

MIANYANG BOE OPTOELECTRONICS TECHNOLOGY CO., ET AL.,
Petitioner,
v.
SAMSUNG DISPLAY CO., LTD.
Patent Owner.

Petitioner's Demonstratives for Oral Hearing

IPR2023-00941 (U.S. Pat. 7,414,599)

September 16, 2024

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Shared Light Signal

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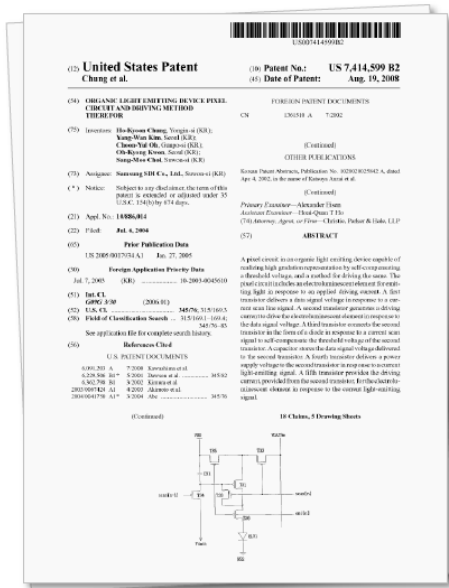
Secondary Considerations

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DEMONSTRATIVE EXHIBIT – NOT EVIDENCE PDX-3

The '599 Patent



- U.S. Pat. 7,414,599
- Priority date – July 7, 2003
- Discloses a “pixel circuit”
- All 18 claims challenged
 - Independent claims 1, 7, 14, 15, 17
 - Claim 1 has unique TFT numbering
 - Claim 7 is used as base claim

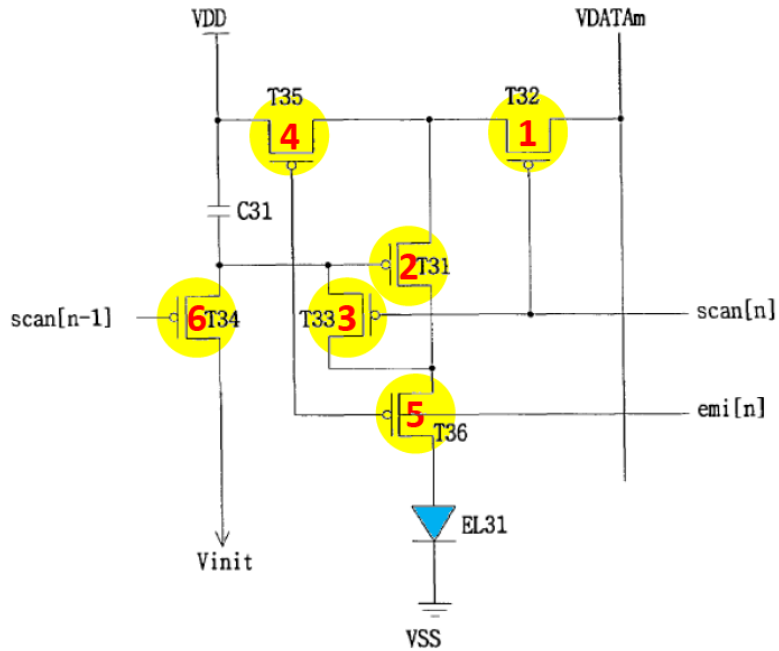
EX1001 ('599 Patent)

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE PDX-4

Mianyang BOE Ex. 1037
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The '599 Specification

FIG. 3

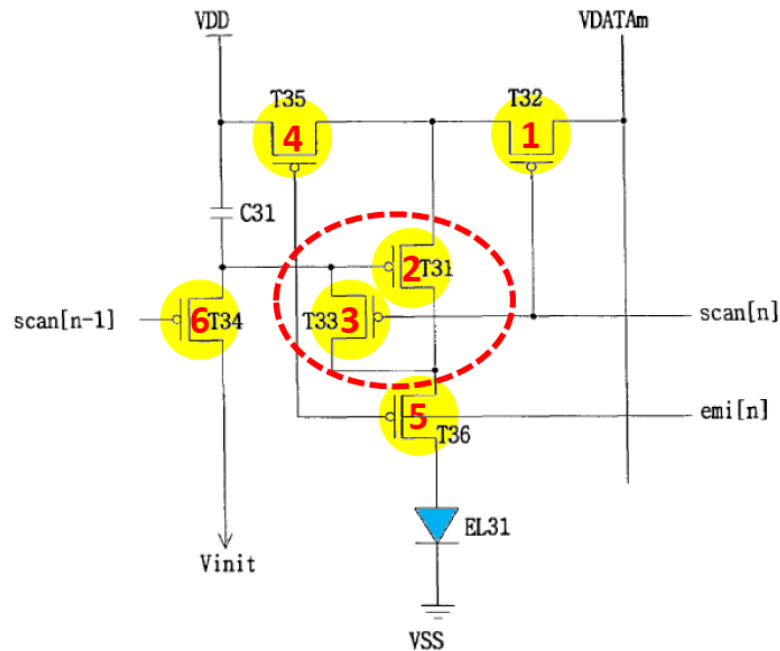


- Fig. 3 is the claimed embodiment

Referring to FIG. 3, each pixel in the organic light emitting device according to the present invention is composed of six transistors T31-T36, one capacitor C31 and electroluminescent (EL) element EL31. That is, each pixel includes organic electroluminescent device EL31 for emitting light corresponding to an applied driving current; first switching transistor T32 for switching data signal voltage VDATAm, applied to the associated data line, in response to current scan line signal SCAN[n] applied to the associated scan line; driving transistor T31 for supplying a driving current of the organic electroluminescent device corresponding to the data signal voltage inputted to its gate through first switching transistor T32; threshold voltage compensation transistor T33 for compensating the threshold voltage of driving transistor T31; and capacitor C31 for storing the data signal that is applied to the gate of driving transistor T31.

The '599 Patent – Vth Compensation

FIG. 3



A pixel circuit in an organic light emitting device capable of realizing high gradation representation by self-compensating a threshold voltage, and a method for driving the same. The

EX1001, Abstract.

the fifth transistor. The third transistor connects the second transistor in the form of a diode in response to the current scan signal, so that the second transistor detects and compensates its threshold voltage deviation in itself.

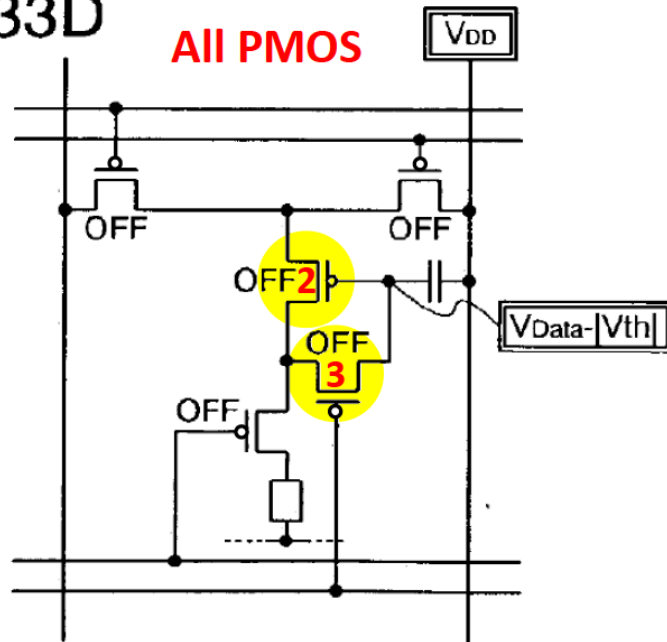
EX1001, col. 4:24-27.

As described above, driving transistor T31 in the present invention can self-compensate the threshold voltage deviation by detecting its own threshold voltage.

EX1001, col. 8:30-32.

Kimura – Vth Compensation

Fig.33D



[0654] An example structure is shown in FIG. 33A. A TFT 3309 is formed between a gate electrode and a drain electrode of a TFT 3309, and the TFT 3308 exhibits the behavior as a diode connected TFT when the TFT 3309 is on. The TFT 3309 behaves as a driver TFT for performing control of electric current supplied to an EL device 3313 when the TFT 3309 is off.

EX1002, [0654].

in **FIG. 33C**. The voltage between the source and the drain of the TFT **3308**, in other words the voltage between the gate and the source of the TFT **3308**, eventually becomes equal to the threshold voltage, at which point the TFT **3308** turns off as shown in **FIG. 33D**.

EX1002, [0655]

Dr. Wolfe Admits Vth Compensation was Known



9 Q Did the '599 patent invent a diode
10 connected transistor configuration, or was that
11 configuration known in the prior art?

12 **A It was known in the prior art.**

The Asserted Ground – Obviousness Over Kimura

- Single reference obviousness based on Kimura (all claims)
- No dispute that Kimura is prior art to the '599 patent
- 3 substantive disputes re Kimura
 - PMOS substitution
 - Shared light signal
 - Initialization/reset TFT

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DEMONSTRATIVE EXHIBIT – NOT EVIDENCE PDX-10

The Board Recognized Two Theories, Each of Which Suffices



ID (Paper 12), 27

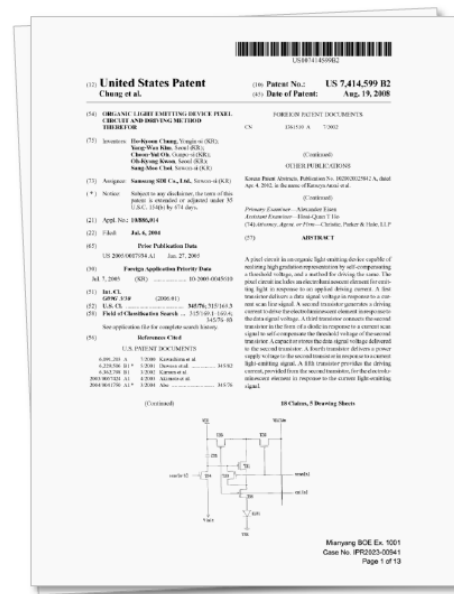
- Theory 1: general interchangeability of pMOS and nMOS
- Theory 2: benefits of single-species circuits
- Either theory suffices, but Petitioner will focus on Theory 1

“It is not necessary to show that a modification is ‘the *best* option, only that it be a *suitable* option.’”

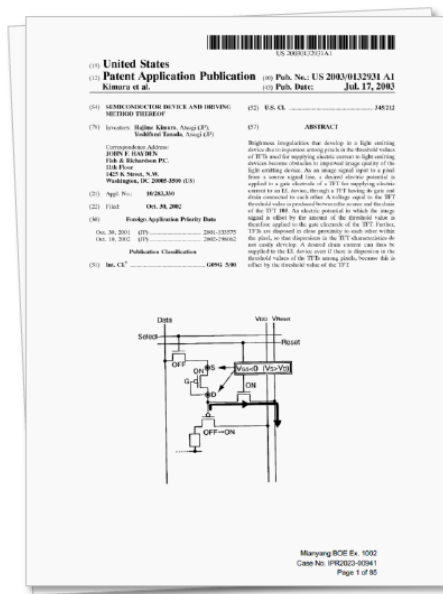
ID (Paper 12), 27 (citing *Intel Corp. v. PACT XPP Schweiz AG*, 61 F.4th 1373, 1380 (Fed. Cir. 2023); *Par Pharm., Inc. v. TWI Pharms., Inc.*, 773 F.3d 1186, 1197–98 (Fed. Cir. 2014))

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE PDX-11

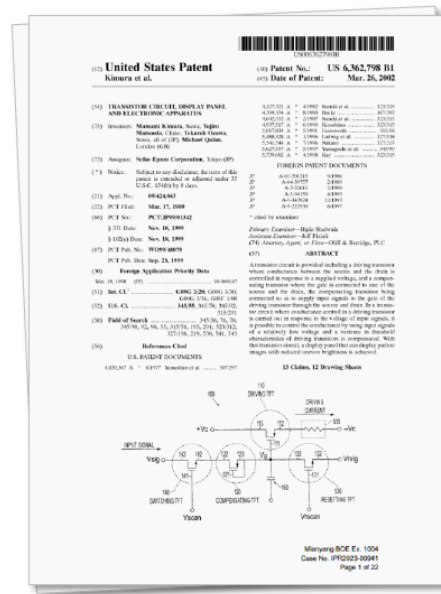
CITE



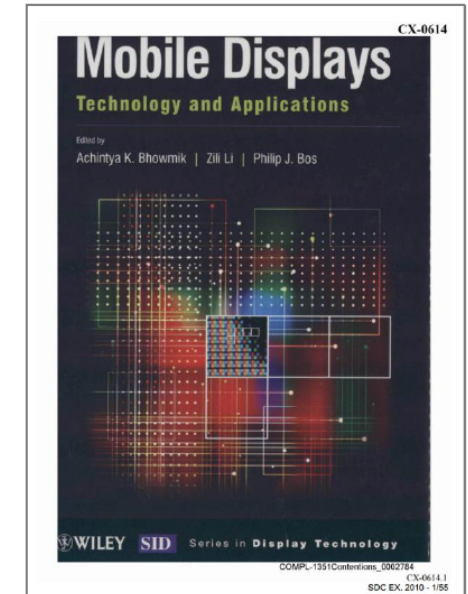
EX1002 (Kimura)



EX1004 (Kimura '798)



EX2010 (Textbook)

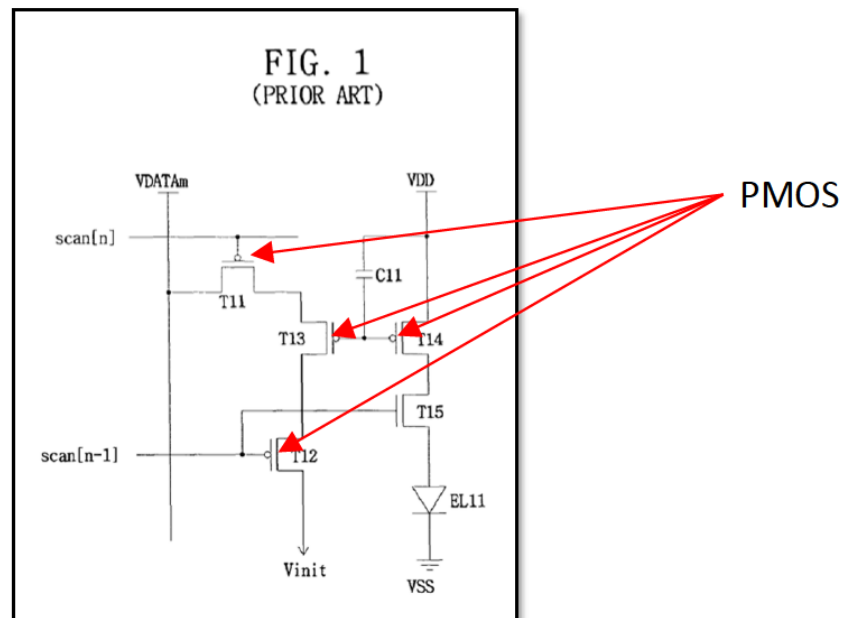


The '599 Patent Supports PMOS/NMOS Interchangeability



Moreover, the pixel circuit can be configured of a NMOS transistor, a CMOS transistor or the like other than the PMOS transistor.

Ex. 1001, 8:36-38 (cited in Reply (Paper 41), 4)



EX1001 ('599 Patent), 8:36-38, Fig. 1

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE PDX-13

Kimura Teaches PMOS/NMOS Interchangeability

line is L level. However, the TFTs 104 and 106 function as
si line is L level. However, the TFTs 304 and 306 function as
us si line is L level. The TFTs 404 and 406 function as simple
us switching devices, however, and may therefore use any
polarity.

Ex. 1002 (Kimura), [0396], [0438], [0445]

[0418] Note that, although the erasure TFT 914 uses an n-channel TFT in FIG. 9 and FIG. 10, and therefore turns on when the third gate signal line is H level and turns off when the third gate signal line is L level, there are no particular limitations placed on the polarity of the erasure TFT 914.

Ex. 1002 (Kimura), [0418]

8. All other TFTs are only used as switching devices for performing only on and off control, and therefore may be of any polarity.

Ex. 1002 (Kimura), [0649] (cited in Pet., 20-21)

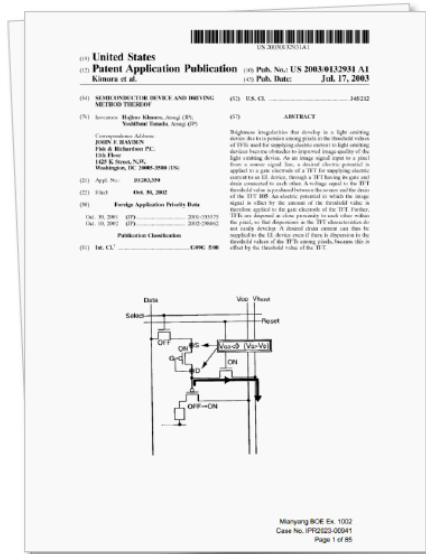
Dr. Wolfe Admits Kimura Teaches PMOS/NMOS Interchangeability



22 Q And so you agree that, with respect to at
1 least some embodiments in Kimura, the reference
2 teaches that you can make an all-PMOS pixel cell
3 circuit, correct?

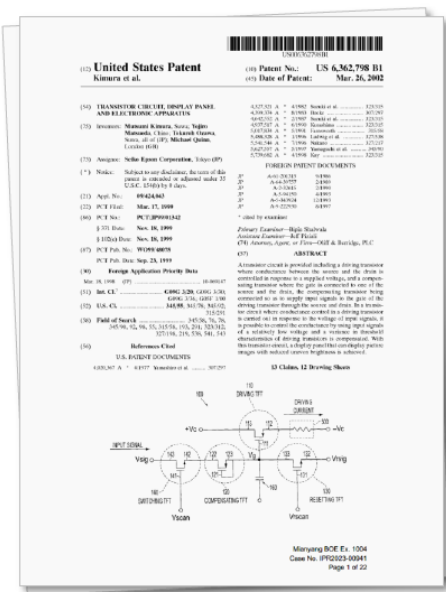
4 A **Not explicably, but it does hint towards**
5 **that modification for Figure 1A where, for example,**
6 **the drive transistor is already PMOS.**

Kimura Supports PMOS/NMOS Interchangeability

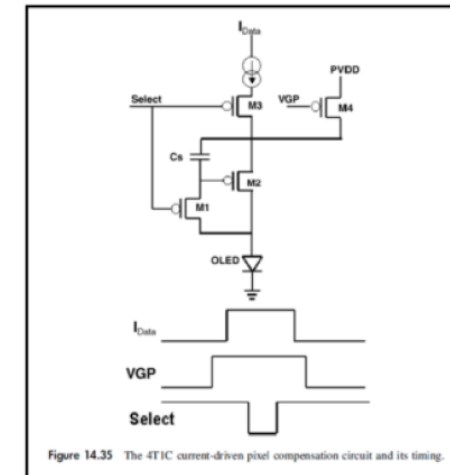
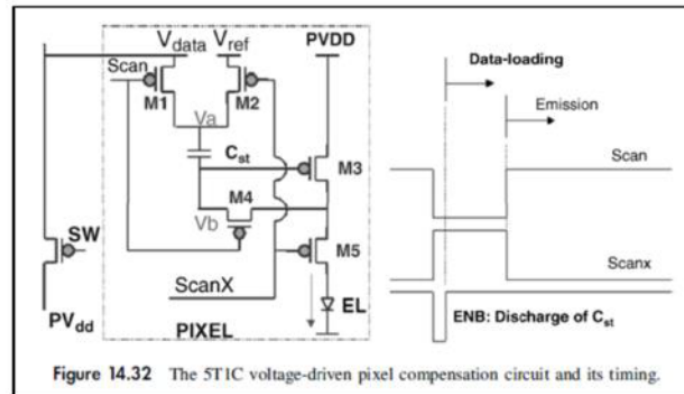
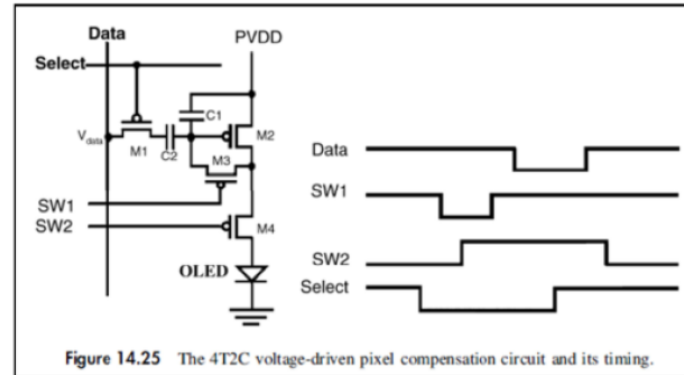
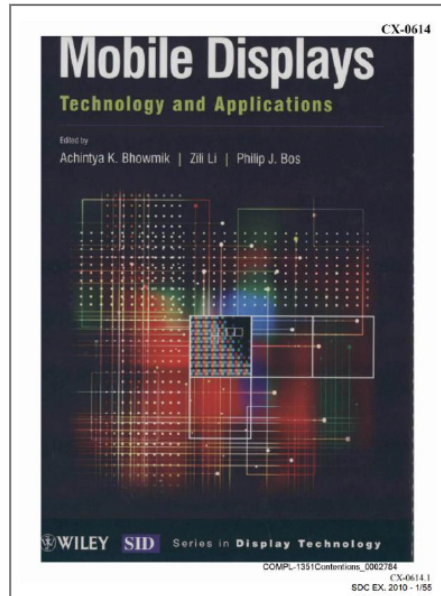


[0434] Circuit operation is shown in **FIGS. 19A to 19C**. However, operation is similar to that of Embodiment Mode 4, except for the point that the H level and L level electric potentials of the second gate signal line **1804** of the i-th row are reversed, and therefore a detailed explanation is omitted here. By turning on and off, the TFT **1809** is used as a switching device for selecting whether an electric current supply path to an EL device is conductive or non-conductive, and therefore any polarity may be used for its operation. Suitable selections may therefore be made for Embodiment Mode 4 and Embodiment Mode 5 depending upon factors such as the actual circuit layout.

Kimura '798 Demonstrates a POSITA's Knowledge



Patent Owner's Own Evidence Shows All-PMOS Pixel Circuits



EX2010 (Bhomik), 38 (top), 42-43 (bottom), 44 (right) (cited in Ex. 2008 (Wolfe Dec.), ¶¶114, 117, 119; EX1029 (Foty Reply Dec.), ¶27) DEMONSTRATIVE EXHIBIT – NOT EVIDENCE PDX-18

Motivation to Modify



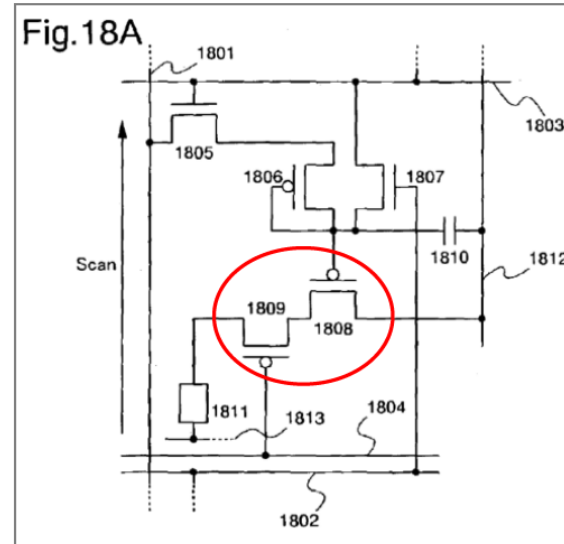
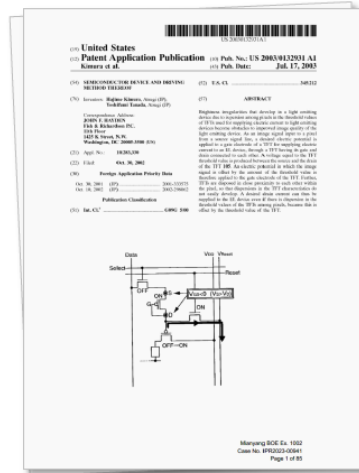
ID (Paper 12), 29

“[I]nterchangeability itself provides the motivation to change ... Recognition of a suitable option provides sufficient motivation to make a change.”

ID, 29 (citing *Intel Corp.*, 61 F.4th at 1380; *Par Pharm., Inc.*, 773 F.3d at 1197–98)

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE PDX-19

Kimura Supplies Additional Motivation



above. In order to increase the aperture ratio within a pixel, and to reduce the tendency for dispersion in TFT characteristics to develop, it is preferable that the TFTs be disposed together as close as possible. A structure is therefore used in which a TFT **1809** is p-channel and capable of being disposed in very close proximity to a TFT **1808**, as shown in **FIG. 18A**.

The Additional Motivation Moots Patent Owner's Argument



CITE

“[A] finding of obviousness based on design choice is precluded where the difference between the claimed feature and prior art results in a functional difference.”

POR (Paper 33), 13 (quoting *Lumenis Be Ltd. v. BTL Healthcare Technologies A.S.*, IPR2021-01275, Paper 8 at 30 (Feb. 8, 2022) (citing *In re Gal*, 980 F.2d 717, 719 (Fed. Cir. 1992)))

- PO argues functional differences render general interchangeability alone inadequate as motivation. POR (Paper 33), 13; Sur-reply (Paper 45), 15
- The additional motivation moots PO's argument

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE PDX-21

Evidence of Interchangeability Refutes PO's Functional-Difference Argument



ID (Paper 12), 27

- The evidence supporting general interchangeability also refutes the alleged functional differences of leakage, speed, and size

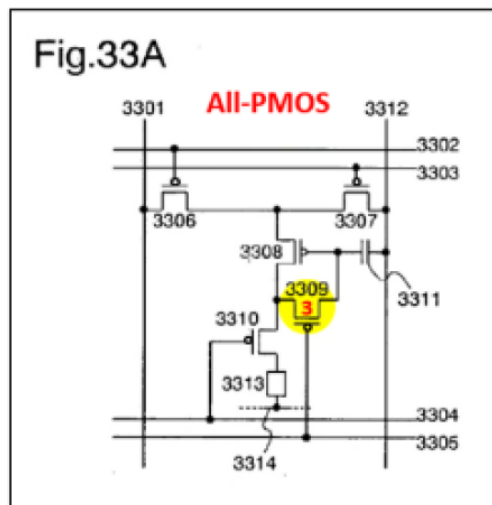
“Even if pMOS transistors are slower in operation than nMOS transistors, that is inconsequential given the teaching that for switching transistors in the pixel circuit, either p-type or n-type transistors can be used.”

ID (Paper 12), 27

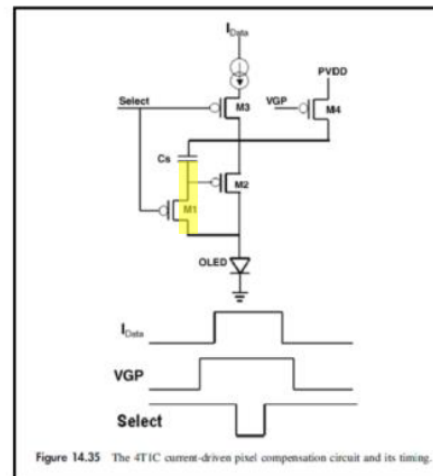
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE PDX-22

The Evidence Contradicts Patent Owner's "Leakage" Argument

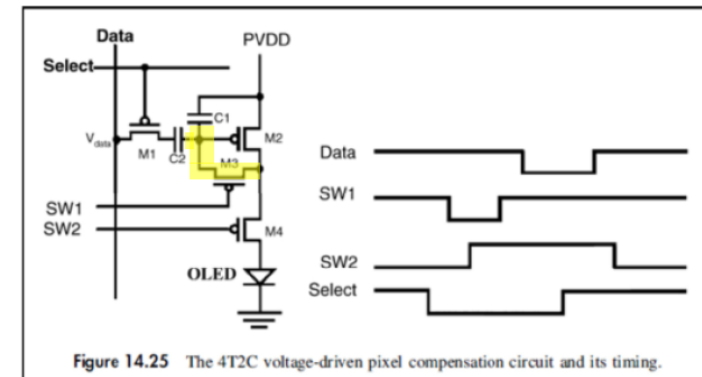
- Undisputed that '599 patent does not consider leakage a concern. Sur-reply (Paper 45), 15-16
- Patent Owner's leakage argument focuses on the third transistor. POR (Paper 33), 14; Sur-reply (Paper 45), 15-16



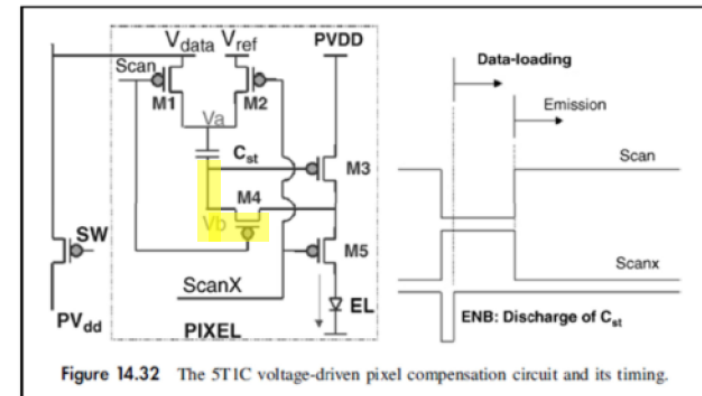
CITE



Ex. 2010 (Bhowmik) at 44.



Ex. 2010 (Bhowmik) at 38.



Ex. 2010 (Bhowmik) at 42–43.

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE PDX-23

The Evidence Contradicts Patent Owner's "Leakage" Argument

- EX1032 & 1033 (dated 1992 and 1999) show de minimus amount (e.g., 1.5 pA/μm) of polysilicon TFT leakage. EX1029 (Foty Dec.), ¶52
- Patent Owner relies on a **failure mechanism** to allege pMOS leakage

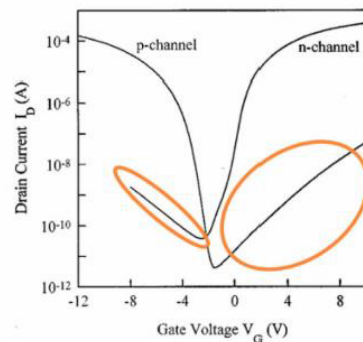
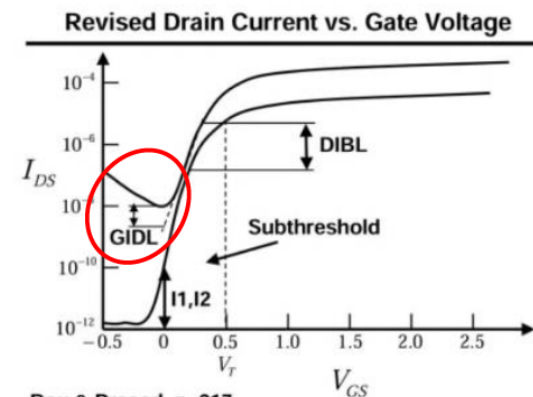


FIG. 1. Typical transfer characteristics of *n*-channel and *p*-channel polysilicon TFTs at drain voltages 5 V and -5 V, respectively. The gate ratio is $W/L = 50/10$.

EX2049, Fig. 1
(cited in EX2008 (Wolfe Dec.), ¶63)



• Roy & Prasad, p. 217
R. Amirtharajah, EEC216 Winter 2009

EX1029 (Foty Dec.), ¶53

CITE

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE PDX-24

The Evidence Contradicts Patent Owner's "Speed" Argument

- Dr. Wolfe admits faster refresh rates were not necessary



6 Q Why don't they make displays for cell
7 phones today that have much faster refresh rates?
8 A I would -- you know, I can't get into
9 other people's heads. My guess is they do. They are
10 just not commercially used very much, and the reasons
11 why they would not be optimal are that a typical
12 person would not be able to perceive the difference
13 between 120 Hertz display and a faster one, and also
14 a faster display would likely use more power, and it
15 is often commercially preferable to increase the
16 number of pixels rather than to increase the refresh
17 rate in order to have more pixels refreshed per
18 second but not necessarily more frames.

- By 1992, polysilicon TFTs ran at 20 MHz. EX1027, 1 (see Reply (Paper 41), 6)

EX1028 (Wolfe Tr.), 27 (Tr., 102:6-18; see also 99:8-13) (cited in Reply (Paper 41), 6)

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE PDX-25

The Evidence Contradicts Patent Owner's "Speed" Argument

- PO admits amorphous silicon (a-Si) is a suitable alternative to polysilicon (LTPS). POR (Paper 33), 3; EX2008 (Wolfe Dec.), ¶34
- Kimura teaches this as well. EX1002 (Kimura), [0357], [0506]
- But amorphous silicon is **300 times slower** than polysilicon

(or saturation) region. The device characteristics of LTPS TFTs and a-Si TFTs are illustrated in Table 14.4. It is apparent that the electron mobility of LTPS TFTs is 300 × that of a-Si TFTs. The high

EX2010, 28 (cited in Reply (Paper 41), 6, n.4)

The Evidence Contradicts Patent Owner's "Size" Argument

- Patent Owner abandoned this argument in Sur-reply. Sur-reply (Paper 45), 14-19.

Summary – the All-PMOS Modification was Obvious

- Two theories – either one supports invalidity
- Ample evidence supports general PMOS/NMOS interchangeability
- General interchangeability itself provides necessary motivation
- Additional motivation exists, mooting Patent Owner's argument
- Evidence supporting interchangeability disproves functional differences
- Further evidence contradicts each alleged functional difference

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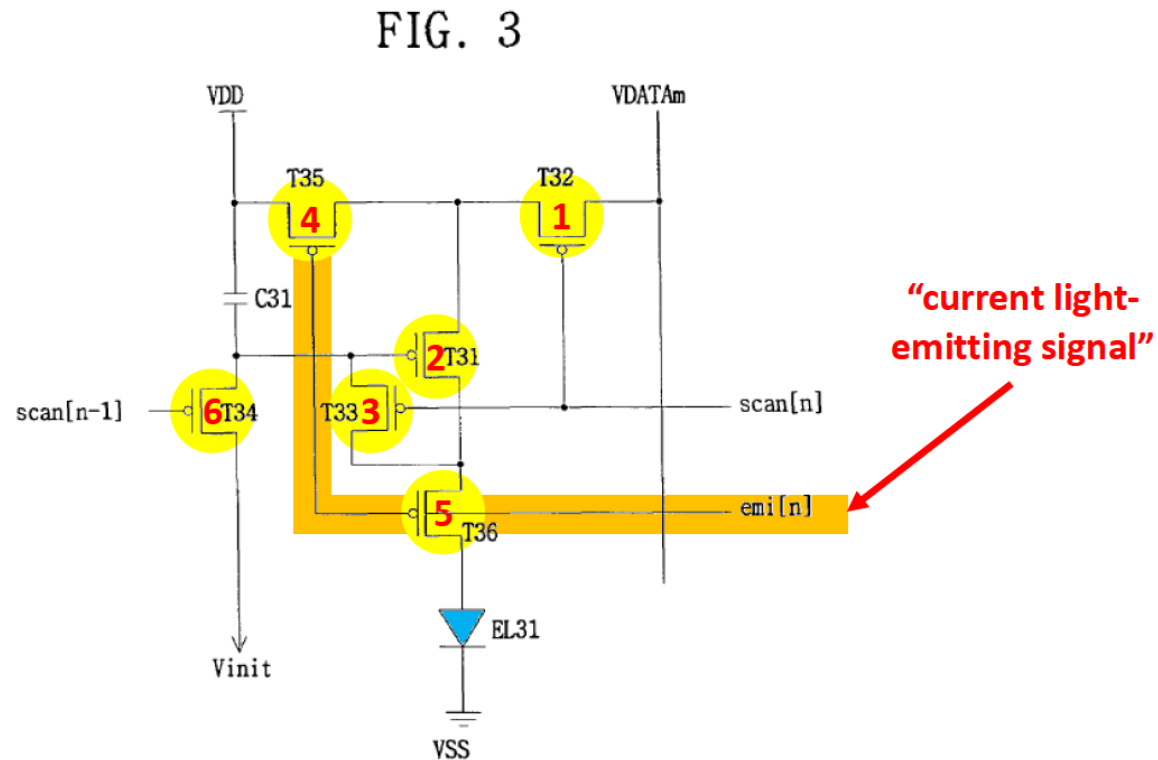
The Shared “Light-Emitting Signal” Claims

- The parties agree that claims 1-6 and 13-18 require a shared light emitting control signal
- And that claims 7-12 do NOT require a shared light emitting signal
- The parties agree on what a shared light-emitting signal is

T4 and T5 Are Controlled by the Same Signal

As the claimed embodiment of the '599 patent shows, the “light emitting signal” is a shared control signal that simultaneously (1) activates the fourth (T35) and fifth (T36) transistors so current flows through the light emitting element during light emission and (2) turns them off during other circuit operation (*i.e.* during initialization and programming). *See, e.g.*, EX1001, Fig. 7 and 7:50-65; *see also id.*, Fig. 4 (showing that `emi[n]` is not asserted during initialization or programming).

The '599 Patent's Shared "Light-Emitting Signal"



Kimura Fig. 33 Does **NOT** Disclose a Shared Light Signal

Fig.33A

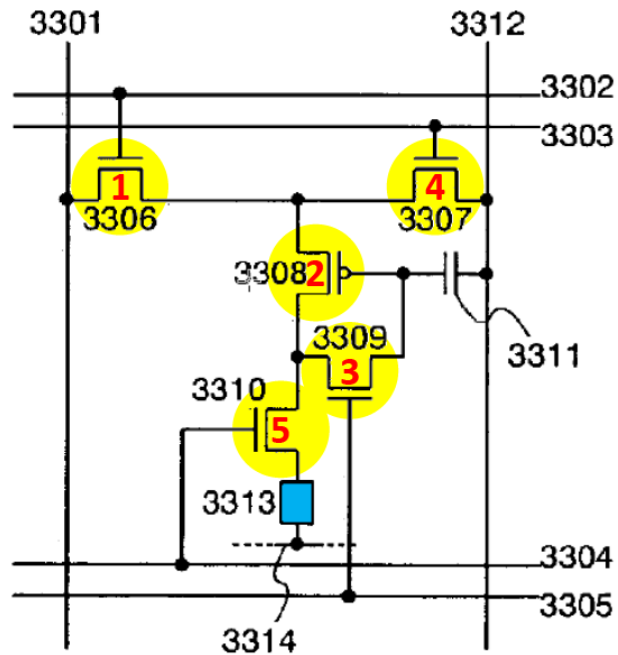


Fig.33B

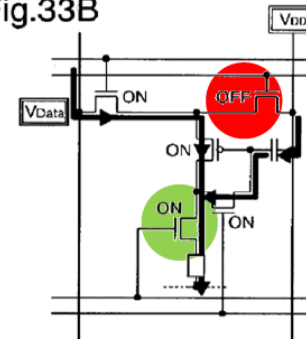


Fig.33C

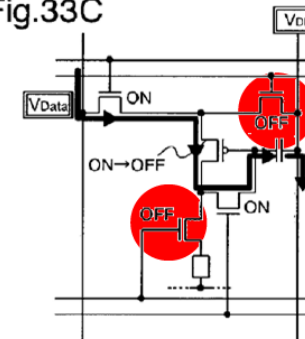


Fig.33D

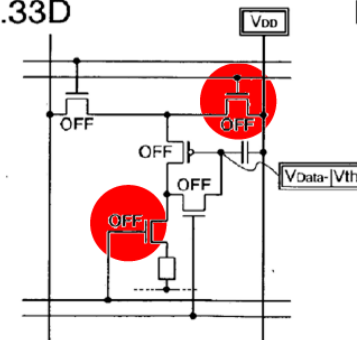
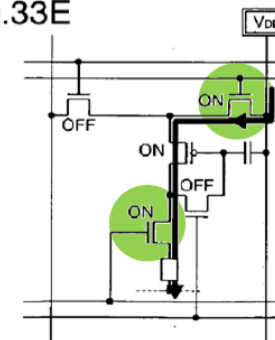


Fig.33E



Pet. (Paper 1), 16 (left); Reply (Paper 41), 11 (right)

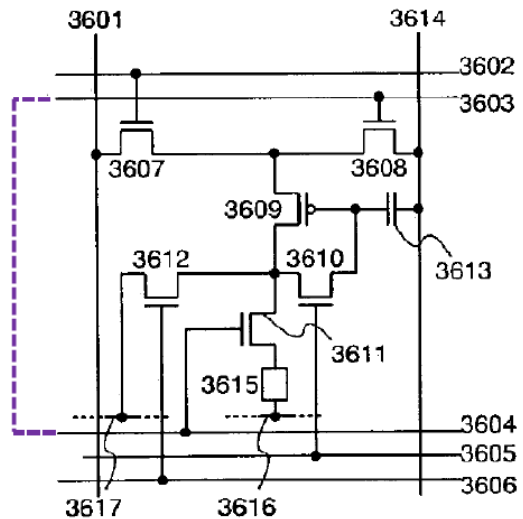
DEMONSTRATIVE EXHIBIT – NOT EVIDENCE PDX-33

Kimura Fig. 33 Does **NOT** Disclose a Shared Light Signal

Although Fig. 33B shows the fourth and fifth transistors controlled by different signals (*viz.*, fourth transistor OFF while fifth transistor ON), that is not the case for Fig. 36. EX1003, ¶257. In all operation states of Fig. 36 (*viz.*, Fig.

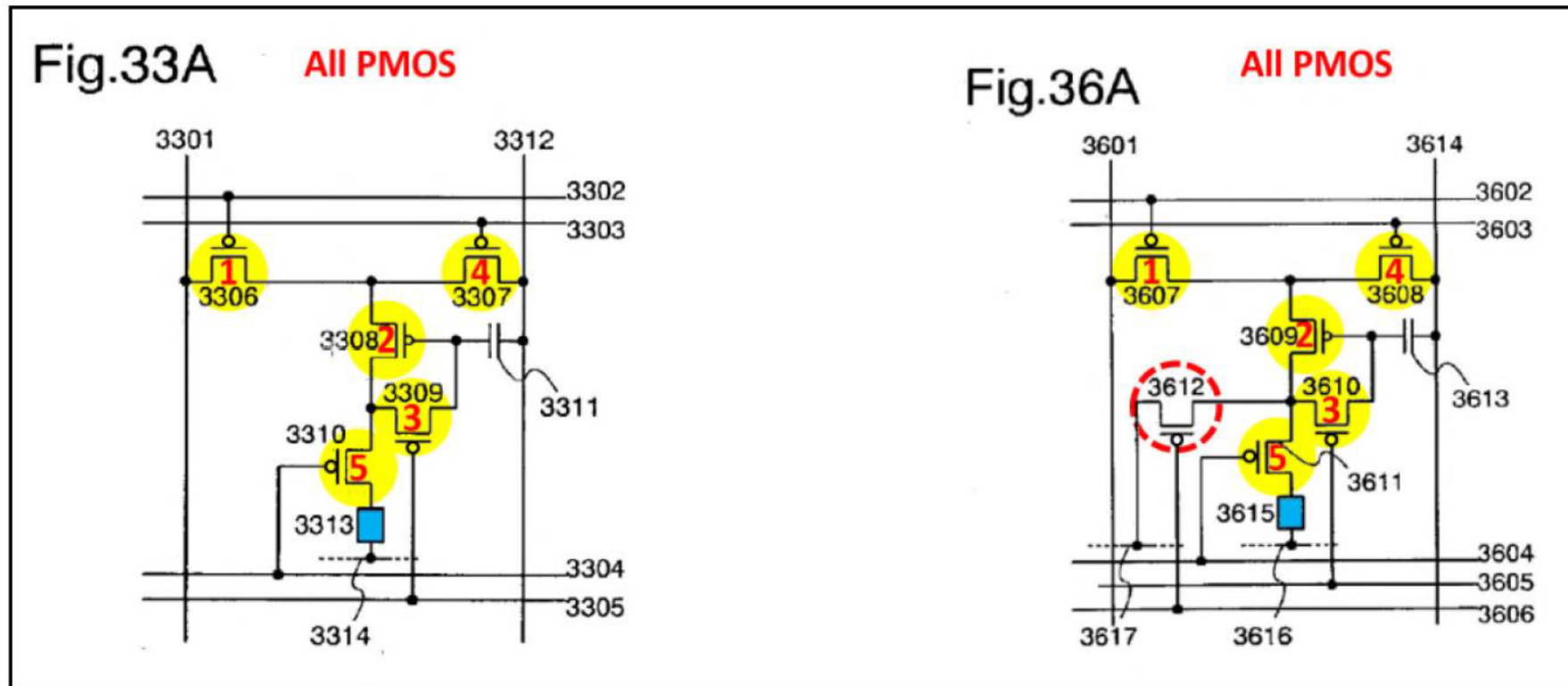
Kimura Fig. 36 Discloses and/or Renders Obvious a Shared Light Signal

Fig.36A



Although Fig. 33B shows the fourth and fifth transistors controlled by different signals (*viz.*, fourth transistor OFF while fifth transistor ON), that is not the case for Fig. 36. EX1003, ¶257. In all operation states of Fig. 36 (*viz.*, Fig. 36B (initialization), Figs. 36C-D (programming), and Fig. 36E (light emission)), the fourth and fifth transistors are always ON/OFF together. EX1003, ¶257. Thus, a POSITA would have understood (or at least found it obvious) that Kimura uses a shared light-emitting signal to control them. EX1003, ¶256-259. Kimura itself

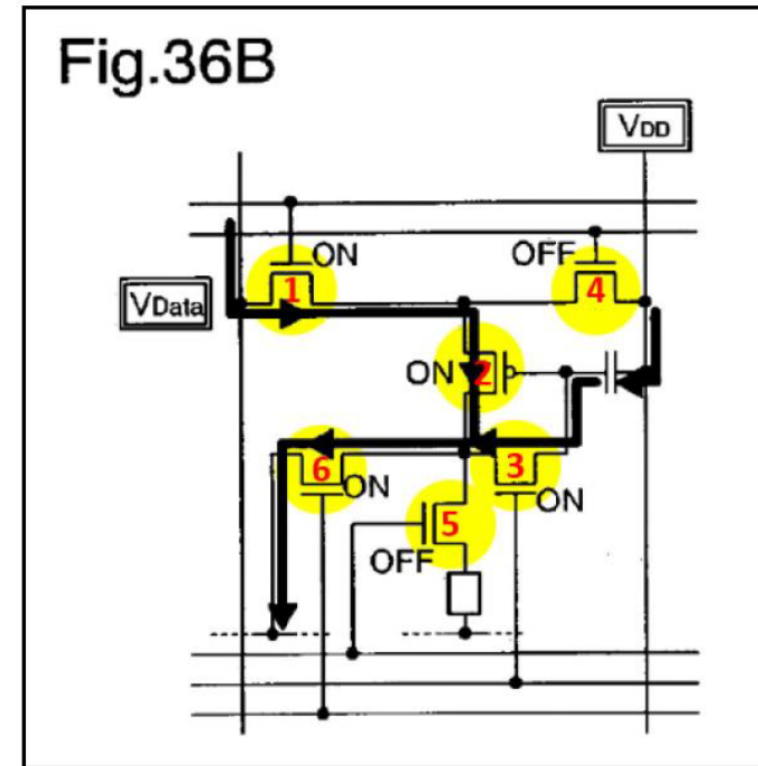
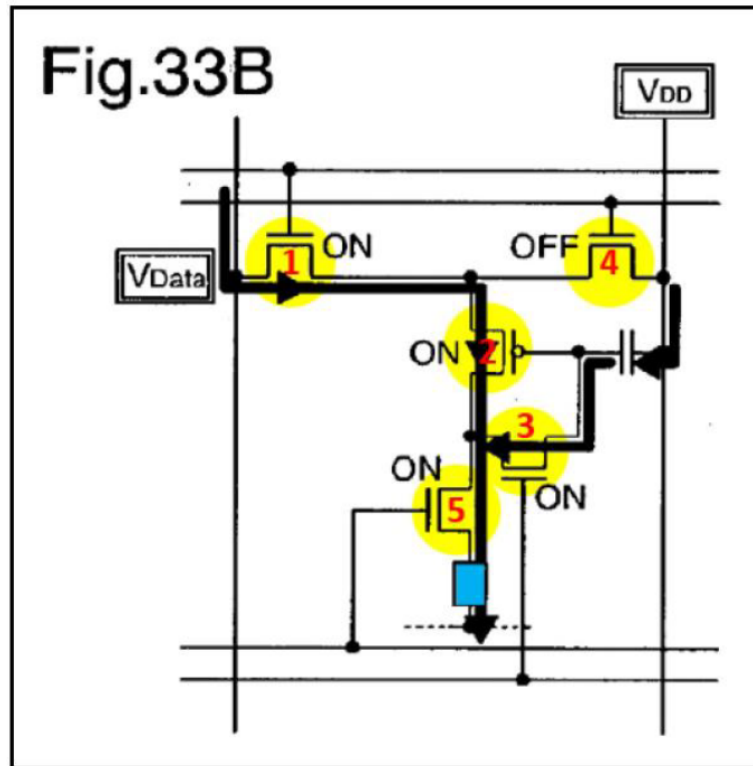
Kimura Fig. 33 Corresponds to Kimura Fig. 36



Reply (Paper 41), 15; EX1002 (Kimura), Fig. 33A (left), Fig. 36A (right)

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE PDX-36

Kimura Fig. 33 Corresponds to Kimura Fig. 36



Pet. (Paper 1), 19 (citing EX1002 (Kimura), Fig. 33B, 36B)

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE PDX-37

All Claims are “Comprising” Claims

1. A pixel circuit in an organic light emitting device, comprising:

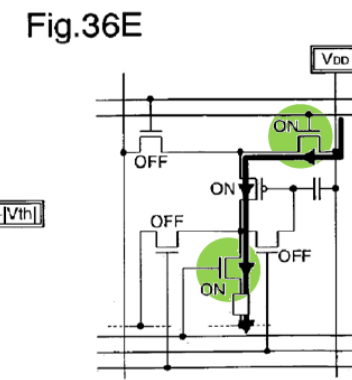
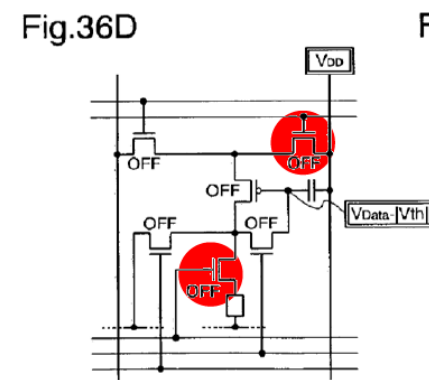
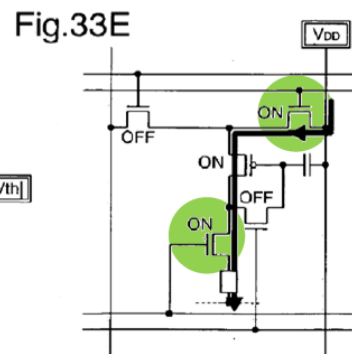
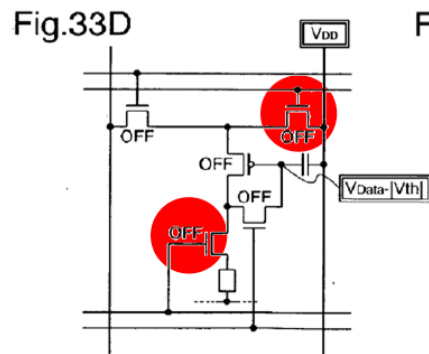
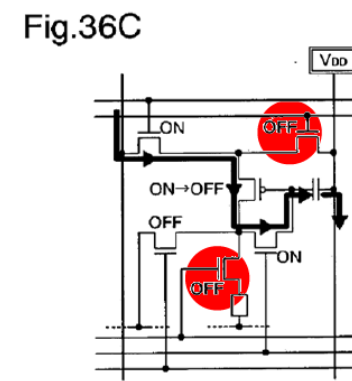
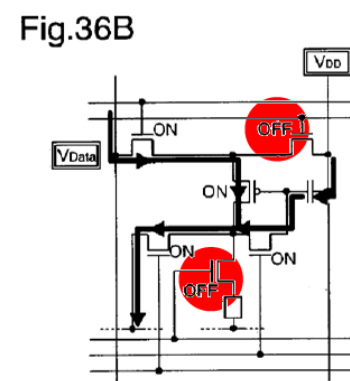
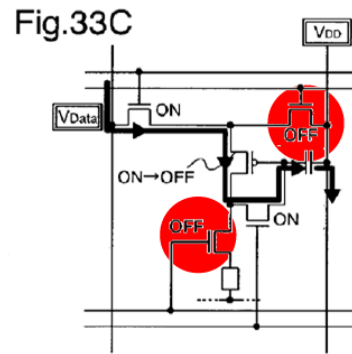
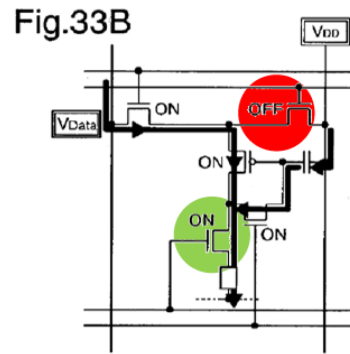
7. A pixel circuit in an organic light emitting device, comprising:

14. A pixel circuit in an organic light emitting device, comprising:

15. A pixel circuit in an organic light emitting device, comprising:

17. A pixel circuit in an organic light emitting device having a plurality of data lines, a plurality of scan lines, a plurality of power lines, and a plurality of pixels each connected to one associated data line, scan line and power line of the plurality of data lines, scan lines and power lines, each pixel comprising:

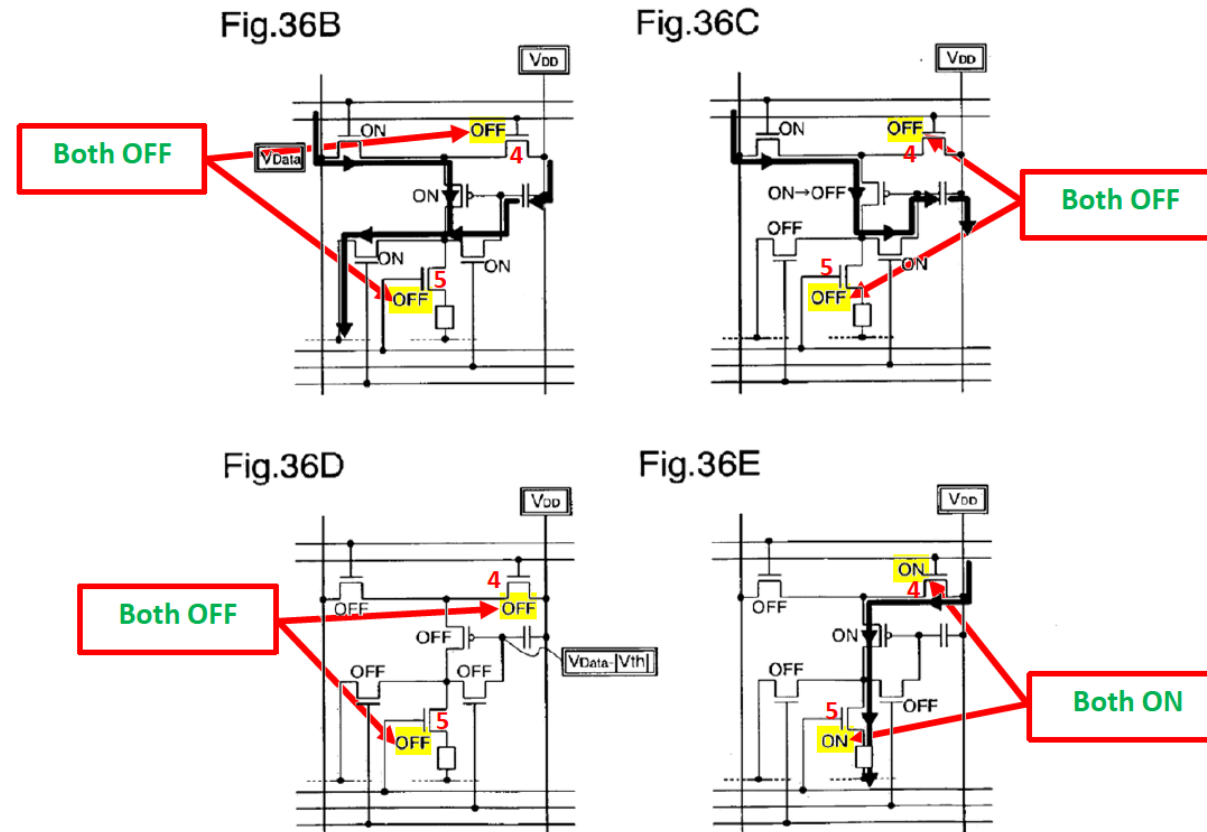
Kimura Fig. 36 Discloses and/or Renders Obvious a Shared Light Signal



Reply (Paper 41), 11 (Fig. 33, left), 13 (Fig. 36, right)

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE PDX-39

Kimura Fig. 36 Discloses and/or Renders Obvious a Shared Light Signal



Dr. Wolfe Admits the 4th and 5th Transistor Have the Same Value



Q. Are the operational phases of the transistors 3608 and 3611 the same in Figure 36B?

THE WITNESS: **They are both off during 36B** while another transistor is turned on.

Q. In Figure 36C, are the operational phases of transistor 3608 and 3611 the same?

THE WITNESS: **In 36C, both those transistors are off.**

Q. In Figure 36D, are the operational phases of transistors 3608 and 3611 the same?

A. Both of those transistors are off in 36D.

Q. And in Figure 36E, are the operational phases of transistors 3608 and 3611 the same?

A In 36E, both of those transistors are on.

Dr. Wolfe Admits the 4th and 5th Transistor Have the Same Value



Q. Is it correct that, in the operational phases of Figure 36B, C, D and E, that the transistors 3608 and 3611 always have the same on/off states?

A. They do during the illustrative times. Although, there are trade-offs to get there.

Q. How, if at all, would the functionality depicted in Figures 36B, C, D and E change if transistors 3608 and 3611 used a common control signal?

A. **The illustrated functionality would be the same**, but the motivation to get there from Figure 33 would be nonexistent because you wouldn't have saved any wires.

Dr. Wolfe Admits a Shared Light Signal Does Not Change Circuit Operation



22 Q Okay. How, if at all, would the
1 operational states depicted in Figure 36B, C, D and E
2 be any different if transistors 3608 and 3611 were
3 controlled by a shared light-emitting signal?

4 MR. GARR: Objection.

5 THE WITNESS: If you start from
6 Figure 36 and you combine them and you
7 only have the illustrated operations,
8 then I don't think there would be a
9 difference.

PO Misframes Petitioner's Argument to Argue "Inoperability"

The Petition's theory is that a POSITA would modify Kimura's Figure 33 embodiment to control the fourth and fifth transistors with a shared light emitting signal. A POSITA would have not reason to make such a modification, nor a reasonable expectation of success, as such a modification would disrupt the operation of the circuit. It is telling that Petitioner was unable to explain how the modified circuit it presented in the Petition would operate. As Dr. Wolfe explains, Petitioner's proposed modification would result in an inoperable circuit. Ex. 2008, ¶97.