pixel; and

- a pair of third pixels separated from the first pixel and the second pixels, the third pixels being located at opposite sides of the first pixel along a second line on which the first pixel, the third pixels, and an additional first pixel are consecutively arranged such that the second line passes through respective centers of the first pixel, the third pixels, and the additional first pixel, the second line crossing the first line at a location of the first pixel,

- wherein a first distance between the second pixels is greater than a second distance between one of the second pixels and a neighboring one of the third pixels, wherein the first pixels are configured to emit green light, which is a color that is different from light emitted by the second pixels and the third pixels, wherein the first pixels are smaller than at least one of the second pixels or the third pixels, and wherein each of the second pixels has a larger area than each of the third pixels.

Ex. 1001 (683 Patent), Claim 1;
see also IPR2023-00988, Paper 1 (Petition) at 1, 6-7.

'578 Patent – Claim 1

1. A pixel arrangement structure of an organic light emitting diode (OLED) display, the pixel arrangement structure comprising a plurality of pixels comprising:

- a plurality of first pixels;
- a plurality of second pixels; and
- a plurality of third pixels,

wherein the OLED display comprises a pixel defining layer defining areas of the first pixels, the second pixels, and the third pixels,

wherein the first pixels, the second pixels, and the third pixels are configured to emit different color lights,

wherein the first pixels are arranged in first sets extending along a first direction to form respective first lines,

wherein the second pixels and the third pixels are alternately arranged in second sets extending along the first direction to form respective second lines parallel to the first lines,

wherein one of the second lines passes through centers of the second pixels and the third pixels in a corresponding one of the second sets and passes between the first pixels in corresponding adjacent ones of the first sets,

wherein the first lines and the second lines are alternately arranged,

wherein the first pixels are also arranged in third sets extending along a second direction that is perpendicular to the first direction to form respective third lines,

wherein the second pixels and the third pixels are also alternately arranged in fourth sets extending along the second direction to form respective fourth lines that are parallel to the third lines,

wherein the third lines and the fourth lines are alternately arranged,

wherein the first pixels and either the second pixels or the third pixels are alternately arranged along a third direction, which crosses the first direction and the second direction,

wherein a region having a width in the second direction that is equal to a width of the first pixels in the second direction, extending parallel to the first direction, and completely overlapping a row of the first pixels extending in the first direction, is entirely offset in the second direction from at least one of the second pixels or the third pixels in at least one of rows of the second pixels and the third pixels adjacent to the row of the first pixels, and

wherein a shortest distance between two nearest ones of the first pixels in one of the first sets is greater than a shortest distance between one of the second pixels and one of the third pixels that are nearest each other in one of the second sets.

Ex. 1001 (578 Patent), Claim 1;

see also IPR2023-01075, Paper 1 (Petition) at 1-2, 7-8

Grounds At Issue

	803 Patent	683 Patent	578 Patent
Matthies + Yamada	Claims 1-5 and 19-21 obvious	Claims 1-2, 4-10, 13, and 15 obvious	Claims 1-6, 10, 12, 17-19, 21-23, 41-42, 44-47, and 52 obvious
Matthies + Yamada + Hong			Claims 40, 43, 45-47, and 51-52 obvious
Phan	Claims 1-4 and 19-21 obvious	Claims 1, 4-10, 13, and 15 obvious	
Phan + Yamada	Claim 5 obvious	Claim 2 obvious	
Murai + Yamada	Claims 1-5 and 19-20 obvious	Claims 1-2, 4-10, 13, and 15 obvious	

IPR2023-00987, Paper 1 (Petition) at 5; IPR2023-00988, Paper 1 (Petition) at 5; IPR2023-01075, Paper 1 (Petition) at 6

Matthies

The present invention concerns electronic display devices and, in particular, large-area display devices which are formed as an array of tiled display devices.

The display 100 is a tiled display in which emissive or reflective elements, on which the image pixels are formed, are built as relatively small arrays on tiles 120 and assembled into a frame to produce the large-area display having a large number of pixel forming elements.

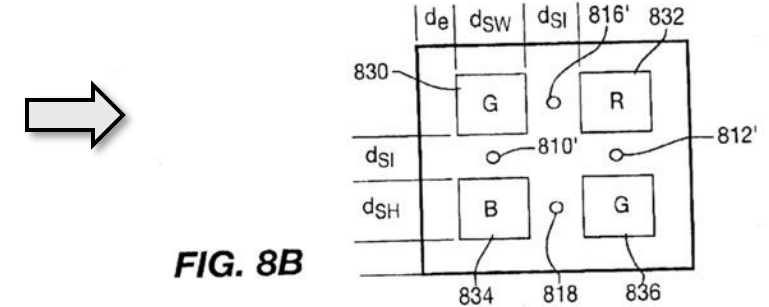
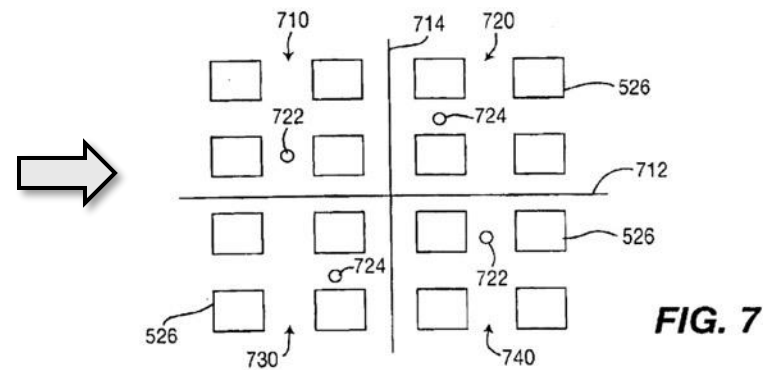
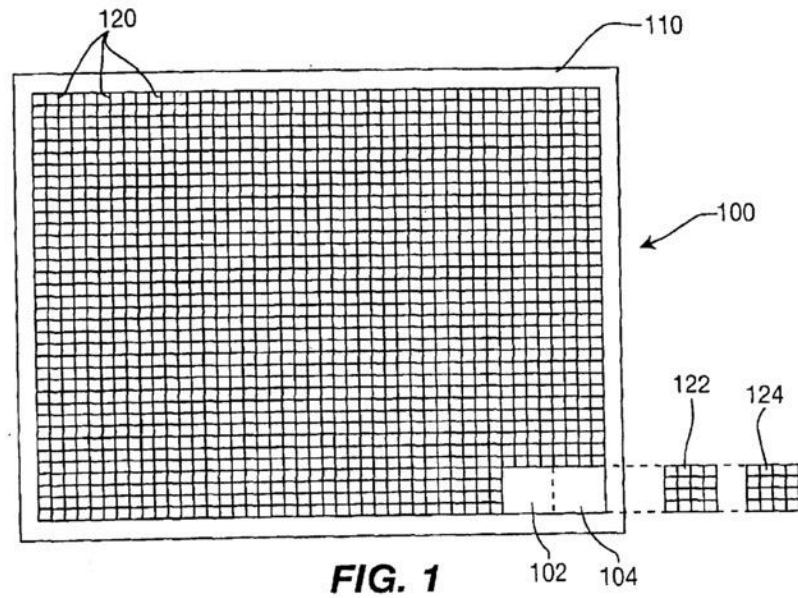
In one exemplary embodiment of the invention, the pixel forming elements are made from an organic light emitting diode (OLED) material. The basic light emitting structure

FIG. 7 is an alternative pixel layout, suitable for use for a tile such as that shown in FIG. 3. In the layout shown in FIG. 7, the active portions 526 of the pixels are centered in their respective pixel regions and the vias which connect the

FIG. 8B illustrates an alternative color pixel structure. This structure includes four sub-pixel elements, 830, 832, 834 and 836. Two of these sub-pixel elements, 830 and 836 emit green light when stimulated while the other two pixel elements, 832 and 834 emit red and blue light, respectively. This structure is known as a quad sub-pixel structure. The

Ex. 1004 (Matthies), 1:8-10, 5:37-55, 6:17-22, 16:62-67;
see also IPR2023-00987, Paper 1 (Petition) at 12-15

Matthies



Ex. 1004 (Matthies), Figs. 1, 7, 8B;
see also IPR2023-00987, Paper 1 (Petition) at 12-15

However, in the EL display apparatus of the related art shown in FIG. 3, emissive regions 1B, 1R, and 1G for the display pixel of the respective color are arranged in a matrix configuration at every intersection of a plurality of the gate signal lines 51 and a plurality of the drain signal lines 53 and all have identical emissive areas in size. Thus, in order to obtain the same luminance at the display pixels having a low emission efficiency, a current larger than that supplied to the other display pixels having a high emission efficiency must be supplied. This causes the life of those display pixels having a low emission efficiency, in particular, to shorten, and also possibly causes the life of the EL display apparatus to shorten.

Furthermore, when the emissive areas of the display pixels of various colors, each having a different emission efficiency, are set to be identical, color balance (white balance) is difficult to achieve, and higher currents must be supplied to certain emissive layers to achieve such a balance. Thus, a drawback is that deterioration occurs at the EL

Ex. 1008 (Yamada), 2:55-3:6;
see also IPR2023-00987, Paper 1 (Petition) at 19, 39-44

It is therefore an object of the present invention, which takes into consideration the above-mentioned disadvantage of the related art, to provide a display apparatus having emissive elements, such as EL elements, in which the control of white balance is simple and the service life is long.

In another aspect of the present invention, the emissive area of the display pixel having the emissive element of a color with the highest emission efficiency, among emissive elements respectively emitting different colors of light for color display, is set smaller than the emissive area of the display pixel having the emissive element of another color.

As shown in FIG. 4, the display pixels for the various colors are arranged in a matrix configuration on the substrate. The emissive areas of the display pixels differ among 1R, 1B, and 1G. Specifically, in the case of FIG. 4, the emissive area of the green display pixel 1G is provided as the smallest. Emissive regions 1R and 1B of the other colors are formed with a larger area than that of emissive region 1G. More specifically in this case: Area of green emissive region $1G < \text{area of red emissive region } 1R < \text{area of blue emissive region } 1B$.

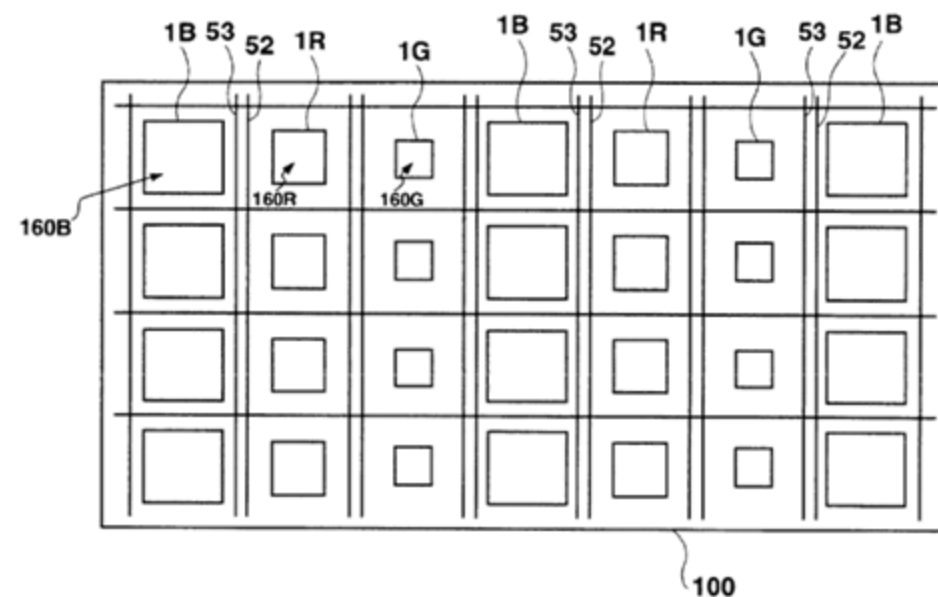
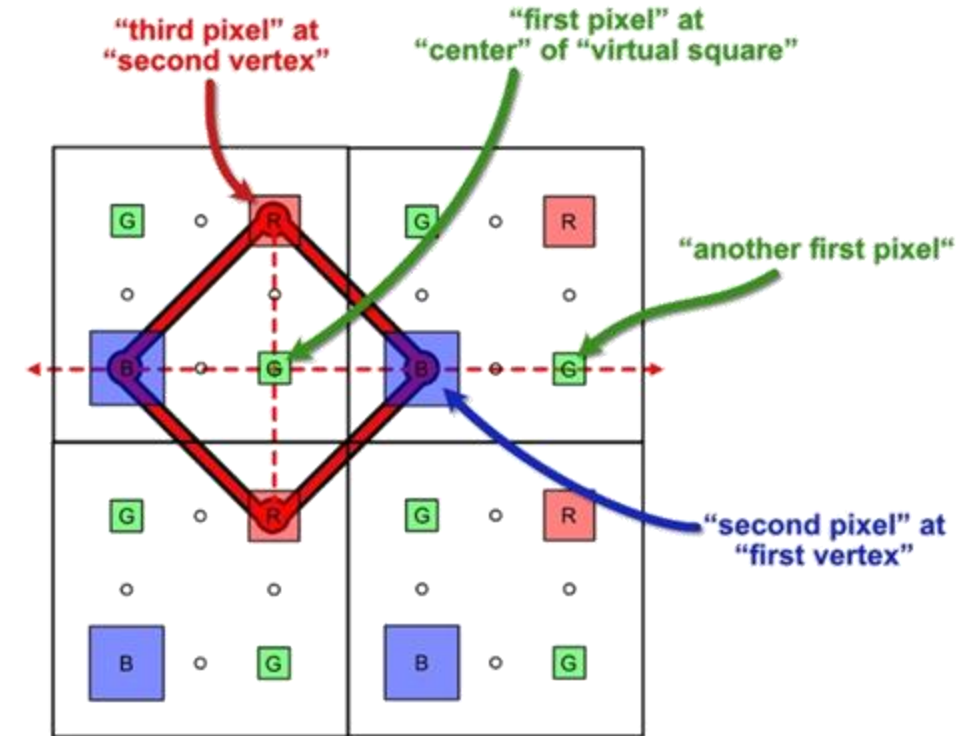
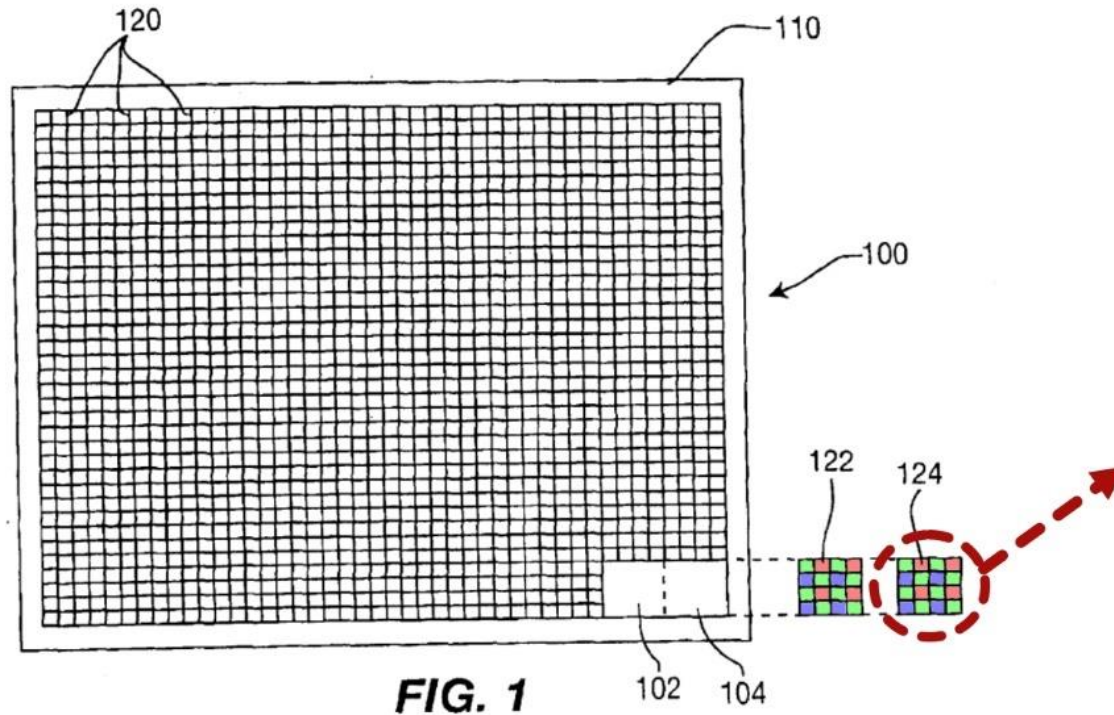


Fig. 4

Ex. 1008 (Yamada), 3:11-16, 3:38-44, 7:3-12, Fig. 4;
see also IPR2023-00987, Paper 1 (Petition) at 19, 39-44.

Application of Matthies / Yamada to Claims



IPR2023-00987, Paper 1 (Petition) at 25-26, 33

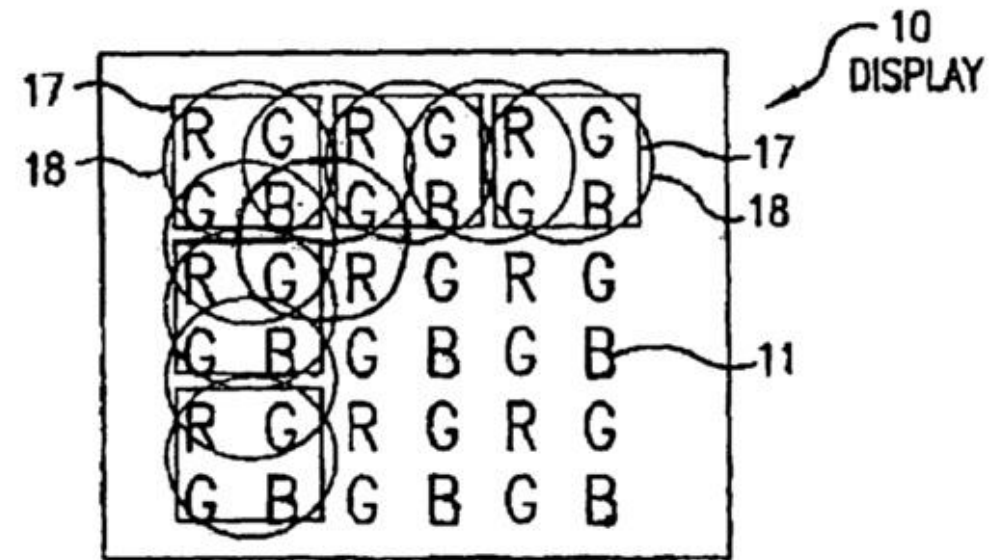
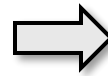
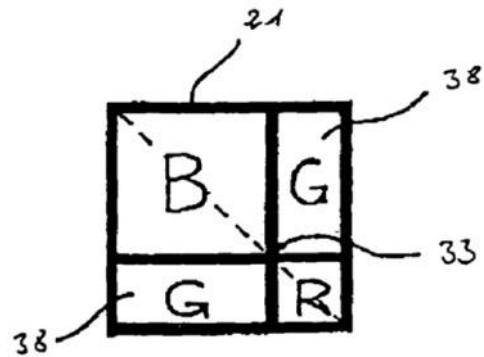
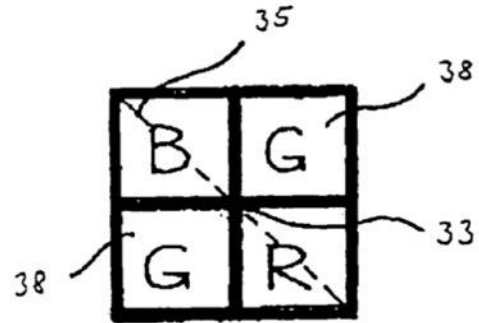
The invention relates to a display comprising pixels and dots, including but not limited to the following display technologies: Cathode Ray Tube (CRT), Field Emission Display (FED), Vacuum Florescent Display (VFD), Plasma Display Panel (PDP), Liquid Crystal Display (LCD), Light Emitting Diode (LED), Organic Light Emitting Diode (OLED), Polymer Light Emitting Diode (PLED), Electroluminescence (EL), Electronic inks, Surface Emitting Display (SED), Digital Light Processing (DLP), Electro-mechanics, Phototronics, Biotronics and any light sources known or invented in the future as well as a method for controlling the (said) display.

As shown in FIGS. 1a to 1c, pixels 12a, 12b and 12c have a square shape. Pixels 12a, 12b and 12c comprise regularly disposed dots 11 radiating the basic colours red (red dot 13), green (green dot 14) and blue (blue dot 15).

FIGS. 2a and 2b show displays 10 and 10a having square static pixels 17. Static pixel 17 corresponds to a well known grid pattern or raster of display 10 or 10a. The dynamic pixels 18 shown in a circular form represent the inventive configuration of display 10 or 10a. Each dynamic pixel 18 comprises three dots 13, 14 and 15 representing the basic colours, as does each static pixel 17.

The dynamic quad pixels comprising common red, green and blue dots overlap each other on a lower resolution screen to give a perception of the higher resolution display. A

Ex. 1005 (Phan), 1:18-29, 2:63-3:18, 4:29-32, 4:41-48;
see also IPR2023-00987, Paper 1 (Petition) at 16-17, 48



Ex. 1005 (Phan), Figs. 2a, 11a-b;
see also IPR2023-00987, Paper 1 (Petition) at 16-17

Application of Phan to Claims

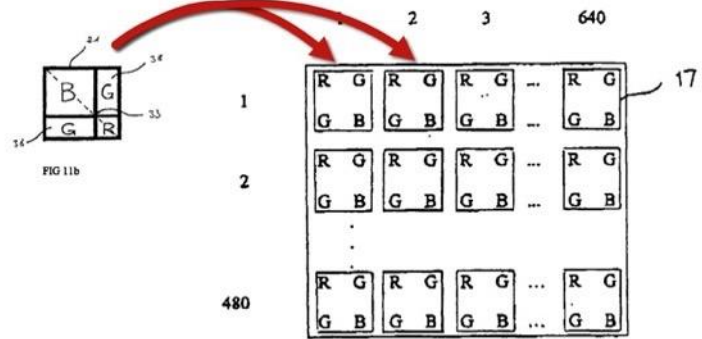


FIG. 12

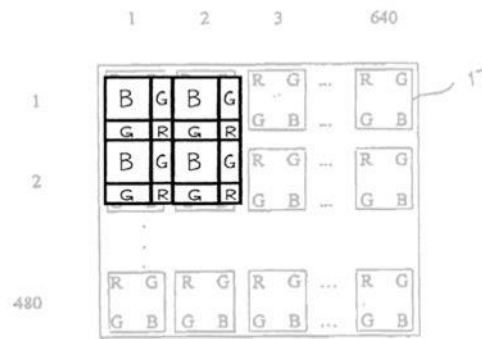
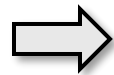
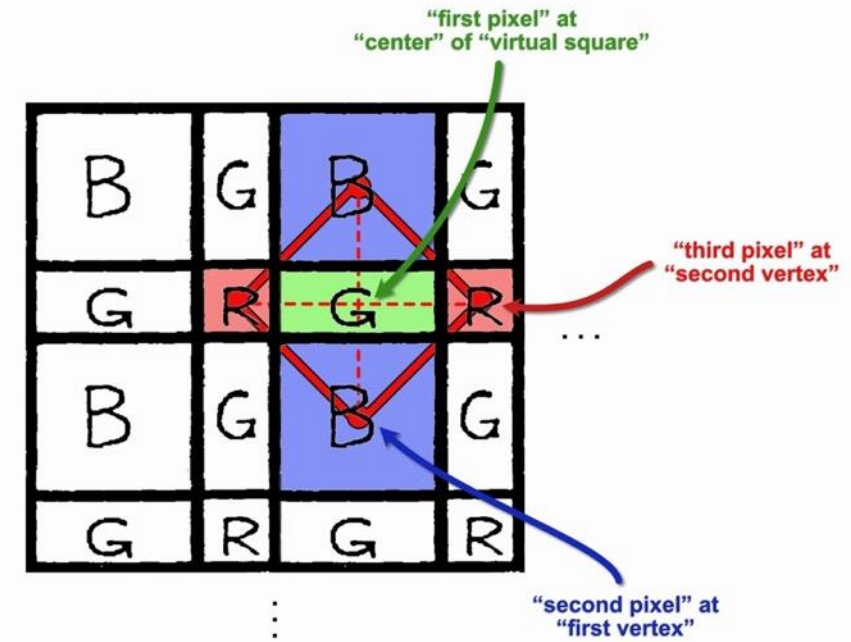
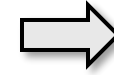
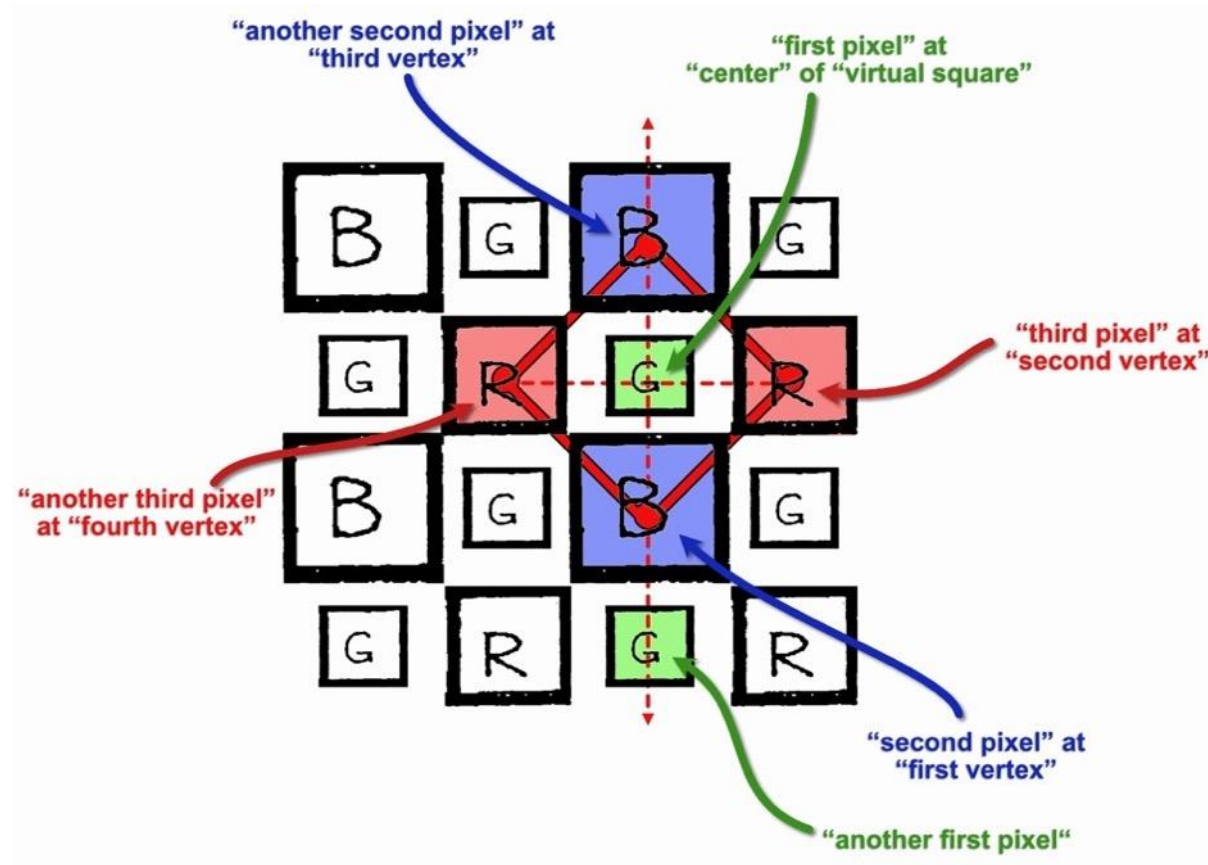


FIG. 12



IPR2023-00987, Paper 1 (Petition) at 48-49, 52-53

Application of Phan / Yamada to the Claims



IPR2023-00987, Paper 1 (Petition) at 61-62

Murai

[0001]

The present invention relates to a color image display device and electronic device.

[0058]

The color image display device according to the present invention can be applied to liquid crystal display devices, organic EL display devices, plasma display devices, projectors, and the like.

[0017]

Furthermore, the first to third dots 11, 12a, 12b, and 13 that configure the unit pixel 10 are respectively rectangular, and have substantially the same shape. It is preferable for the rectangular shape thereof to be a square, but it may also be an oblong rectangle. The four dots (first to third dots 11, 12a, 12b, and 13) that configure the unit pixel 10 are respectively disposed to surround one point, and make up a rectangle made up of four rectangles.

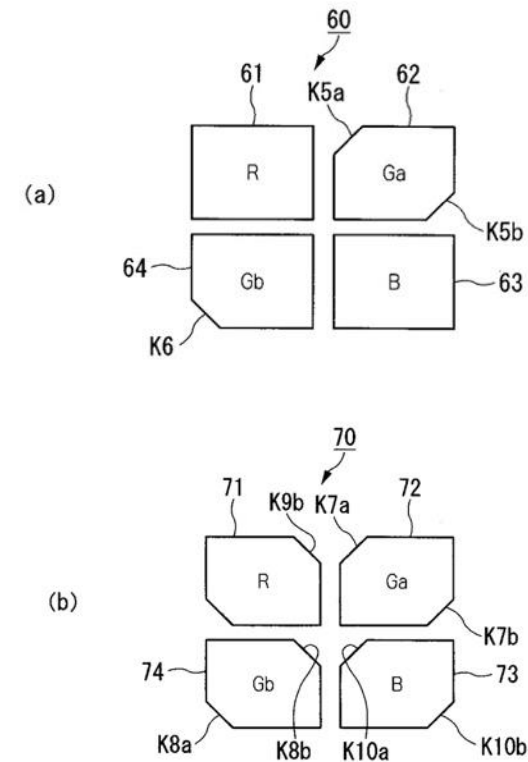
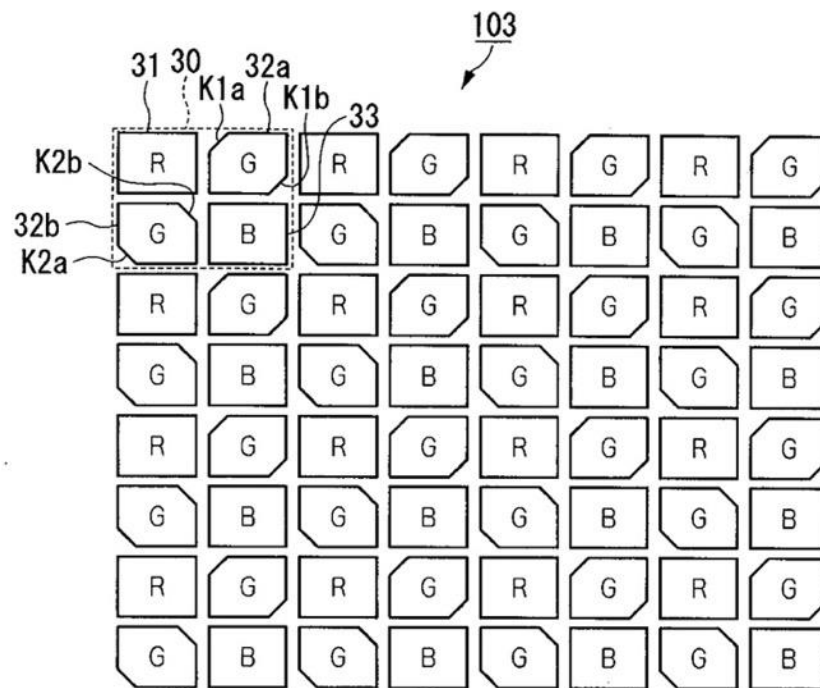
[0011]

Furthermore, it is preferable in the color image display device of the present invention for the first auxiliary dot and the second auxiliary dot to be shaped having cut-off portions wherein at least one corner of the rectangular shape is cut off, and to be disposed so that there is a cut-off portion near a space between the first auxiliary dot and the second auxiliary dot.

According to the present invention, there is a cut-off portion between the first auxiliary dot and the second auxiliary dot disposed to be adjacent on a diagonal line of the rectangle made up by the unit pixel. Thus, in the present invention, the cut-off portions can prevent dots having the same color (or a similar color) from being adjacent in the diagonal direction of the screen. Therefore, the color image display device of the present invention can avoid streaks in the diagonal direction, the vertical direction, and the horizontal direction of the screen, and an image having a higher-quality appearance can be displayed.

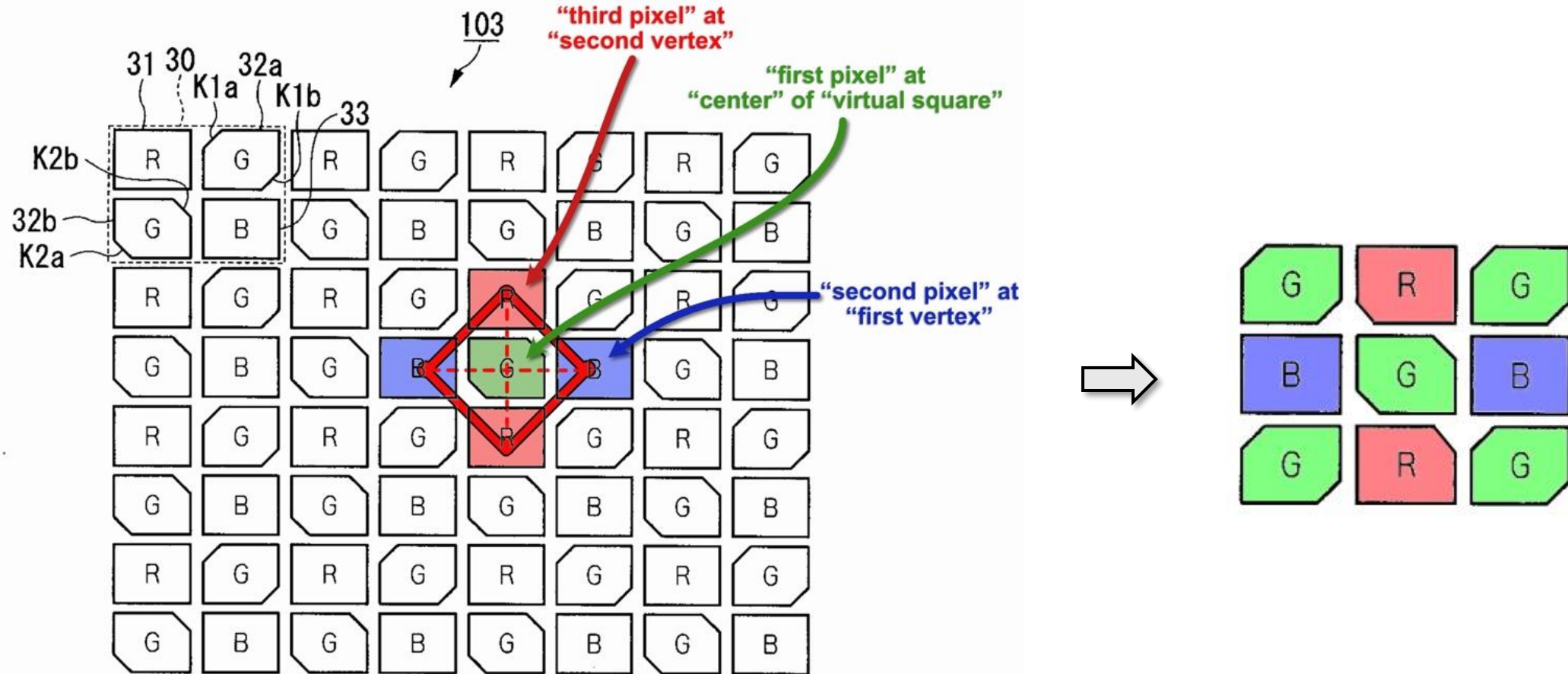
Ex. 1007 (Murai), [0001], [0011], [0017], [0058];
see also IPR2023-00987, Paper 1 (Petition) at 17-18

Murai



Ex. 1007 (Murai), Figs. 3, 6(a), 6(b);
see also IPR2023-00987, Paper 1 (Petition) at 72-73.

Application of Murai / Yamada to Claims



IPR2023-00987, Paper 1 (Petition) at 70-71, 74

Overview of Argument

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Matthies is not limited to passive-matrix displays

Motivation to apply Yamada's teachings

Phan's teaching of OLED display pixel arrangements

Murai's teaching of OLED display pixel arrangements

'578 patent-specific issues

Secondary considerations

Pending motions to strike

Both Active and Passive Matrix OLEDs Were Well-Known

Q. So in paragraph 47 you explain that, quote, "There are two different ways to operate flat panel displays -- active-matrix driving and passive-matrix driving," end quote.

Do you see that?

A. Yes, I see that.

Q. Now, when the '803 patent was filed, were both of those different ways of operating a display known?

A. Yes. Both of those techniques were known at that time.

Q. Was it also known, when the '803 patent was filed, that an OLED display could employ either active-matrix driving or passive-matrix driving?

A. Yes, this was known.

Ex. 1018 (Kymissis Depo), 17:18-18:9;
see also IPR2023-00987, Paper 29 (Reply) at 3-4

The Term OLED Embraces Both PMOLEDs and AMOLEDs

- Q. Okay. So when the term, quote, "OLED display," end quote, is used by itself when the '803 patent was filed, this could be referring to an OLED display that employs active-matrix driving or a display that employs passive-matrix driving; is that right?
- A. That is correct. They would, of course, be different displays, but OLED displays could be architected for either passive-matrix drive or for active-matrix drive.

Ex. 1018 (Kymissis Depo), 18:16-19:2;
see also IPR2023-00987, Paper 29 (Reply) at 12

There Were Also Known Disadvantages to Passive Matrix Displays

119. Further, there were well-recognized shortcomings with PMOLED displays, and well before the time of the invention of the '803 Patent, the industry was shifting away from PMOLED displays to AMOLED displays. PMOLED displays have limited resolution. As discussed above, PMOLED displays require

IPR2023-00987, Ex. 2009 (Kymissis Dec.), ¶ 119

Matthies Only References Passive Addressing as an Example

The exemplary embodiment of the invention employs a passive addressing technique within a block in which only one row of pixels is illuminated at any time. The scanning

Ex. 1004 (Matthies), 10:31-33;
see also IPR2023-00987, Paper 29 (Reply) at 2-3

Matthies Repeatedly References Actively Driven Displays

One exemplary tile structure consists of a multilayer ceramic circuit board **132** that serves as a substrate upon which: the display material is mounted on the viewer side while the **electronics 134 (active and passive) for drive or other functions** are mounted mostly on the back side. Con-

rials. The multiple layers together with the connectors and vias provide the basic function of a circuit board upon which **active and passive electrical devices and circuits** can be placed.

The **electronics which form the image processing and pixel driving circuitry** are mounted on the layers. Electronics are used in the broadest sense to include both active and passive, and both discrete devices mounted on the layers and devices formed in place by processes such as those now used to make active matrix circuits for displays on various high temperature substrates. While these electronics can be placed anywhere, the most convenient location is the back surface. This permits standard assembly and attachment equipment and processes to be used. In addition, the placing of active or passive devices on the intervening layers or viewer surface permits greater flexibility in the system design.

Ex. 1004 (Matthies), 7:15-19, 7:42-45, 8:20-33;
see also IPR2023-00987, Paper 29 (Reply) at 2-3

Dr. Pattison Testified that Matthies Teaches Active Matrix Addressing

Q Now, is it your opinion that one of the things a person having ordinary skill in the art would consider Matthies to be contemplating in the passages we just discussed in Column 7 to Column 8 and the other passages you referenced in your declaration is a display that employs active matrix addressing?

MR. LERNER: Objection to form.

A Yes.

Q So --

A Yes.

Q -- when Matthies uses the terms, quote, active, end quote, and, quote, passive, end quote, a person having ordinary skill in the art would understand Matthies to be referring to more than just individual components and circuits. Correct?

MR. LERNER: Objection to form.

A Correct.

Ex. 2086 (Pattison Reply Depo.), 77:7-78:2

The Art Teaches that the Same Pixel Layout Can Be Implemented as an AMOLED or PMOLED

The present invention relates to organic light emitting diode (OLED) displays, and more particularly, to OLED displays having repeated patterns of colored light emitting elements.

This invention is advantageously practiced with both top-emitting and bottom-emitting OLED active matrix devices. This invention may be used in any OLED device including simple matrix or passive matrix devices.

Ex. 1015 (Cok), 1:7-10, 5:53-56

The present invention relates to a color organic light emitting diode (OLED) display having improved lifetime and to a method of designing such a display.

The present invention can be employed in most OLED device configurations. These include very simple structures comprising a single anode and cathode to more complex devices, such as passive matrix displays comprised of orthogonal arrays of anodes and cathodes to form pixels, and active-matrix displays where each pixel is controlled independently, for example, with a thin film transistor (TFT). For example, the structure described in U.S. Pat. No.

Ex. 2011 (Arnold), 1:8-10, 4:10-17

[0001] The present invention relates generally to a full color display, and more particularly, to an organic light emitting diode display device with arrangements of sub-pixels.

[0009] The display panel further comprises a driving circuit to individually drive the red, green and blue light emission zones of each of the plurality of pixels to emit light of corresponding colors therefrom. In one embodiment, the driving circuit is formed such that the display panel corresponds to one of a passive matrix OLED device and an active matrix OLED device.

Ex. 2021 (Chao), [0001], [0009]

see also IPR2023-00987, Paper 29 (Reply) at 4

'803, '683, and '578 Patents Embrace Both AMOLEDs and PMOLEDs

Q. And there is also no statement in the specification that says that the claims -- or the inventions set forth in this patent are limited to just active-matrix driven displays. True?

A. So there's no limitation to active matrix displays. There is discussion, for example, however, in the specification of the features of an active matrix display if we go, for example, in the background discussion of a gate line, data line, which are features that are in active matrix displays but not passive matrix displays. But I do agree that the patent does not limit itself in that way.

Q. And the specification also does not say anywhere that the claims exclude displays that use passive-matrix driving. Correct?

A. That is correct. The language of the claims does not exclude passive matrix display.

Q. So I think you just agreed. Right? The claims are broad enough to embrace displays regardless of whether they're active-matrix driven or passive-matrix driven. Correct?

A. So, again, I agree that the claim itself does not limit us to an active matrix display.

Ex. 1018 (Kymissis Depo.), 25:20-26:9, 26:10-14, 28:4-9
IPR2023-00987, Paper 29 (Reply) at 4

The Petition Pointed Out that Matthies Teaches AMOLEDs

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.)

IPR2023-00987, Paper 1 (Petition) at 13

Patent Owner Recognized These Teachings in its Preliminary Response

² Although Matthies includes general statements that “[e]lectronics are used in the broadest sense to include both active and passive, and both discrete devices mounted on the layers and devices formed in place by processes such as those now used to make active matrix circuits for displays on various high temperature substrates,” *id.* at 8:21–26, the display structures that it actually depicts (and on which Petitioner relies) are all passive matrix OLEDs.

IPR2023-00987, Paper 9 (Preliminary Response) at 14 n.2

Overview of Argument

Introduction

Matthies is not limited to passive-matrix displays

Motivation to apply Yamada's teachings

Phan's teaching of OLED display pixel arrangements

Murai's teaching of OLED display pixel arrangements

'578 patent-specific issues

Secondary considerations

Pending motions to strike

The *Petition* Identified Numerous Reasons to Apply Yamada's Teachings

- Resized pixels improve overall display life
- Resized pixels allow for easier white balance control
- Applying Yamada produces a simplified display
- Matthies is open to the use of “other” methods to address aging
- Pixel resizing was routine in the art
- Smaller green and red pixels would increase layout design flexibility

IPR2023-00987, Paper 1 (Petition) at 39-43

Patent Owner's Arguments Are Premised on a *Literal* Interpretation of the Petition's Demonstratives

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."

IPR2023-00987, Paper 1 (Petition) at 32

19. As an initial matter, Dr. Kymissis appears to have taken the demonstrative figure from my prior declaration literally. This figure (*see, e.g.*, Ex. 1003, ¶¶ 225-229) was meant to provide an example of how a POSITA would have applied Yamada's teachings to Matthies.

20. A POSITA would of course be able to tailor the sizes of the display's blue, red, and green pixels to achieve any desired balance between display lifetime and brightness.

21. Moreover, a POSITA would have readily recognized that other physical constraints—such as the need for intervening driving circuitry—would also play a role in the appropriate sizing of pixels.

Ex. 1017 (Pattison Reply Dec.), ¶¶ 19-21
see also IPR2023-00987, Paper 29 (Reply) at 7

Yamada *Would* Improve Matthies' Display Life

sive area of the emissive element. By setting the emissive area of the display pixel, namely, the emissive area of the emissive element, in accordance with the emission efficiency of the emissive element as in the foregoing, and by supplying, for example, the same power to the emissive elements of colors having different emission efficiencies, it becomes possible to have the same emission luminance at the various display pixels. In other words, in order to obtain a target display luminance for the respective colors, it is not necessary to supply only the emissive element of a particular color, having low emission efficiency, with a power higher than the other elements. Therefore, even for an emissive element for which deterioration accelerates as the amount of the supplied power increases, it is possible to prevent the deterioration from accelerating when a load is selectively placed on the emissive element having low emission efficiency and extend the life of the display device.

Furthermore, since the emission efficiency of the element is taken into consideration in the emissive area of each emissive element, it is possible to prevent the emissive element having low emission efficiency from deteriorating faster than the element having high emission efficiency.

Therefore, in an EL display apparatus in which the area ratio has been determined by this method, the luminance balance of the various colors is adjusted by the emissive areas so that control of the white balance is extremely simple and the need for supplying large currents only to the EL elements of a particular color is obviated, thereby enabling the service life of the overall display apparatus to be extended.

Ex. 1008 (Yamada), 3:62-4:14, 5:4-7, 11:48-55
see also IPR2023-00987, Paper 1 (Petition) at 39-40
Paper 29 (Reply) at 6

Yamada *Would* Improve Matthies' Display Life

34. Next, in my opinion, Dr. Kymissis is wrong when he argues that the life of Matthies' display would not be improved by reducing the sizes of the red and green pixels as exemplified in my demonstrative. *See, e.g.*, Ex. 2009, ¶ 136.

35. The aging (and life) of the blue pixels is not the only relevant parameter that bears on the life of an OLED display.

36. Among other things, OLED display life is also dictated by how the display's pixels age relative to each other.

37. Showing this, Yamada explains that if increased "load is selectively placed" on a subset of pixels, their "deterioration" is "accelerated" relative to the other pixels. Yamada, 3:62-4:14; *see also* 5:4-8.

38. This not only increases the risk of individual pixel failure, but it also decreases the display's overall "service life" by making it more difficult to maintain color or "white balance." *Id.*, 11:48-55.

39. Similarly, Yamada explains that application of larger currents to certain pixels both "causes the life of those display pixels ... to shorten" and impacts overall "life of the EL display apparatus." *Id.*, 2:64-67.

40. So, resizing OLED pixels in accordance with emission efficiency has two effects. First, it can prevent less efficient blue pixels from failing earlier. Second, it also prevents different pixel aging rates from impacting display usability over time.

Ex. 1017 (Pattison Decl.), ¶¶ 34-40
see also IPR2023-00987, Paper 29 (Reply) at 6-7

Other Prior Art ***Confirms*** that Resizing Pixels Improves Display Life

To maintain a well-balanced, full color display, it is important that the relative luminance of the three-colored materials be maintained throughout the lifetime of the display. If these relative luminance values change dramatically, images may have a serious color imbalance, and the user is likely to become dissatisfied with the display and consider the display to be at the end of its life. Some

three colors. To maximize the useful lifetime of the display, it is important to maximize the time that the relative luminance of the three-color elements can be maintained while minimizing the loss of absolute luminance.

Ex. 2011 (Arnold), 1:50-56, 2:1-4

In operation, over time, the light emitting pixel elements in the display age. Since the relative sizes of the light emitting elements are proportional to the rate at which their materials age and to their relative efficiencies, the light emitting elements will age at approximately the same rate, thus improving the lifetime of the device. Additionally, since the relative spatial frequencies of the light emitting elements occur in proportion to the human visual response for different colors, the apparent spatial resolution of the display device is improved while improving the lifetime of the display. Because the differently colored light emitting elements age at approximately the same rate, the color shift experienced by prior-art OLED display devices will not occur in OLED display devices of the present invention.

Ex. 1015 (Cok), 4:32-45

see also IPR2023-00987, Paper 29 (Reply) at 6-7

Yamada Would **Also** Improve Matthies' Display In Other Ways

In the color display device having emissive elements, the target white that is set can be represented, for example, by the addition of the lights of R, G, and B. In this sort of device, by setting the emissive area of each display pixel in accordance with the emission efficiency of the emissive element of each color R, G, and B as described above, with the chromaticity of the R, G, and B emitted by the respective emissive element, and with the chromaticity of target display white, for example, the display of a target white is simplified with the supply of the same amount of power to each emissive element of R, G, and B. In other words, the white balance is controlled by the emissive area of each emissive element so that the white balance, while these emissive elements are driven, becomes extremely easy to control.

Ex. 1008 (Yamada), 4:57-5:3

see also IPR2023-00987, Paper 1 (Petition) at 39-40

Paper 29 (Reply) at 5

The Petition *DID* Point to Easier White Balance Control As a Motivation

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.)

IPR2023-00987, Paper 1 (Petition) at 40

Resized Pixels Reduce the Need for Additional Components to Address Aging

The tile may also include circuitry which automatically adjusts the pixel brightness to compensate for aging of the display material. This circuitry may, for example, allow a viewer to display a predetermined brightness value, select an individual tile and adjust the brightness value up or down to match the brightness of the selected tile to match its neighbors. Alternatively, the tile may include a small light sensor over one or more pixel positions which continually monitors the brightness of that pixel and adjusts the current level applied to that pixel—and the current levels applied to all of the other pixels on the display—to compensate for variations in pixel brightness due to aging of the display. To minimize the visibility of the light sensor, it may be placed away from the active pixel area so that it is responsive to scattered light.

Alternatively, the circuitry 134 may include an all electronic compensation system which continually adjusts the brightness of individual pixels to compensate for aging. The

Ex. 1004 (Matthies), 11:47-63
IPR2023-00987, Paper 1 (Petition) at 41-42

Matthies Already Contemplates the Use of “Other” Methods to Address Aging

While specific examples have been given, it is contemplated that any of these methods for adjusting the current applied to a pixel in order to maintain a predetermined brightness level may be combined with any other method either as a check or to augment the performance of the other method.

Ex. 1004 (Matthies), 12:41-47;
see also IPR2023-00987, Paper 1 (Petition) at 42

Patent Owner's Other Points of Distinction Lack Merit

- X A POSITA would not have limited themselves to just striped pixel arrangements
- X A POSITA would not have limited themselves to the use of 2 blue pixels
- X Aperture ratio is not the only relevant design consideration
- X Chromaticity is just another factor among many that can be considered when sizing pixels
- X No art teaches away from the use of Matthies
- X Resizing Matthies' pixels does not run afoul of any design constraints

IPR2023-00987, Paper 29 (Reply) at 8-12

Quad Sub-Pixels Were Known to Be Advantageous Compared to Striped Arrangements

[0006] Improvements over the basic arrangement shown in FIG. 1 have been suggested, such as the arrangements disclosed in US 2003/0117423, WO 03/060870 and 2004/0080479. These “checkerboard” arrangements are adapted to provide better visual performance when compared to the standard arrangement shown in FIG. 1. An example is shown

Ex. 1011 (Smith), [0006]

space increments. Conventional display methods also use a single color in a vertical stripe. Since conventional stripes have limited the Modulation Transfer Function (MTF), high spatial frequency resolution, in the horizontal axis, stripes of a single color are non-optimal.

Ex. 1012 (Brown Elliot), 2:18-21

Recently, a quadruple type pixel has been introduced to improve the efficiency of the OLED. Improvement of an

Ex. 2012 (Yoo), 2:5-6

see also IPR2023-00987, Paper 29 (Reply) at 8-9

Both Matthies and Other Prior Art Highlight Benefits of More Green Sub-Pixels

FIG. 8B illustrates an alternative color pixel structure. This structure includes four sub-pixel elements, **830**, **832**, **834** and **836**. Two of these sub-pixel elements, **830** and **836** emit green light when stimulated while the other two pixel elements, **832** and **834** emit red and blue light, respectively. This structure is known as a quad sub-pixel structure. The structure uses two green sub-pixels because more of the luminance information in a color display is in the green pixels than is in either of the red or blue pixels. Thus, the use of two green sub-pixels allows for a brighter display.

Ex. 1004 (Matthies), 16:62-17:4

patterns are repeated within the OLED display device. Since the human visual frequency response is more sensitive to green and less sensitive to red and blue, a display will appear to have a resolution equal to the frequency of green light emitting elements. Thus by providing more green light emitting elements in the patterns, the apparent resolution of the display can be improved.

Ex. 1015 (Cok), 3:5-11

see also IPR2023-00987, Paper 29 (Reply) at 9

“It is not decisive ... whether or not there are other ways to improve” on the prior art.

Volvo Penta of the Am. v. Brunswick Corp,
81 F.4th 1202, 1209 (Fed. Cir. 2023);

see also IPR2023-00987, Paper 29 (Reply) at 9

Display Aperture Ratio Is Just One Factor Among Others to Be Balanced

mask such as a fine metal mask (FMM). When reducing a gap between the neighboring pixels to obtain a high aperture ratio of the pixel, deposition reliability may be deteriorated.

Ex. 1001 (803 Patent), 1:40-43

to achieve the same display brightness). When the resolution is high, it is hard to ensure the aperture ratio of sub-pixel, which may influence on the characteristics of the products, such as lifetime, brightness and the like, consequently.

Ex. 2015 (Wang), 2:3-6

see also IPR2023-00987, Paper 29 (Reply) at 9-10

Chromaticity Is Simply Another Factor Balanced When Sizing Pixels

If the materials to be used are different, the chromaticity coordinate values of the R, G, and B lights emitted from the organic EL elements are also different. The luminance ratio of R to G to B also changes accordingly, and the emission efficiency values also change. The emissive area ratio is determined accordingly and is therefore not limited to the values given above.

Ex 1008 (Yamada), 11:56-62

see also IPR2023-00987, Paper 29 (Reply) at 10

The Other Art Patent Owner Cites ***Further Confirms*** that Pixels Should Be Relatively Resized

The need is met according to the present invention by providing an OLED color display device, in which a display pixel has a plurality of subpixels of different colors, wherein the areas of the subpixels are different in size based on the emission efficiency of the emissive elements, the chromaticity of a target display white point, and the relative luminance stability over time of the subpixels, thereby extending the useful lifetime of the display.

Ex. 2011 (Arnold), 2:50-57

The need is met by providing an OLED display device for displaying a color image that includes an array of different colored independently controllable light emitting elements arranged in repeated patterns, a number of light emitting elements of at least one color in each pattern being different than a number of light emitting elements of a different color and the different number of light emitting elements of the different colors being a function of a relative human visual frequency response to the colors, and a relative size of light emitting elements of different colors being a function of a lifetime of the light emitting elements, an efficiency of the light emitting elements, and the number of light emitting elements of the different colors in the pattern, wherein at least one of the lifetime, and the efficiency is different for different colors.

Ex. 1015 (Cok), 2:15-28

see also IPR2023-00987, Paper 29 (Reply) at 11

Resizing Matthies' Pixels Does Not Run Afoul of Any Design Constraints

While FIGS. 8A and 8B show the distances d_c and d_{sr} as being equal in the horizontal and vertical directions, it is contemplated that these values may be different. The exemplary pixel structures shown in FIGS. 8A and 8B both have active pixel areas covering approximately 25 percent of the pixel area to produce a pixel aperture of approximately 25 percent. This value is exemplary only. The invention contemplates both larger and smaller pixel apertures.

Other tile configurations are contemplated by the subject invention. One desirable configuration is a tile which

display. The different tiles may also employ different pixel pitches such that the tiles on the sides of the display may have a relatively large pixel pitch while the tiles near the center of the display have a relatively small pixel pitch.

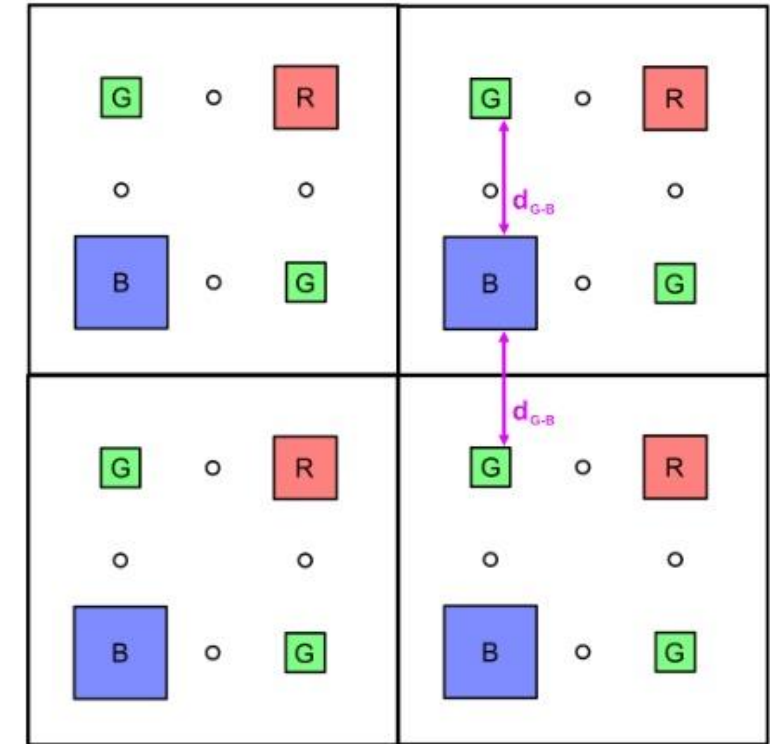
Ex 1004 (Matthies), 17:31-37, 18:63-64, 19:8-12
see also IPR2023-00987, Paper 29 (Reply) at 11

Resizing Matthies' Pixels Does Not Run Afoul of Any Design Constraints

The tiles are constructed with pixel forming elements evenly spaced up to the edges of the tiles. As described below with reference to FIGS. 15 through 19, the tiles are formed such that, when they are joined, 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. The display shown in FIG. 1 is missing two

The edges of the tiles are desirably carefully formed to ensure that the tiled display has no visible seams between the tiles. One criterion for the tiles is that the spacing between the pixels separated by the tile seam is the same as the spacing of pixels on the tile. To satisfy this criterion, the tile

Ex 1004 (Matthies), 5:47-53, 8:39-41



Ex 1017 (Pattison Reply Decl.), ¶ 59

see also IPR2023-00987, Paper 29 (Reply) at 11-12

Overview of Argument

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Phan's teaching of OLED display pixel arrangements

Murai's teaching of OLED display pixel arrangements

'578 patent-specific issues

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Pending motions to strike

Phan Teaches Pixel Arrangements for *OLED Displays*

The invention relates to a display comprising pixels and dots, including but not limited to the following display technologies: Cathode Ray Tube (CRT), Field Emission Display (FED), Vacuum Florescent Display (VFD), Plasma Display Panel (PDP), Liquid Crystal Display (LCD), Light Emitting Diode (LED), Organic Light Emitting Diode (OLED), Polymer Light Emitting Diode (PLED), Electroluminescence (EL), Electronic inks, Surface Emitting Display (SED), Digital Light Processing (DLP), Electro-mechanics, Phototronics, Biotronics and any light sources known or invented in the future as well as a method for controlling the (said) display.

Ex. 1005 (Phan), 1:18-29;
see also IPR2023-00987, Paper 1 (Petition) at 16-17, 48

Other Prior Art Confirms that Phan's Pixels Are Intended for OLEDs

Phan:

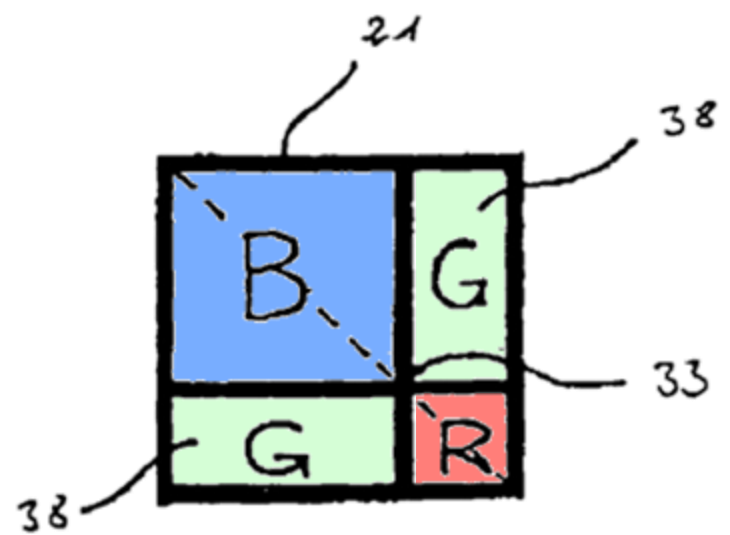
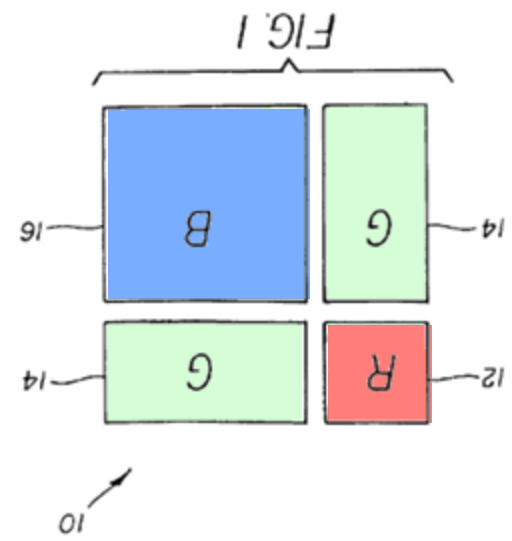


FIG 11b

Ex. 1005 (Phan), Fig. 11b

Other Prior Art:



The present invention is useful for both top-emitting OLED display devices (those that emit light through a cover placed above a substrate on which the OLED is constructed) and bottom-emitting OLED display devices (those that emit light through the substrate on which the OLED is constructed). It is also useful for passive-matrix or active-matrix devices.

Referring to FIG. 1, a pixel pattern 10 in an OLED display device according to one embodiment of the present invention includes two green light emitting elements 14 having a first size (area), a red light emitting element 12 having a second smaller size, and a blue light emitting element 16 having a larger size. The relative sizes of the pixel elements are determined as described above with respect to equation (1).

Ex. 1015 (Cok), Fig. 1, 2:61-67, 4-8-15

see also IPR2023-00987, Paper 29 (Reply) at 12-13

Phan's Colored Dots *Are* Arranged in a “Virtual Square”

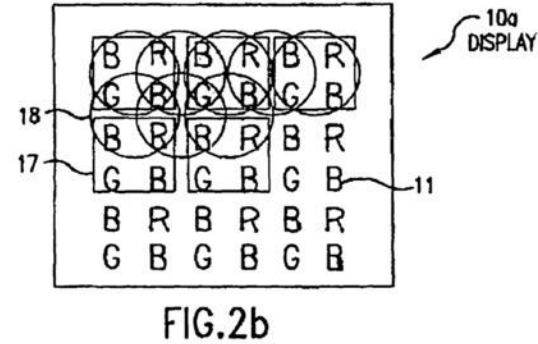
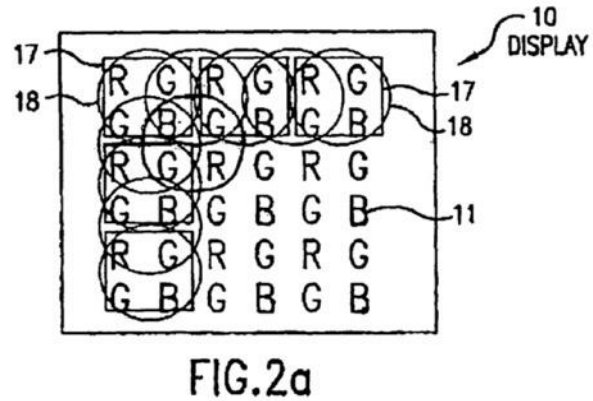
It is the object of the present invention to provide a display of the aforesaid kind which has a higher optical resolution for a given grid.

FIGS. 2*a* and 2*b* show displays 10 and 10*a* having square static pixels 17. Static pixel 17 corresponds to a well known grid pattern or raster of display 10 or 10*a*. The dynamic pixels 18 shown in a circular form represent the inventive configuration of display 10 or 10*a*. Each dynamic pixel 18 comprises three dots 13, 14 and 15 representing the basic colours, as does each static pixel 17.

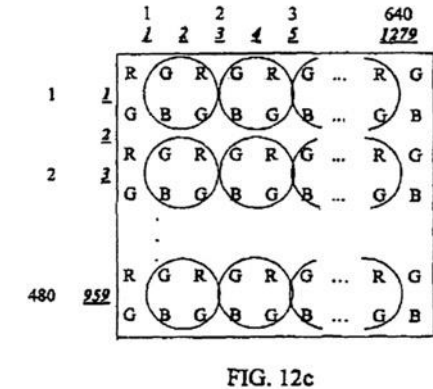
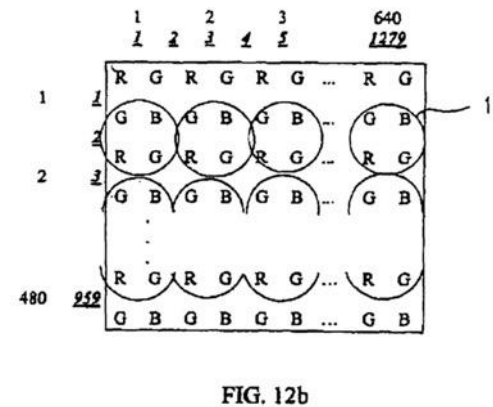
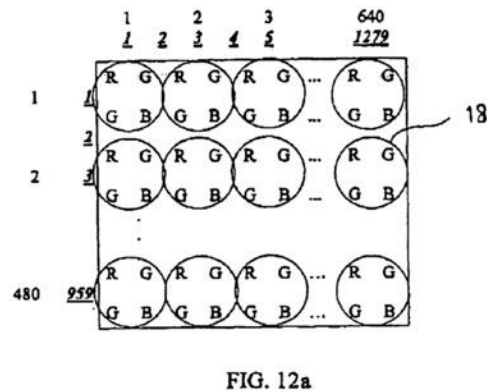
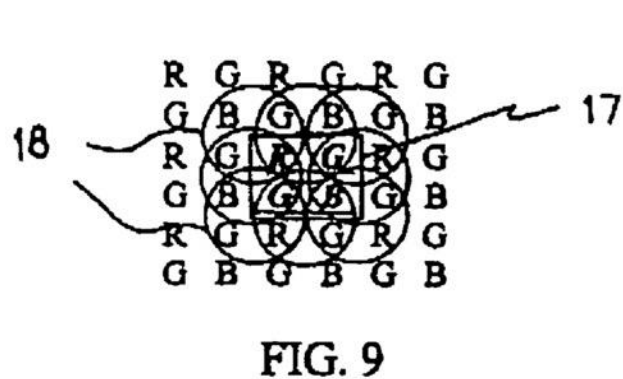
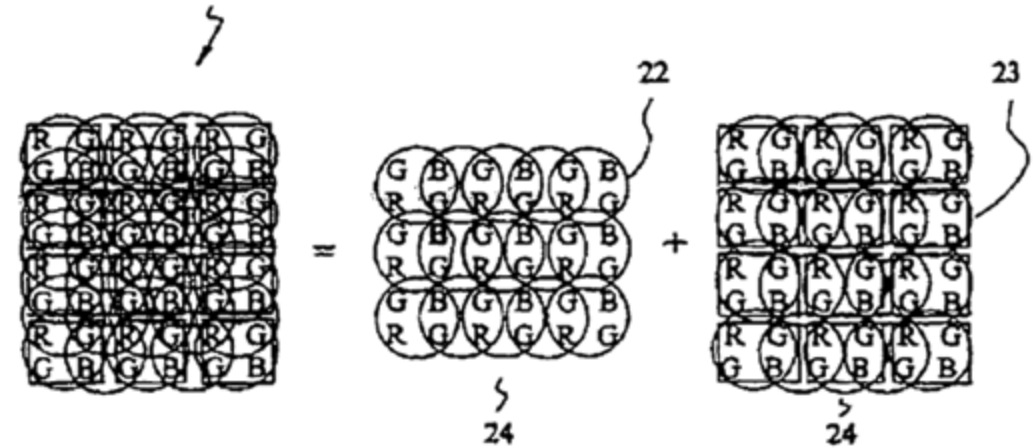
In contrast to static pixels 17, the dynamic pixels 17 overlap; they should not overly each other completely,

Ex. 1005 (Phan), 2:51-53, 4:41-49;
see also IPR2023-00987, Paper 1 (Petition) at 49-50;
Paper 29 (Reply) at 13

Phan's Dots Are Equally Spaced in *All* of Its Figures



10 DISPLAY with 12a PIXEL



Ex. 1005 (Phan), Figs. 2a, 2b, 7, 9, 12a-12c;
see also IPR2023-00987, Paper 29 (Reply) at 13

Patent Owner's Inconsistent Treatment of Phan's Figures

1

Phan actually says “each quad pixel group as well as of its individual elements are preferable in the form of *rectangle* or square,” Phan, 7:63-65, and depicts spacing between quad-pixels in Figure 12. Phan does not teach quad pixels must have *no space* between them.

2

Petitioner asserts Phan's figures show “regularly” or “evenly spaced” dots. Reply, 13-14. Phan does not describe its figures as drawn to scale. *Hockerson-*

IPR2023-00987, Paper 31 (Patent Owner Sur-Reply) at 18

Patent Owner's Interpretation of Phan Creates *Differently Sized* Dynamic Pixels

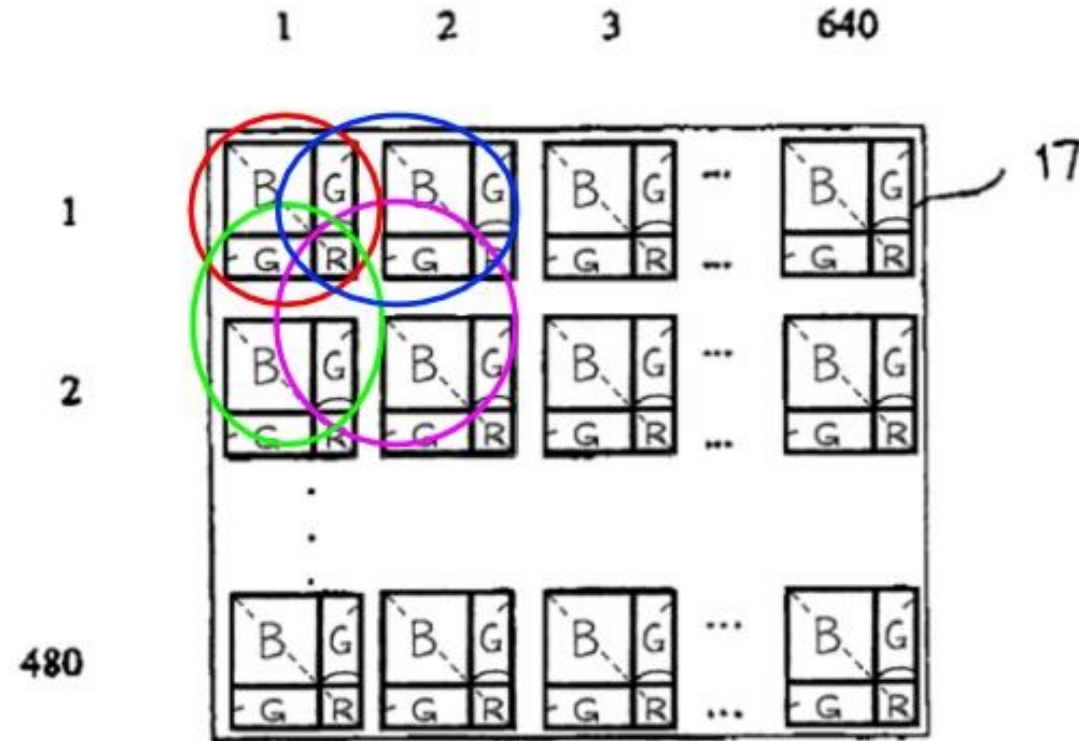


FIG. 12

Ex.1017 (Pattison Reply Decl.), ¶ 71;
see also IPR2023-00987, Paper 29 (Reply) at 15

Patent Owner's Interpretation Negates the Purpose of Phan's Dynamic Pixels

It is the object of the present invention to provide a display of the aforesaid kind which has a higher optical resolution for a given grid.

The above object is achieved by a variable generation of pixels from existing dots, said pixels forming a dynamically generated logical unit by grouping adjacent dots so that adjacent pixels are physically superimposed. In the process, said generation of the dynamic pixels takes place at a rate high enough not to be perceivable by the human eye.

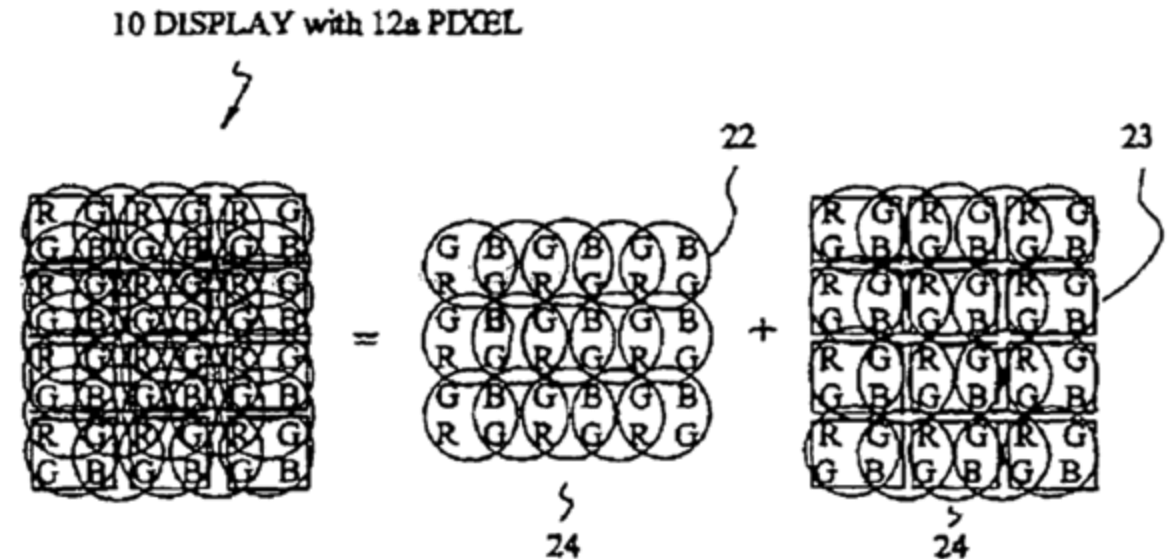


FIG. 7

Ex. 1005 (Phan), 2:51-59; Fig. 7
see *also* IPR2023-00987, Paper 29 (Reply) at 14-15

Patent Owner's Expert Agreed that OLED Pixels Should All Have the Same Size

Q. Is that a standard way to form a display, by repeating the same unit pixel again and again and again across the display?

A. Yes, it is.

Q. And that's also the case for an OLED display. As a general matter, the pixels are generally the same across the display; is that true?

A. So for the displays that we're speaking about, the pixels are the same size across the display.

Ex.1018 (Kymissis Depo.), 105:9-12; 16:2-6
see also IPR2023-00987, Paper 29 (Reply) at 15

Phan Is Not Incompatible With Yamada's Teachings

contrast between the dynamic pixels 18. The precise arrangement of the various colour dots 13, 14, 15 is not critical; care should be taken, however, that the arrangement of the different dots 13, 14, and 15 should be identical in each static pixel 17 within a display 10.

The dynamic pixels 18 should preferably be formed to comprise the same number of dots 11. The spatial arrangement of the different colour dots 13, 14, 15 is not critical.

dynamic pixels 18. Other pixel shapes are contemplated.

It is another objective of the present invention to adjust the light emitting area and space of different individual elements in a pixel contoured by black mask or barrier ribs of the same structure to optimize the luminance and the brightness of a display.

Ex.1005 (Phan), 4:37-40, 5:3-5, 5:32, 1:30-34
see also IPR2023-00987, Paper 29 (Reply) at 16-17

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Murai Teaches Pixel Arrangements for *OLED Displays*

[0058]

The color image display device according to the present invention can be applied to liquid crystal display devices, organic EL display devices, plasma display devices, projectors, and the like.

Ex. 1007 (Murai), [0058];
see also IPR2023-00987, Paper 1 (Petition) at 65

Murai's Dots *Are* Arranged in a “Virtual Square”

Furthermore, in the color image display device of the present invention, the unit pixel is configured by four dots, and the four dots that make up the unit pixel are disposed to surround one point and make up a rectangle made up of four rectangles. It is preferable for the four respective dots that make up the unit pixel to be rectangular and to be the same or substantially the same shape.

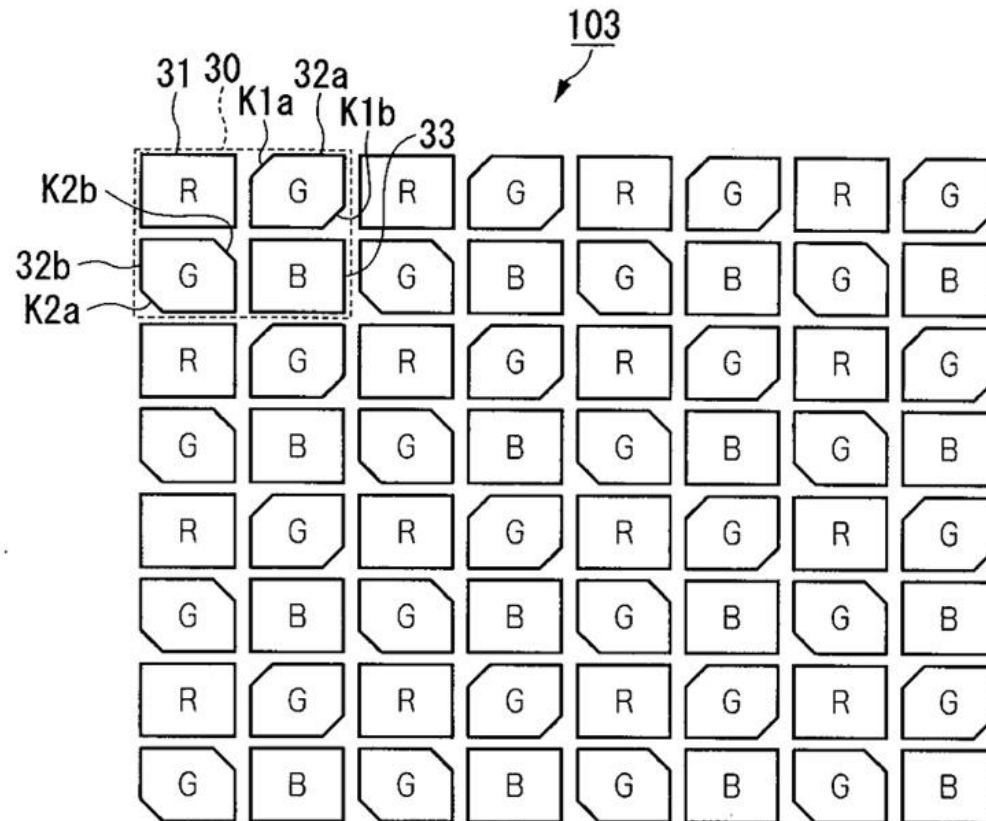
According to the present invention, the unit pixel is configured using four dots disposed in a rectangle made up of four rectangles, so each unit pixel can easily and accurately be regularly disposed, and the aperture ratio can be easily improved. Additionally, according to the present invention, two dots of the same color are disposed on

Furthermore, the first to third dots 11, 12a, 12b, and 13 that configure the unit pixel 10 are respectively rectangular, and have substantially the same shape. It is preferable for the rectangular shape thereof to be a square, but it may also be an oblong rectangle. The four dots (first to third dots 11, 12a, 12b, and 13) that configure the unit pixel 10 are respectively disposed to surround one point, and make up a rectangle made up of four rectangles.

FIG. 2 is a plane view illustrating dot shape and dot arrangement in a color image display device according to the second embodiment of the present invention. Similar to the color image display device 101 in the first embodiment, a color image display device 102 of the present embodiment has unit pixels 20 made up of four dots disposed as a grid in the vertical and horizontal direction. However, the unit pixels 20 are different than the unit pixels 10 in the first embodiment in that the four dots that configure it display respectively different colors.

Ex. 1007 (Murai), [0010], [0017], [0020];
see also IPR2023-00987, Paper 1 (Petition) at 66-68;
Paper 29 (Reply) at 17-18

Murai's Dots *Are* Arranged in a “Virtual Square”



Ex. 1007 (Murai), Fig. 3;
see also IPR2023-00987, Paper 1 (Petition) at 66-68

Patent Owner's Addition of Unnecessary Space Between Murai's Pixels is Unwarranted

[0042]

Furthermore, in FIG. 3 and FIG. 4, a TFT for driving each dot, an electrode of a holding capacitor, or the like may be disposed on parts that oppose the outline of the cut-off portions K1a, K1b, K2a, and K2b (region of the cut-off corners). Thus, all regions of the screen, including regions of the cut-off corners, can be effectively utilized, for example, the shape of the pixel electrode and the shape of the pixel of the color filter can be made to be similar, and the overall aperture ratio can be improved.

Ex. 1007 (Murai), [0042]
see also IPR2023-00987, Paper 29 (Reply) at 18-19

Murai Already Allows For Variably Sized Pixels

Differently sized cut-outs:

rectangle made up of four rectangles. Moreover, in the color image display device of the present invention, on the first auxiliary dot and the second auxiliary dot, the cut-off portion disposed near a center of the rectangle made up of four rectangles may have a smaller shape than the cut-off portion disposed near an outer edge of the rectangle made up of four rectangles.

The dot 52 is a second modified example of a cut-off portion. The dot 52 is shaped having cut-off portions K4a and K4b on a corner of a diagonal of a rectangular shape. The outline of the cut-off portions K4a and K4b are configured by a straight line, but the cut-off portion K4a has a shape being more cut off than the cut-off portion K4b. Here, the cut-off portion K4b may have a shape being more cut off than the cut-off portion K4a.

Furthermore, FIG. 6(a) is configured so that no cut-off portions are provided on the diagonal of the cut-off portion K6 on the dot 64, but it is also possible to configure so that a cut-off portion smaller than the cut-off portion K6 is provided on the diagonal of the cut-off portion K6 on the dot 64. Even in such a configuration,

Different cut-out numbers and locations:

FIG. 6(b) illustrates a unit pixel 70 of a color image display device of a second example in the present embodiment. The difference between the unit pixel 70 of the present embodiment and the unit pixels 30 and 40 in FIG. 3 and FIG. 4 is that there are respective cut-off portions on the four dots 71, 72, 73, and 74 that configure the unit pixel 70.

As such, in the present embodiment, the four dots 71, 72, 73, and 74 disposed in a rectangle made up of four rectangles in the unit pixel 70 have two respective cut-off portions. However, when comparing the dot 71 and the dot 73, and the dot 72 and the dot 74 disposed on a diagonal in the unit pixel 70, the positions on which the cut-off portions are provided on each dot differ. That is, a cut-off portion is provided on the top right corner and

Ex. 1007 (Murai), [0013], [0039], [0048]-[0052]

see also IPR2023-00987, Paper 1 (Petition) at 71-72; Paper 29 (Reply) at 19-20

Overview of Argument

Introduction

Matthies is not limited to passive-matrix displays

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Phan's teaching of OLED display pixel arrangements

Murai's teaching of OLED display pixel arrangements

'578 patent-specific issues

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Pending motions to strike

'578 Patent – Claim 1

1. A pixel arrangement structure of an organic light emitting diode (OLED) display, the pixel arrangement structure comprising a plurality of pixels comprising:

a plurality of first pixels;
a plurality of second pixels; and
a plurality of third pixels,

wherein the OLED display comprises a pixel defining layer defining areas of the first pixels, the second pixels, and the third pixels,

wherein the first pixels, the second pixels, and the third pixels are configured to emit different color lights, wherein the first pixels are arranged in first sets extending along a first direction to form respective first lines, wherein the second pixels and the third pixels are alternately arranged in second sets extending along the first direction to form respective second lines parallel to the first lines,

wherein one of the second lines passes through centers of the second pixels and the third pixels in a corresponding one of the second sets and passes between the first pixels in corresponding adjacent ones of the first sets, wherein the first lines and the second lines are alternately arranged,

wherein the first pixels are also arranged in third sets extending along a second direction that is perpendicular to the first direction to form respective third lines,

wherein the second pixels and the third pixels are also alternately arranged in fourth sets extending along the second direction to form respective fourth lines that are parallel to the third lines,

wherein the third lines and the fourth lines are alternately arranged,

wherein the first pixels and either the second pixels or the third pixels are alternately arranged along a third direction, which crosses the first direction and the second direction,

wherein a region having a width in the second direction that is equal to a width of the first pixels in the second direction, extending parallel to the first direction, and completely overlapping a row of the first pixels extending in the first direction, is entirely offset in the second direction from at least one of the second pixels or the third pixels in at least one of rows of the second pixels and the third pixels adjacent to the row of the first pixels, and

wherein a shortest distance between two nearest ones of the first pixels in one of the first sets is greater than a shortest distance between one of the second pixels and one of the third pixels that are nearest each other in one of the second sets.

Ex. 1001 (578 Patent), Claim 1;
see also IPR2023-01075, Paper 1 (Petition) at 1-2, 7-8

“Pixel Defining Layer” in the ‘578 Patent

In general, the OLED display includes a plurality of pixels for emitting light of different colors. The plurality of pixels emit light to display an image. Here, the pixel refers to a minimum unit for displaying the images. For instance, there may be a gate line, a data line, and a power line such as a driving power line to drive each pixel. In addition, there may be an insulation layer such as a pixel definition layer to define an area and a shape of each pixel. Further, each pixel may be positioned between its neighboring pixels.

Further, among the first pixels 100, the second pixels 200, and the third pixels 300, power lines for driving each of the pixels, such as a gate line, a data line, a driving power line, and the like, may be located. In addition, an insulation layer, such as a pixel defining layer, for defining each of the pixels may be disposed. Finally, an OLED including an anode, an organic emission layer, and a cathode to correspond to each of the first pixels 100, the second pixels 200, and the third pixels 300 may be disposed. These configurations are technologies known in the art and further description thereof is omitted for ease of description. A shape of each of the pixels may be defined by the power lines, the pixel defining layer, the anode, or the like, but is not limited thereto.

Ex. 1001 (578 Patent), 1:36-44, 4:1-12;
see also IPR2023-01075, Paper 1 (Petition) at 23; Paper 29 (Reply) at 12

Matthies Teaches a Shaped Layer of Pixels

Although the display 100 is shown as being formed from tiles having 16 pixel forming elements in a four by four array, it is contemplated that each tile may include many more pixels. In one exemplary embodiment of the invention,

In one exemplary embodiment of the invention, the pixel forming elements are made from an organic light emitting diode (OLED) material. The basic light emitting structure consists of a thin organic polymer layer sandwiched between a pair of appropriately selected and patterned electrodes.

ITO to form the electrodes. The display materials, red, green and blue OLED materials 324 and 326, including a hole transport layer, a light emitting layer and an electron injecting layer, are deposited on top of the column electrodes to define the active area of the pixel. The hole transport layer

layout. The active portion 526 of the pixels occupies only about $\frac{1}{4}$ of the total pixel area. This defines a pixel aperture of approximately 25%. In this exemplary embodiment of the

Ex. 1004 (Matthies), 5:56-61; 6:18-22; 13:1-5
see also IPR2023-01075, Paper 1 (Petition) at 22-23; Paper 29 (Reply) at 12-13

Matthies Also Teaches that ***Other*** Layers May Be Present

layer. Additional layers such as blocking or passivation layers may be present to improve the function or life of the display layers. The transparent electrode is preferably the

to connect to external power and signal sources. The tile structure may also have a structural layer(s) such as a high softening point metal or insulator to provide freedom from distortion during the processing of the ceramic materials, and/or thermal management during the operation of the display. The tile structure also contains a transparent layer

Ex. 1004 (Matthies), 6:37-39; 7:24-28
see also IPR2023-01075, Paper 1 (Petition) at 12-13

Yamada Provides An Example of a "Pixel Defining" Layer Formed from Insulating Material

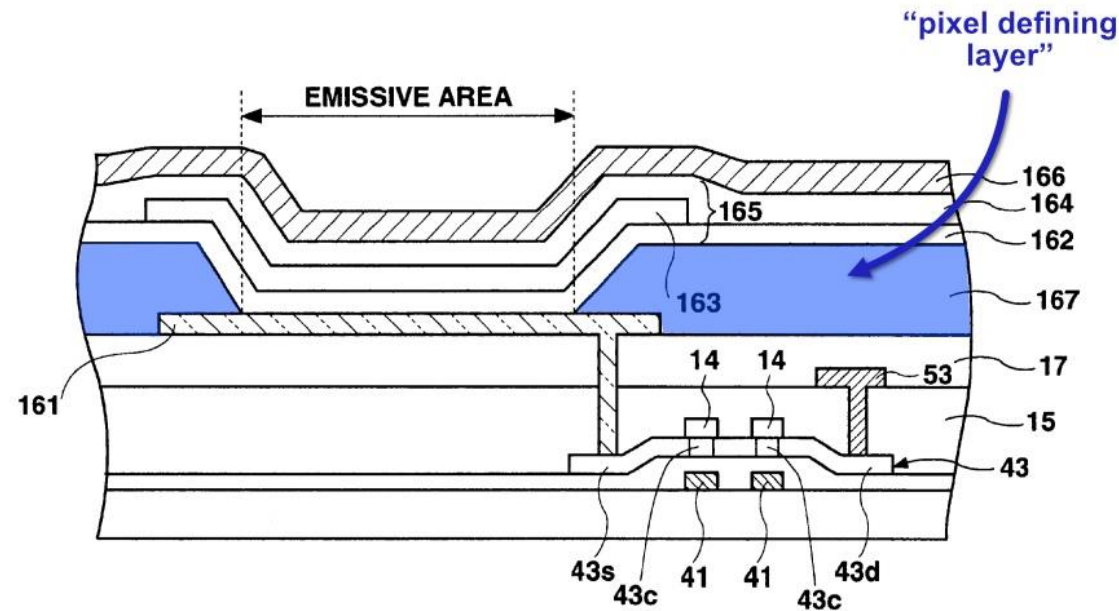


Fig. 6B

Ex. 1005 (Yamada), Fig. 6B
see also IPR2023-01075, Paper 1 (Petition) at 13

The Petition Explained Where a Layer Like Yamada's Would Be Located in Matthies' Display

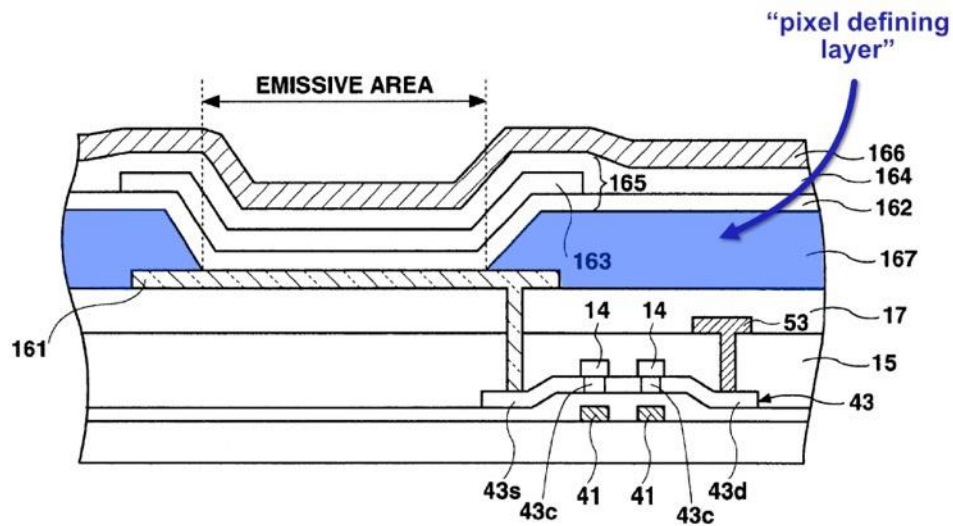


Fig. 6B

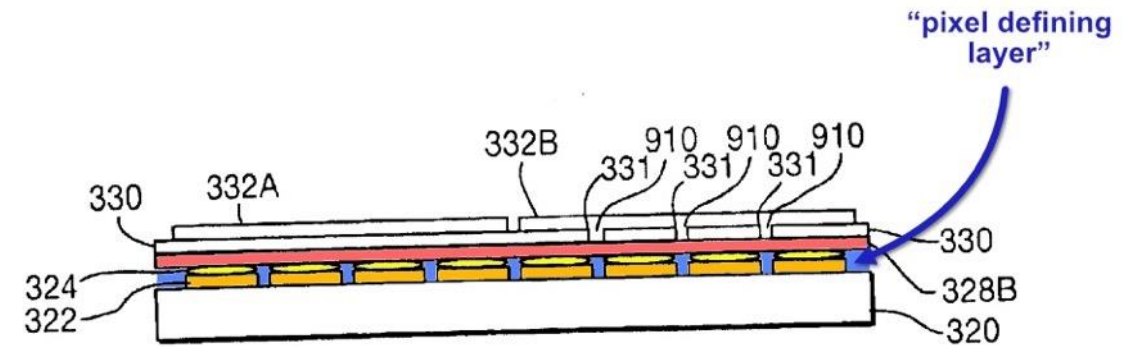
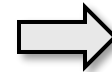


FIG. 10B

Ex. 1005 (Yamada), Fig. 6B; Ex. 1004 (Matthies), Fig. 10B
see also IPR2023-01075, Paper 1 (Petition) at 25-26

'578 Patent – Claim 5

5. The pixel arrangement structure of claim 1, wherein a shortest distance between the first pixels and the second pixels, and a shortest distance between the first pixels and the third pixels, are a same first length.

Ex. 1001 (578 Patent), Claim 5

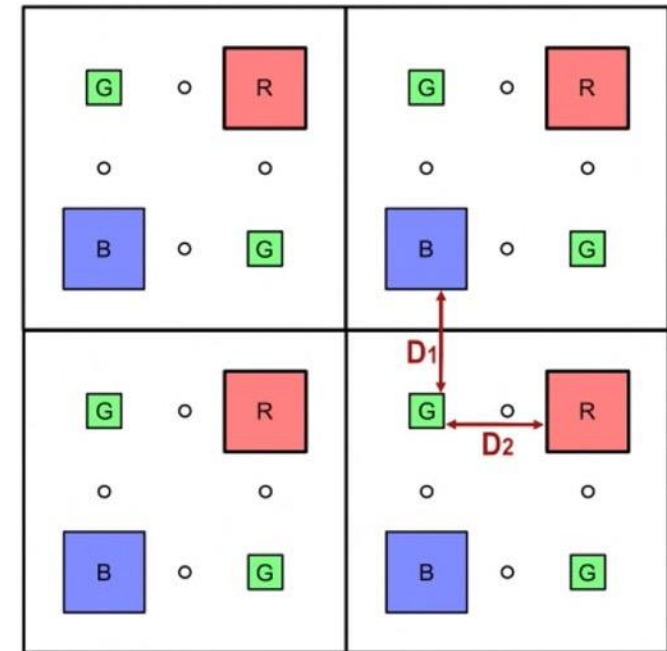
Yamada Also Teaches Equally Sized Red and Blue Pixels

In the above-mentioned embodiment, when the emission efficiency is green>red>blue, an example was described where the emissive area of the display pixels was green<red<blue so that the size of the emissive area for the various colors differed in this order. However, an embodiment need not be limited to this example. For example, with the emission efficiency at the same green>red>blue, the emissive areas may be set to green=red<blue or to green<red=blue.

Ex. 1005 (Yamada), 10:52-60;
see also IPR2023-01075, Paper 1 (Petition) at 45

Matthies Continues to Teach Claim 1 When Using Same Sized Red/Blue Pixels

(*Id.*) As shown, Matthies' sub-pixels continue to be arranged in sets and along lines. The distance between the still smaller green sub-pixels continues to exceed the distance between larger red and blue sub-pixels. And, the region around the green pixels still does not overlap the red or blue pixels. *See supra*, Section IX.A.1. But, the distance between green and blue and green and red pixels is now the same.



IPR2023-01075, Paper 1 (Petition) at 45-46

'578 Patent – Claim 41 (and Similar Claims 44, 52)

41. The pixel arrangement structure of claim 1, wherein a shortest distance between two elongated sides of one of the first pixels is less than a shortest distance between the one of the first pixels and a nearest one of the second pixels in the third direction or a fourth direction crossing the third direction.

Ex. 1001 (578 Patent), Claim 41

Matthies Contemplates Different Pixel Geometries

in drive current for that pixel. The exact form of this adjustment depends on the geometry of the pixels and the materials that are used to form the pixels. A suitable adjust-

ness automatically without manual adjustments. This proportionality constant varies for different pixel geometries and different OLED materials. It can be easily determined by one skilled in the art of designing OLED displays by monitoring the performance of an exemplary pixel over time.

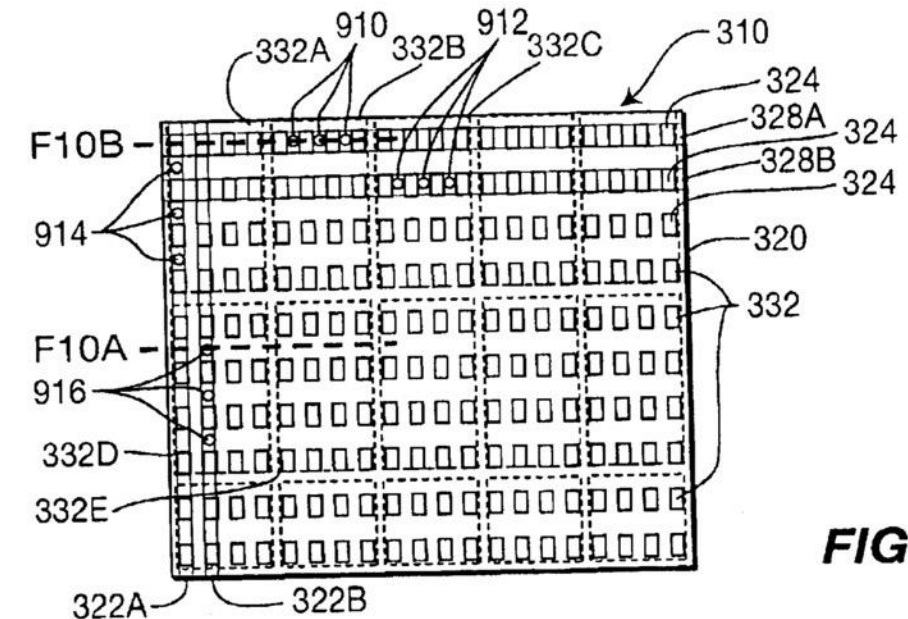


FIG. 9

Ex. 1004 (Matthies), 12:8-10, 12:28-30; Fig. 9
see also IPR2023-01075, Paper 1 (Petition) at 60-61; Paper 29 (Reply) at 15

Rectangular Pixels Were Well-Known, in Routine Use, and Considered Interchangeable

Furthermore, although the display pixels assumed the form of a square in the example (FIG. 4), the present invention is not limited to such a form, and is applicable to a rectangular shape or an “L” shape, or any shape that does not hinder the emission of light from the emissive layer.

Ex. 1005 (Yamada), 12:32-36

In the examples of FIGS. 4-14, each subpixel has a substantially rectangular shape. However, it is understood that the shape of each subpixel in other examples may vary. For example, FIG. 15 depicts one example of a subpixel repeating group 1500 having subpixels in a substantially rectangular shape with curved corners. Other shapes of the subpixels include, but are not limited to, substantially round, triangle, pentagon, hexagon, heptagon, octagon, or any other suitable shape. The regions between the subpixels 1502 may be filled with the black matrix 1504 as noted above.

Ex. 1012 (Gu), 13:57-67

[0010] By two-dimensional array, we mean an array comprising a plurality of point-like discrete colour-forming regions. The point-like colour-forming regions may have various shapes including circular, oval, rectangular, square and hexagonal.

Ex. 1006 (Smith), [0010]

Optionally, the shapes of the first sub-pixel, the second sub-pixel, the third sub-pixel and the fourth sub-pixel are any one of round shape, triangular shape, quadrangular shape, pentagonal shape, hexagonal shape or octagonal shape or a combination thereof.

Ex. 2015 (Wang), 4:1-5

[0030] Each of the red, green, and blue light emission zones 150, 160, and 170 may be formed in any geometrical shape, such as square, rectangle, circle, triangle, trapezoid, polygon, or any combinations thereof. Preferably, the red,

Ex. 2021 (Chao), [0030]

see also IPR2023-01075, Paper 29 (Reply) at 15

The '578 Patent Itself Is Indifferent to Pixel Shape

Nevertheless, even though each of the pixels are drawn as stereotypical polygonal shapes in the drawings, the present invention is not limited to this shape. That is, the shapes of the pixels may be modified to avoid interference with the other components of the OLED (e.g., wirings) within the spirit and scope of the appended claims.

Ex. 1001 (578 Patent), 3:51-56;
see also IPR2023-01075, Paper 29 (Reply) at 15-16

'578 Patent – Claims 40, 43, 45-47, and 51-52

40. The pixel arrangement structure of claim 1, wherein each of the first pixels has two elongated sides that are elongated in the third direction or a fourth direction crossing the third direction and different from the first and second directions, and two connection portions that connect the two elongated sides to each other at respective ends, and wherein at least one of the two connection portions has a length that is greater than a shortest distance between the two elongated sides.

Ex. 1001 (578 Patent), Claim 40

Hong Teaches the Removal of Pixel Corners

[0061] Since each of the first, second and third organic patterns 250a, 250b and 250c has a rectangular shape having two truncated corners, the second distance d2 between two of the first, second and third organic patterns 250a, 250b and 250c may be greater than the first distance d1 (of FIG. 5) between two of the first, second and third organic patterns 200a, 200b and 200c (of FIG. 5) each having a rectangular shape. Alternatively, each of the first, second and third organic patterns 250a, 250b and 250c may be formed to have an area greater than an area of each of the first, second and third organic patterns 200a, 200b and 200c by designing the second distance d2 equal to the first distance d1. Accordingly, each of the first, second and third organic patterns 250a, 250b and 250c may have a further enlarged area as compared with the organic pattern 60 (of FIG. 2) of the related art. As a result, an aperture ratio is further improved with obtaining the first distance d1.

Ex. 1011 (Hong), [0061];
see also IPR2023-01075, Paper 1 (Petition) at 78

The Petition Simply Applied Hong's Truncated Corners to Matthies/Yamada

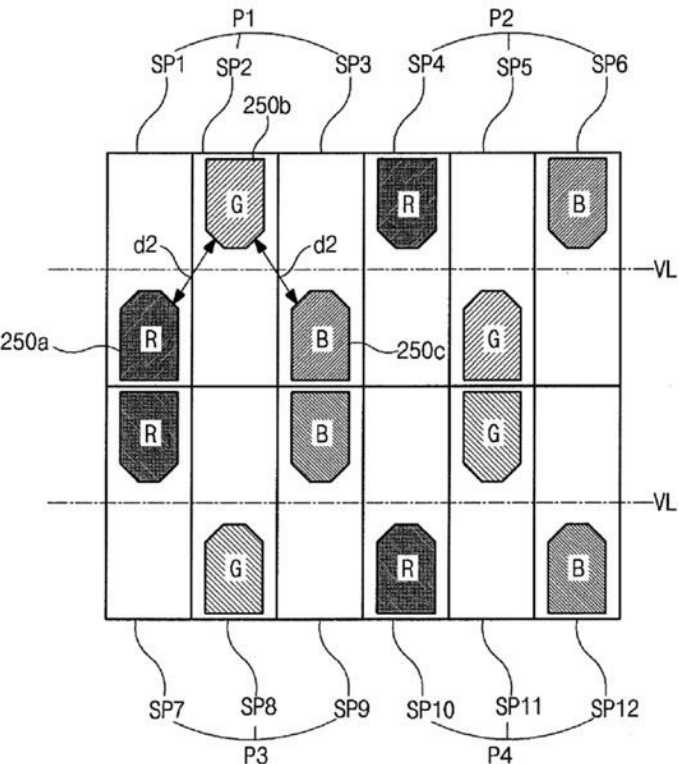
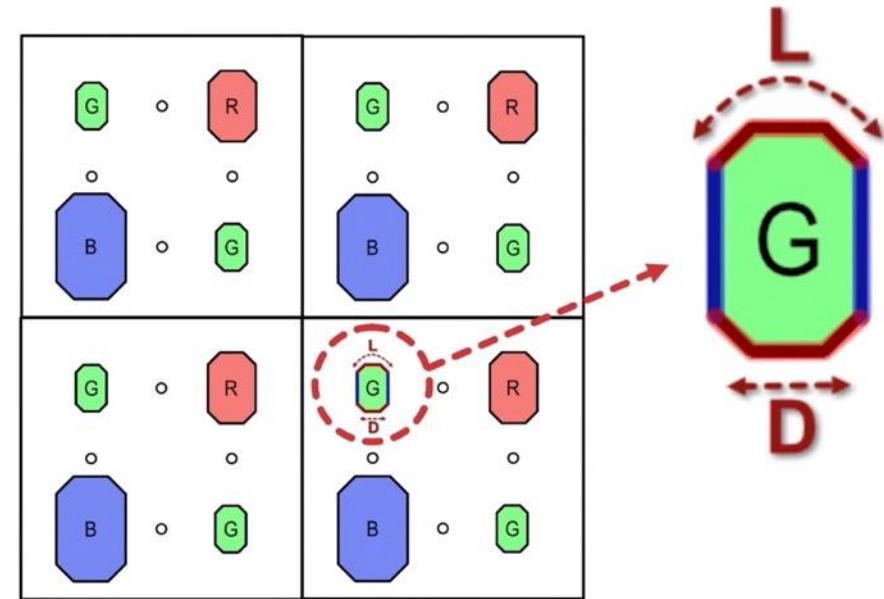


FIG. 9



Ex. 1011 (Hong), Fig. 9
IPR2023-01075, Paper 1 (Petition) at 78-80

Other Art Confirms that Hexagonal, Octagonal, and Similar Pixel Shapes Were Known

In the examples of FIGS. 4-14, each subpixel has a substantially rectangular shape. However, it is understood that the shape of each subpixel in other examples may vary. For example, FIG. 15 depicts one example of a subpixel repeating group 1500 having subpixels in a substantially rectangular shape with curved corners. Other shapes of the subpixels include, but are not limited to, substantially round, triangle, pentagon, hexagon, heptagon, octagon, or any other suitable shape. The regions between the subpixels 1502 may be filled with the black matrix 1504 as noted above.

Ex. 1012 (Gu), 13:57-67

Optionally, the shapes of the first sub-pixel, the second sub-pixel, the third sub-pixel and the fourth sub-pixel are any one of round shape, triangular shape, quadrangular shape, pentagonal shape, hexagonal shape or octagonal shape or a combination thereof.

Ex. 2015 (Wang), 4:1-5

The pixel arrangement in FIG. 9 is similar to that in FIG. 8. However, there is a difference in the shape of the red and green sub-pixel regions “R-SP” and “G-SP”. Each of the red and green sub-pixel regions “R-SP” and “G-SP” may have a pentagonal shape, a hexagonal shape, and so on.

Ex. 2012 (Yoo), 9:4-7

see also IPR2023-01075, Paper 1 (Petition) at 82;
Paper 29 (Reply) at 17

Octagonal and Hexagonal Pixels Are Easier to Manufacture and Improve Aperture Ratio

[0064] FIG. 7 shows a similar arrangement to that of FIG. 5 which utilizes hexagonal discrete colour-forming regions rather than square. This arrangement provides a good aperture ratio while having corners that have a greater angle than in the square arrangement such that ink can readily wet the whole of each discrete colour-forming region.

Ex. 1006 (Smith), [0064]

In the first to fourth unit pixels PXL1-PXL4, the subpixels may have a polygonal shape having five or more sides. For example, the red and green subpixels SPR and SPG may have a pentagonal shape, and the blue shared subpixels SPB may have an octagonal shape. In the embodiment of the invention, a reason to form the subpixels in the polygonal shape is to further increase the aperture ratio by keeping a distance between the subpixels of the different colors constant as indicated by an arrow 800 of FIG. 7. Further, another reason is to optimize the FMM process.

Ex. 1013 (Hwang), 7:58-67

second distance d2 equal to the first distance d1. Accordingly, each of the first, second and third organic patterns 250a, 250b and 250c may have a further enlarged area as compared with the organic pattern 60 (of FIG. 2) of the related art. As a result, an aperture ratio is further improved with obtaining the first distance d1.

Ex. 1011 (Hong), [0061]

[0146] The opening OPEN of the bank BANK is formed in a rectangular shape in a flat area substantially at the center of the pixel in order to form the organic electroluminescent light emitting area OLED with high uniformity. The corners of the rectangle are cut off to form an octagonal shape for the purpose of realizing improvement in reliability by restraining concentration of an electric field while realizing improvement of evaporation likelihood with respect to displacement and deformation of the evaporated mask.

Ex. 1019 (Tokuda), [0146]

see also IPR2023-01075, Paper 1 (Petition) at 82-83;
Paper 29 (Reply) at 17-18

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Patent Owner's Secondary Considerations Arguments Are Deficient

- X The arguments are not supported by evidence from Patent Owner.
- X Patent Owner has not shown the required nexus.
- X Any success, praise, unexpected results, or the like is attributable to factors other than the claimed subject matter.

IPR2023-00987, Paper 29 (Reply) at 20-26

The Nexus Requirement

A nexus is presumed only if secondary considerations evidence “is tied to a specific product” that “embodies the claimed features, and is coextensive with them.”

Alternatively, there may a nexus if any “secondary considerations” are “the direct result of the unique characteristics” of the claims and not the prior art.

Fox Factory, Inc. v. SRAM, LLC, 944 F.3d 1366, 1373 (Fed. Cir. 2019)

IPR2023-00987, Paper 29 (Reply) at 20-22

Patent Owner's Evidence Is Not "Coextensive" With the Claims

Q. All right. So let's move back to Claim 1 of the '803 patent. And to summarize, the -- Claim 1 is not limited to just active matrix OLED displays. Correct?

A. So Claim 1 makes no statement about the mode of drive for the display.

Q. And Claim 1 is not limited to just high definition displays for mobile devices. True?

A. Claim 1 makes no statement about the number of pixels that are required to be in the display.

Q. So the claim is also not limited to displays with high pixel densities that have high aperture ratios. True?

A. So Claim 1 makes no statement about the pixel pitch or the aperture ratio required for satisfaction of the claim.

Q. And the claim is also not limited to just the pixel arrangement in Figure 5. Correct?

A. Claim 1 is -- it's limited by the -- excuse me, the text of the claim, and Figure 5 is one example, and there are others that could also be imagined.

Q. So instead, the claim embraces all types of OLED displays that include the claimed pixel arrangement, including both active and passive-matrix driven displays. Correct?

MR. KUDZIN: Objection.

A. So, again, the claim itself is silent as to the mode of pixel drive.

BY MR. HERMAN:

Q. And the claim can embrace displays for nonmobile devices. True?

A. Again, the claim is silent as to the end use of the display which is being described.

Q. And the claim can embrace lower definition displays with lower pixel densities and low aperture ratios. True?

MR. KUDZIN: Same objection.

A. Yeah, the claim has no statement as to the -- I guess two different things. One is the aperture, and there's no statement as to the pixel density.

BY MR. HERMAN:

Q. And the -- and it also embraces pixel arrangements that are different from those in the '803 patent's figures. Correct?

A. Correct. The claim -- the patent is limited by the claim language and not by the figures. The figures are examples.

Ex. 1018 (Kymissis Depo.), 49:11-51:11
see also IPR2023-00987, Paper 29 (Reply) at 21

Patent Owner's Evidence Is Also Not the “Direct Result” of the Claimed Subject Matter

Samsung Display neatly overturned the competitors' expectation of the “impossibility.” The company developed the 4.99-inch Full HD AMOLED panel at the end of last year and in April, it was successful in mass production by applying it to Galaxy S4. The number of pixels per inch is 441 ppi, much higher than the iPhone 5's 326 ppi. A company official said that “It is putting 441 dots on one inch,” and mentioned that “it required a highly sophisticated evaporation technology to accurately place the fine dots.”

Ex. 2065, p. 5
IPR2023-00987, Paper 29 (Reply) at 22

Any Praise, Success, and the Like Is Rooted in Extraneous Factors

- X **No “*long felt need*.”** Working OLED displays existed long before the patents.
- X **No “*failure*.”** OLEDs, including AMOLEDs, existed and were in commercial use before the patents.
- X **No “*praise*.”** Praise focused on new mobile device features and unclaimed display features (such as HD, pixel density, etc.).
- X **No “*copying*”** has been shown: only similarity between pixels.
- X **No “*commercial success*.”** No market share or sales data provided.

IPR2023-00987, Paper 29 (Reply) at 22-26

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