

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

BOE TECHNOLOGY GROUP CO., LTD.,
Petitioner

v.

SAMSUNG DISPLAY CO., LTD.,
Patent Owner.

PTAB Case No. IPR2025-01481
U.S. Patent No. 10,013,088

DECLARATION OF RICHARD FLASCK
IN SUPPORT OF PETITION FOR INTER PARTES REVIEW
OF U.S. PATENT NO. 10,013,088

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

Date: 9/25/25

By: Richard Flawer

Richard Flasck

TABLE OF CONTENTS

I.	INTRODUCTION	12
II.	BACKGROUND AND QUALIFICATIONS	13
III.	LEVEL OF ORDINARY SKILL IN THE ART	18
IV.	MATERIALS CONSIDERED AND RELIED UPON	20
V.	LEGAL STANDARDS	20
VI.	TECHNOLOGY OVERVIEW	27
	A. Active Matrix Displays	27
	1. A Brief History	27
	2. Active Matrix Liquid Crystal Displays (AMLCDs)	29
	3. The Backlight Unit (BLU)	39
	B. Touch Panels	45
	C. Integrating Active Matrix Displays and Touch Panels: Touchscreen Displays	54
VII.	'088 PATENT OVERVIEW	62
	A. Specification	62
	B. Prosecution History	65
VIII.	CLAIM CONSTRUCTION	67
IX.	SUMMARY OF OPINIONS	67
X.	DETAILED EXPLANATION OF GROUNDS	67
	A. Ground 1A: Obviousness in view of Chen, Jang, Sano, and Sakamoto (Claims 1-13)	67
	1. Prior Art	67
	2. Independent Claim 1	106
	3. Claim 2: The display according to claim 1, wherein the first portion is located on the sealing thin film and the second portion is located on the second area	

	of the substrate, and wherein first portions of the sensing lines are located on a same layer.	139
4.	Claim 3: The display according to claim 2, wherein second portions of the sensing lines are located on a different layer from the first portions of the sensing lines.	145
5.	Claim 4: The display according to claim 1, wherein a first distance between first portions of the sensing lines and the substrate is greater than a second distance between second portions of the sensing lines and the substrate.	145
6.	Claim 5: The display according to claim 1, wherein the sensing lines are electrically connected to the driving circuit through wiring lines.	146
7.	Claim 6: The display according to claim 1, wherein the sensing lines include a different material from the sensing cells.	151
8.	Claim 7: The display according to claim 1, wherein the driving circuit is located on the second area of the substrate.....	152
9.	Claim 8: The display according to claim 7, further comprising a flexible printed circuit board (FPCB) attached to the second area of the substrate.....	153
10.	Claim 9: The display according to claim 8, wherein the sensing lines are electrically connected to the driving circuit through the FPCB.....	153
11.	Claim 10: The display according to claim 1, wherein the sensing lines are arranged outside the pixel area.	154
12.	Claim 11: The display according to claim 1, wherein the first area has a greater area than the second area.	155

EX-1003, PTAB Case No. IPR2025-01481
Declaration of Richard Flasck in support of Petition for
Inter Partes Review of U.S. Patent No. 10,013,088 B2

13.	Claim 12: The display according to claim 1, wherein the sealing thin film includes at least one organic layer and at least one inorganic layer.....	156
14.	Claim 13: The display according to claim 1, wherein the first connection patterns are respectively patterned to have independent patterns in upper or lower layers of the first sensing cells so that the first connection patterns are electrically connected to the first sensing cells at upper or lower portions of the first sensing cells.	157
B.	Ground 1B: Obviousness in view of Chen, Matsuo, Sano, and Sakamoto (Claims 1-13).....	157
1.	Prior Art	157
2.	Independent Claim 1	161
3.	Claim 2: The display according to claim 1, wherein the first portion is located on the sealing thin film and the second portion is located on the second area of the substrate, and wherein first portions of the sensing lines are located on a same layer.	176
4.	Claim 3: The display according to claim 2, wherein second portions of the sensing lines are located on a different layer from the first portions of the sensing lines.	180
5.	Claim 4: The display according to claim 1, wherein a first distance between first portions of the sensing lines and the substrate is greater than a second distance between second portions of the sensing lines and the substrate.	180
6.	Claim 5: The display according to claim 1, wherein the sensing lines are electrically connected to the driving circuit through wiring lines.	181
7.	Claim 6: The display according to claim 1, wherein the sensing lines include a different material from the sensing cells.	182

EX-1003, PTAB Case No. IPR2025-01481
Declaration of Richard Flasck in support of Petition for
Inter Partes Review of U.S. Patent No. 10,013,088 B2

8.	Claim 7: The display according to claim 1, wherein the driving circuit is located on the second area of the substrate.....	183
9.	Claim 8: The display according to claim 7, further comprising a flexible printed circuit board (FPCB) attached to the second area of the substrate.....	184
10.	Claim 9: The display according to claim 8, wherein the sensing lines are electrically connected to the driving circuit through the FPCB.....	186
11.	Claim 10: The display according to claim 1, wherein the sensing lines are arranged outside the pixel area.	186
12.	Claims 11, 12 and 13	186
C.	Grounds 2A/2B: Obviousness in view of Imamura, Yang, and Sakamoto or Imamura, Yang, Sakamoto, and Chen (Claims 1-13).....	186
1.	Prior Art	186
2.	Independent Claim 1	196
3.	Claim 2: The display according to claim 1, wherein the first portion is located on the sealing thin film and the second portion is located on the second area of the substrate, and wherein first portions of the sensing lines are located on a same layer.	216
4.	Claim 3: The display according to claim 2, wherein second portions of the sensing lines are located on a different layer from the first portions of the sensing lines.	221
5.	Claim 4: The display according to claim 1, wherein a first distance between first portions of the sensing lines and the substrate is greater than a second distance between second portions of the sensing lines and the substrate.	222

6.	Claim 5: The display according to claim 1, wherein the sensing lines are electrically connected to the driving circuit through wiring lines.	223
7.	Claim 6: The display according to claim 1, wherein the sensing lines include a different material from the sensing cells.	223
8.	Claim 7: The display according to claim 1, wherein the driving circuit is located on the second area of the substrate.....	225
9.	Claim 8: The display according to claim 7, further comprising a flexible printed circuit board (FPCB) attached to the second area of the substrate.....	225
10.	Claim 9: The display according to claim 8, wherein the sensing lines are electrically connected to the driving circuit through the FPCB.....	227
11.	Claim 10: The display according to claim 1, wherein the sensing lines are arranged outside the pixel area.	227
12.	Claim 11: The display according to claim 1, wherein the first area has a greater area than the second area.....	228
13.	Claim 12: The display according to claim 1, wherein the sealing thin film includes at least one organic layer and at least one inorganic layer.....	229
14.	Claim 13: The display according to claim 1, wherein the first connection patterns are respectively patterned to have independent patterns in upper or lower layers of the first sensing cells so that the first connection patterns are electrically connected to the first sensing cells at upper or lower portions of the first sensing cells.	230
XI.	SUMMARY AND ADDITIONAL REMARKS.....	232

EX-1003, PTAB Case No. IPR2025-01481
Declaration of Richard Flasck in support of Petition for
Inter Partes Review of U.S. Patent No. 10,013,088 B2

EXHIBIT LIST

No.	Exhibit
1001	U.S. Patent No. 10,013,088
1002	File History of the '088 patent
1003	(Reserved)
1004	(Reserved)
1005	U.S. Patent No. 8,723,413 (“ <i>Chen</i> ”)
1006	U.S. Publication No. 2010/0007616 (“ <i>Jang</i> ”)
1007	U.S. Publication No. 2005/0156513 (“ <i>Sano</i> ”)
1008	English Translation and Certification of Japanese Unexamined Patent Application Publication No. JP2003317943 (“ <i>Sakamoto</i> ”)
1009	Original of Japanese Unexamined Patent Application Publication No. JP2003317943
1010	U.S. Publication No. 2008/0309635 (“ <i>Matsuo</i> ”)
1011	U.S. Publication No. 2003/0164674 (“ <i>Imamura</i> ”)
1012	U.S. Publication No. 2009/0085891 (“ <i>Yang</i> ”)
1013	U.S. Patent No. 8,598,787 (“ <i>Bouten</i> ”)
1014	U.S. Patent No. 6,879,319 (“ <i>Cok</i> ”)
1015	U.S. Publication No. 2010/0156810 (“ <i>Barbier</i> ”)
1016	English Translation and Certification of Japanese Unexamined Patent Application Publication No. JP20017257 (“ <i>Akaboshi</i> ”)

EX-1003, PTAB Case No. IPR2025-01481
Declaration of Richard Flasck in support of Petition for
Inter Partes Review of U.S. Patent No. 10,013,088 B2

No.	Exhibit
1017	Original Japanese Unexamined Patent Application Publication No. JP20017257
1018	U.S. Publication No. 2009/0096757 (“ <i>Hotelling</i> ”)
1019	U.S. Publication No. 2010/0207519 (“ <i>Hayashi</i> ”)
1020	U.S. Patent No. 6,268,695 (“ <i>Affinito</i> ”)
1021	U.S. Patent No. 6,413,645 (“ <i>Graff</i> ”)
1022	U.S. Patent No. 8,552,541 (“ <i>Lim</i> ”)
1023	U.S. Patent No. 8,063,489 (“ <i>Shigihara</i> ”)
1024	U.S. Patent No. 7,969,009 (“ <i>Chandrasekaran</i> ”)
1025	U.S. Publication No. 2006/0192299 (“ <i>Hashimoto</i> ”)
1026	U.S. Publication No. 2009/0207560 (“ <i>Lee ’560</i> ”)
1027	U.S. Publication No. 2009/0160824 (“ <i>Chih-Yung</i> ”)
1028	(Reserved)
1029	U.S. Publication No. 2010/0134426 (“ <i>Lee ’426</i> ”)
1030	Willem den Boer, <i>Active Matrix Liquid Crystal Displays</i> (“ <i>den Boer</i> ”)
1031	Teruhiko Yamazaki, et al., <i>Color TFT Liquid Crystal Displays</i> (“ <i>Yamazaki Displays</i> ”)
1032	U.S. Patent No. 5,575,549 (“ <i>Ishikawa</i> ”)
1033	JPH06230378 Machine English and Original (“ <i>Kisoo</i> ”)
1034	Gary Barrett & Ryomei Omote, <i>Projected-Capacitive Touch Technology</i> (“ <i>Barrett</i> ”)

EX-1003, PTAB Case No. IPR2025-01481
Declaration of Richard Flasck in support of Petition for
Inter Partes Review of U.S. Patent No. 10,013,088 B2

No.	Exhibit
1035	JP2003187605A Machine English and Original (“ <i>Saizo</i> ”)
1036	U.S. Patent No. 5,499,120 (“ <i>Hansen</i> ”)
1037	U.S. Patent No. 6,007,209 (“ <i>Pelka</i> ”)
1038	Fumiaki Yamada, et al., <i>52:2: Invited Paper: Color Sequential LCD Based on OCB with an LED Backlight</i> (“ <i>Yamada</i> ”)
1039	U.S. Publication 2010/0182250A1 to Kang, et al. (“ <i>Kang</i> ”)
1040	U.S. Publication 2010/0214247 to Tang, et al. (“ <i>Tang</i> ”)
1041	JP2009110790A Machine English and Original (“ <i>Kaneko</i> ”)
1042	Toshinari Yamazaki, et al, <i>Pattern Formation of Sputtered Films by Deposition through Mask</i> (“ <i>Yamazaki Mask</i> ”)
1043	U.S. Publication 2010/0110041A1 to Jang, et al. (“ <i>Jang '041</i> ”)
1044	English Translation and Certification of Japanese Unexamined Patent Application Publication No. JP2008216996A (“ <i>Kiyose</i> ”)
1045	Original of Japanese Unexamined Patent Application Publication No. JP2008216996A
1046	U.S. Patent No. 7,960,914 (“ <i>Hara</i> ”)
1047	Z.W. Zhong, <i>Wire bonding using insulated wire and new challenges in wire bonding</i> (“ <i>Zhong</i> ”)
1048	Y.F. Yao, et al., <i>Improving the Deflection of Wire Bonds in Stacked Chip Scale Package (CSP)</i> (“ <i>Yao</i> ”)
1049	Dimitrios Velenis, et al., <i>Impact of 3D Design Choices on Manufacturing Cost</i> (“ <i>Velenis</i> ”)
1050	K.N. Tu, <i>Reliability challenges in 3D IC packaging technology</i> (“ <i>Tu</i> ”)
1051	U.S. Publication No. 2009/0179566 to Imamura, et al. (“ <i>Imamura '566</i> ”)

LISTING OF CHALLENGED CLAIMS

U.S. Patent No. 10,013,088 B2
Claim 1
1[pre] A display comprising:
1[a] a substrate including a first area having a pixel area and a second area adjacent to the first area;
1[b] a plurality of pixels in the pixel area of the substrate;
1[c] a sealing thin film covering the first area of the substrate and including an inclined surface at an end of the sealing thin film to inhibit infiltration of oxygen or moisture into the pixels;
1[d] a plurality of sensing cells formed over a top surface of the sealing thin film to sense a touch;
1[e] a plurality of sensing lines coupled to the sensing cells, the sensing lines comprising a first portion and a second portion;
1[f] a driving circuit electrically connected to the sensing cells via the sensing lines; and
1[g] an insulating layer,
1[h] wherein the inclined surface of the sealing thin film is formed to be inclined downwardly toward the driving circuit,
1[i] wherein the sensing lines include inclined portion along the inclined surface of the sealing thin film,
1[j] wherein the sensing lines are formed over the top surface of the sealing thin film in the first portion and formed over the substrate in the second portion, and the sensing lines extend from the sensing cells along the inclined surface of the sealing thin film to the second area of the substrate, wherein the sensing lines are electrically connected to the driving circuit,

1[k] wherein the sensing cells include a plurality of first sensing cells connected along a first direction by first connection patterns and a plurality of second sensing cells connected along a second direction by second connection patterns, and
1[l] wherein the insulating layer is interposed between the first connection patterns and the second connection patterns.
Claim 2
2. The display according to claim 1, wherein the first portion is located on the sealing thin film and the second portion is located on the second area of the substrate, and wherein first portions of the sensing lines are located on a same layer.
Claim 3
3. The display according to claim 2, wherein second portions of the sensing lines are located on a different layer from the first portions of the sensing lines.
Claim 4
4. The display according to claim 1, wherein a first distance between first portions of the sensing lines and the substrate is greater than a second distance between second portions of the sensing lines and the substrate.
Claim 5
5. The display according to claim 1, wherein the sensing lines are electrically connected to the driving circuit through wiring lines.
Claim 6
6. The display according to claim 1, wherein the sensing lines include a different material from the sensing cells.
Claim 7

7. The display according to claim 1, wherein the driving circuit is located on the second area of the substrate.
Claim 8
8. The display according to claim 7, further comprising a flexible printed circuit board (FPCB) attached to the second area of the substrate.
Claim 9
9. The display according to claim 8, wherein the sensing lines are electrically connected to the driving circuit through the FPCB.
Claim 10
10. The display according to claim 1, wherein the sensing lines are arranged outside the pixel area.
Claim 11
11. The display according to claim 1, wherein the first area has a greater area than the second area.
Claim 12
12. The display according to claim 1, wherein the sealing thin film includes at least one organic layer and at least one inorganic layer.
Claim 13
13. The display according to claim 1, wherein the first connection patterns are respectively patterned to have independent patterns in upper or lower layers of the first sensing cells so that the first connection patterns are electrically connected to the first sensing cells at upper or lower portions of the first sensing cells.

I, Richard Flasck, do hereby declare:

I. INTRODUCTION

1. I have been retained on behalf of BOE Technology Group Co., Ltd. (“BOE” or “Petitioner”) to offer technical opinions related to U.S. Patent No. 10,013,088 (“the ’088 patent”) (Ex-1001). I understand that BOE is requesting that the Patent Trial and Appeal Board (“PTAB” or “Board”) institute an inter partes review (“IPR”) proceeding of the ’088 patent. Specifically, I have been asked to consider the validity of claims 1–13 of the ’088 Patent (the “Challenged Claims”) in view of prior art, anticipation and obviousness considerations from the perspective of a person of ordinary skill in the art at the time of the invention (“POSITA”) as it relates to the ’088 Patent.

2. I am being compensated for my time at my standard consulting rate. I am also being reimbursed for expenses that I incur during the course of this work. My compensation is not contingent upon the results of my study, the substance of my opinions, or the outcome of any proceeding involving the challenged claims. I have no financial interest in the outcome of this matter or on the pending litigation between Petitioner and Patent Owner.

3. My analysis here is based on my years of education, research and experience, as well as my investigation and study of relevant materials, including

those cited herein.

4. I may rely upon these materials, my knowledge and experience, and/or additional materials to rebut arguments raised by the Patent Owner. Further, I may also consider additional documents and information in forming any necessary opinions, including documents that may not yet have been provided to me.

5. My analysis of the materials produced in this proceeding is ongoing and I will continue to review any new material as it is provided. This declaration represents only those opinions I have formed to date. I reserve the right to revise, supplement, and/or amend my opinions stated herein based on new information and on my continuing analysis of the materials already provided.

II. BACKGROUND AND QUALIFICATIONS

6. I am over the age of 18 and am competent to write this declaration. I have personal knowledge, or have developed knowledge of these technologies based upon education, training, or experience, of the matters set forth herein.

7. My qualifications are set forth in my curriculum vitae, a copy of which is attached as Appendix A to this Declaration. The following is a brief summary of my relevant qualifications and professional experience.

8. My qualifications for forming the opinions set forth in this Declaration are summarized here and explained in more detail in my curriculum vitae, which is attached as Exhibit Ex-1004.

9. I received a Bachelor of Science degree in Physics from the University of Michigan, Ann Arbor, in 1970. I thereafter received a Master of Science degree in Physics from Oakland University in Rochester, Michigan, in 1976. I am the founder and CEO of RAF Electronics, where I developed and patented Liquid Crystal on Silicon (LCOS) microdisplay projection technology using active matrix transistor arrays as well as developed proprietary LED-based Solid State Lighting (SSL) products.

10. After receiving my bachelor's degree, I was employed as a scientist and a manager by Energy Conversion Devices, Inc., from 1970 through 1982. My work at Energy Conversion Devices concerned the development of electroluminescent displays, thin film photovoltaics, ablative imaging films, non-volatile memory, multi-chip modules, and superconducting materials. After leaving Energy Conversion Devices, I founded and served as CEO of Alphasil, Inc., where I developed amorphous silicon thin film transistor (TFT) active matrix liquid crystal displays (AMLCDs). My work at Alphasil included thin film transistor array substrate process and circuit design, data driver and gate driver design, scalars, video

circuits, gamma correction circuits, backlighting, and inverter design. At Alphasil I also designed and incorporated touch panel screens into active matrix display devices. The touch panel technologies included surface acoustic wave, resistive, and capacitive sensing. I worked at Alphasil from 1982 through 1989.

11. After leaving Alphasil, I founded RAF Electronics, described above. I have served as CEO of RAF Electronics since that time. At RAF I developed HDTV projection technology including transistor array substrates for LCOS devices and the associated optical systems. My activities at RAF have included developments in lighting systems using both traditional LED and OLED (Organic Light Emitting Diode) technologies. In 2016 I was granted US Patent 9,328,898 which includes OLED and LED technology and lighting systems. In 2019 RAF received a CalSEED grant from the California Energy Commission to develop ultra-efficient lighting products and explore establishing a Central Valley manufacturing facility.

12. In 1997, I took the position of President and COO at Alien Technology Corporation, where I was responsible for completing a Defense Advanced Research Projects Agency (DARPA) contract, and for implementing MEM fluidic self-assembly (FSA) technology for flat panel displays. I left that position in 1999.

13. In 2002, I co-founded and served as COO of Diablo Optics, Inc., where I developed, produced, and commercialized key optical components for HDTV

projectors, such as polarization optics, condenser lenses, projection lenses, and ultra-high performance optical interference filters using thin film stacks in conjunction with LED and thin film transistor arrays and devices. I left Diablo in 2007.

14. I am listed as an inventor on twenty-six patents issued in the United States and foreign countries, including one United States design patent. My inventions concern technologies including LED devices, semiconductor materials, glass materials, non-volatile memory cells, thin film transistors, flat panel backplanes and displays, and wafer based active matrices, and various transistor array substrates.

15. I have authored or co-authored twenty-five articles or conference presentations, including numerous papers and presentations concerning lighting and display technologies. My curriculum vitae (Exhibit Ex-1004) lists these articles, conference presentations, and patents.

16. I am also a member of several professional organizations, including Optica, SPIE, AES, SID, and the IEEE.

17. In summary, I have 55 years of experience in the field of high-tech product development including flat panel displays, transistor array substrates, touch panels, and OLED and LED devices.

EX-1003, PTAB Case No. IPR2025-01481
Declaration of Richard Flasck in support of Petition for
Inter Partes Review of U.S. Patent No. 10,013,088 B2

18. I have been an expert witness in over 60 patent cases, have written scores of expert reports and declarations, and have testified in district court or before the International Trade Commission (ITC) eight times.

19. Since 2019, I have served as an expert witness for patent infringement litigation (or arbitrations) or PTAB proceedings in the following cases involving OLED displays:

- *Solas v Samsung*, Case No. 2:19-cv-00152-JRG
- *Solas v LG / Sony*, Case No. 6:19-cv-00236-ADA
- *Solas v Samsung*, Case No. 2:19-cv-00152-JRG
- *Solas v Dell*, Case No. 6:19-cv-00514-ADA
- *Solas v Google*, Case No. 6:19-cv-00515-ADA
- *Solas v Apple*, Case No. 6:19-cv-00537-ADA
- *Solas v HP*, Case No. 6:19-cv-00631-ADA
- *LGD v Solas*, IPR2020-00177
- *Samsung v Solas*, IPR2020-00320
- *Solas v BOE/Samsung*, ITC337-TA-1243
- *Solas v Samsung*, Case No. 2:21-cv-000104-JRG

20. Since 2019, I have served as an expert witness for patent infringement litigation (or arbitrations) or PTAB proceedings in the following cases involving touch panel screens:

- *Neodron v Lenovo / Motorola*, Case No. 3:19-cv-05644-SI
- *Neodron v Dell*, Case No. 1:19-cv-00819-ADA
- *Neodron v Microsoft*, Case No. 1:19-cv-00874-ADA
- *Neodron v Amazon*, Case No. 1:19-cv-00898-ADA
- *Samsung v Neodron*, IPR2020-00192
- *Samsung v Neodron*, IPR2020-00234
- *Samsung v Neodron*, IPR2020-00225
- *Samsung v Neodron*, IPR2020-00406
- *Samsung v Neodron*, IPR2020-00267
- *Samsung v Neodron*, IPR2020-00267
- *Samsung v Neodron*, IPR2020-00515
- *Dell, Lenovo, HP v Neodron*, IPR2020-00731
- *Samsung v Neodron*, IPR2020-00308

III. LEVEL OF ORDINARY SKILL IN THE ART

21. In rendering the /opinions set forth in this declaration, I was asked to consider the patent claims and the prior art through the eyes of a POSITA at the time

of the alleged invention, which I understand is asserted to be September 14, 2010—the earliest possible priority date of the '088 Patent. I understand that the factors considered in determining the ordinary level of skill in a field of art include the level of education and experience of persons working in the field; the types of problems encountered in the field; the teachings of the prior art, and the sophistication of the technology at the time of the alleged invention. I understand that a POSITA is not a specific real individual, but rather is a hypothetical individual having the qualities reflected by the factors above. I understand that a POSITA would also have knowledge from the teachings of the prior art, including the art cited below.

22. Taking these factors into consideration, a person of ordinary skill in the art (“POSITA”) of the subject matter in the '088 patent on or before the time of its earliest effective filing in September 2010 would have had a bachelor’s degree in electrical engineering, physics, materials science or engineering, or a related field and at least four years of experience with design or development of touchscreen displays, or the equivalent. Additional education could substitute for industry experience and vice versa.

23. Before September 14, 2010, my level of skill in the art was at least that of a POSITA. I am qualified to provide opinions concerning what a POSITA would have known and understood at that time, and my analysis and conclusions herein are

from the perspective of a POSITA as of that date.

IV. MATERIALS CONSIDERED AND RELIED UPON

24. In developing my opinions below relating to the '088 patent, I have considered the '088 patent, its prosecution history, and any materials cited throughout my declaration.

V. LEGAL STANDARDS

25. Counsel has informed me of the legal principles that apply in determining whether patent claims are unpatentable for obviousness. Paragraphs below beginning with “I understand” or “I have been informed” capture my understanding of the law as provided to me by counsel. The other paragraphs are my opinion.

26. I understand that the patent laws were amended in 2011 by what is called the Leahy–Smith America Invents Act (“AIA”). I understand that patent applications filed after March 16, 2013, are subject to the amended, post-AIA versions of the patent laws, but patent applications filed before that date are subject to the pre-AIA versions of the patent laws. I have been informed that based on the earliest possible effective date of the '088 patent (which I understand is September 14, 2010), the pre-AIA versions of the patent laws apply.

27. I understand that §102 defines what is and is not prior art, and the amended, post-AIA version of §102 applies here. Specifically, I understand that under post-AIA §102(a)(1), any patents, printed publications, public use, sales, or other public availability of subject matter “before the effective filing date of the claimed invention” constitutes prior art. However, I also understand that §102(b)(1) sets out certain exceptions: if any of the above disclosures were made less than one year before the effective filing date of the claimed invention, the disclosure is not prior art if (A) “the disclosure was made by the inventor or joint inventor or by another who obtained the subject matter disclosed directly or indirectly from the inventor or a joint inventor,” or (B) “the subject matter disclosed had...been publicly disclosed by the inventor or a joint inventor or another who obtained the subject matter disclosed directly or indirectly from the inventor or a joint inventor.” I also understand that, for a printed publication to qualify as prior art, the Petitioner must demonstrate that the publication was disseminated or otherwise sufficiently accessible to the public.

28. I also understand that certain patents and patent applications that were not published before the effective filing date, but had been filed earlier than the effective filing date can also constitute prior art under §102(a)(2), as long as the subject matter in these disclosures was not (A) “obtained directly or indirectly from

the inventor or a joint inventor”; (B) “publicly disclosed by the inventor or a joint inventor or another who obtained the subject matter disclosed directly or indirectly from the inventor or a joint inventor”; or (C) “owned by the same person or subject to an obligation of assignment to the same person” as described in the exceptions of §102(b)(2).

29. I understand that a claim may be unpatentable as obvious under § 103(a) if the subject matter described by the claim as a whole would have been obvious to a hypothetical “person of ordinary skill in the art” (“POSITA”) in view of a prior-art reference, or combination of prior-art references before the effective filing date of the claimed invention.

30. I understand that the “effective filing date” of a claimed invention is either the date the patent application was filed with the U.S. Patent and Trademark Office, or the date an earlier U.S. or foreign priority application was filed to which the patent application claims priority.

31. I understand that, before considering the prior art, the claims are first construed to determine their scope. I understand that the claims are read from the perspective of POSITA at the time of the alleged invention. I understand that the words of a claim are generally given their ordinary and customary meaning as

understood by a POSITA in light of the entire patent specification in which they appear, as well as the prosecution history of the patent.

32. I understand, however, that the words of a claim may be given a meaning other than their plain and ordinary meaning if: (1) a patentee expressly and unambiguously defined a term in a way that is different from its plain meaning; or (2) a patentee “disclaims” the full scope of a claim term’s plain meaning, for instance, by making clear and unambiguous statements during prosecution that a claim term does or does not encompass certain features.

33. I understand that, after construing the claims, the teachings of the prior art are considered. I also understand that a POSITA is assumed to be aware of all relevant prior art in the field of endeavor covered by the patent-at-issue and all analogous prior art. Counsel has informed me, and I understand, that analogous prior art is either/both: (1) in the same field of endeavor as the ’088 patent and (2) reasonably pertinent to solving the same problem as that faced by the inventor of the ’088 patent.

34. I understand that although the ultimate question of the obviousness of a claimed invention is a legal determination, obviousness is based on several factual inquiries, including: the scope and content of the prior art, the differences between the claimed subject matter and the prior art, the level of ordinary skill in the art at

the time of the invention, and any “objective indicia” or “secondary considerations” of non-obviousness, which must all be considered.

35. I understand that, in determining the scope and content of the prior art, a reference is considered relevant prior art if it falls within the field of the inventor’s endeavor, or if it is reasonably pertinent to the particular problem that the inventor was trying to solve. A reference is reasonably pertinent if it logically would have commended itself to an inventor’s attention in considering his problem.

36. I understand that, to assess the differences between prior art and the claimed subject matter to determine whether a claim is obvious, the claimed invention must be considered as a whole. I understand that this involves showing that a POSITA, confronted by the same problems as the inventor and with no knowledge of the claimed invention, would have identified the elements in the prior art and combined them in the claimed manner.

37. I understand that there are several rationales for combining prior-art references. For instance, I understand that it is considered obvious to: combine prior-art elements according to known methods to yield predictable results; substitute one known element for another to obtain predictable results; use the prior-art elements in a predictable way according to their established functions; apply a known technique to a known device (method or product) ready for improvement to yield

predictable results; choose from a finite number of identified, predictable solutions, with a reasonable expectation of success; or if there is some teaching, suggestion, or motivation in the prior art that would have led a POSITA to modify a prior-art reference or combine prior-art teachings to arrive at the claimed invention. I understand, however, that a POSITA does not need to have the same motivations or reasons to combine the prior art as the inventors, and can arrive at the claimed invention for completely different reasons than the inventors.

38. However, I also understand that the prior art cannot be modified or combined using “hindsight.” I understand that hindsight refers to situations in which the patent-at-issue is used as a framework to pick and choose pieces from the prior art to arrive at the claims, or adopting rationales identified by the patent-at-issue that those in the art would not have recognized. Instead, I understand that the obviousness inquiry is evaluated from the perspective of a POSITA as of the critical date of the patent-at-issue, with all the prior art before them, to determine whether the POSITA would have independently arrived at the claimed invention without the benefit of the patent-at-issue for guidance.

39. I understand that “objective indicia” or “secondary considerations” of non-obviousness include whether: (1) there was a long-felt need for the claimed invention; (2) the claimed invention has achieved commercial success; (3) there was

copying of the claimed invention by others; (4) there were failed attempts by others to make the alleged invention; (5) there was praise of the invention in the field; and (6) there was skepticism the claimed invention could be achieved, among a few others.

40. As of the time that I prepared this declaration, the Patent Owner had not identified any secondary considerations of non-obviousness. Therefore, I reserve the right to elaborate on my understanding of these secondary considerations and to address any secondary considerations that Patent Owner may subsequently identify.

41. Finally, I understand that, in an *inter partes* review proceeding, the obviousness of a claim must be demonstrated by “a preponderance of the evidence,” and that this burden falls on the Petitioner. I understand that the preponderance of the evidence standard requires that a reasonable factfinder could find a material fact is more probable than the nonexistence of that fact. It does not allow for speculation regarding specific facts and is instead focused on whether the evidence more likely than not demonstrates the existence or non-existence of specific material facts. I understand that “preponderance of the evidence” is a lower standard than “clear and convincing evidence” (which requires a fact to be substantially more likely to be true than untrue), or “beyond a reasonable doubt” (which is an exceedingly high standard that I understand is generally reserved for criminal matters).

42. I have applied the “preponderance of the evidence” standard throughout my declaration.

VI. TECHNOLOGY OVERVIEW

A. Active Matrix Displays

1. A Brief History

43. The Cathode Ray Tube (CRT) was the dominant display device from the 1940’s through the end of the last century. The CRT relies on raster scanning a focused electron beam inside a large vacuum tube, allowing the beam to impinge on a phosphor coating on the inner surface of the tube. The phosphor emits light in proportion to the electron beam intensity. Pictures are thus drawn on the inner surface of the CRT with an electron beam of modulated intensity.

44. During the 1970’s, interest began to arise to find a “flat panel” technology to supplant the large, heavy CRTs. Many technologies were pursued, including electroluminescent, electro-chromic, electrophoretic, vacuum fluorescent, plasma, liquid crystal, and others. By 1990, liquid crystal displays (LCD) began emerging as the winning technology to supplant the CRT in most commercial and consumer applications. Organic Light Emitting Diode (OLED) displays are now common in smart phones. Today, both LCD and OLED displays are implemented

with active matrix technology where one or more thin film transistors (TFTs) are located at each pixel.

45. The first LCDs were low segment count, direct driven displays, such as watch and calculator displays. Each segment had a common upper and a patterned lower electrode. These electrodes were continuously actively driven. Each segment required a separate dedicated conductor running to the segment. While this was feasible for low information content displays, passive and active matrix LCDs were required for higher pixel count display devices. Active matrix generally has brightness, contrast, response time, and viewing angle advantages over passive matrix.

46. Although there are exceptions, most LCDs comprise two outer polarizer sheets, with a glass plate adjacent to each polarizer. The inner surfaces of the glass plates have transparent indium-tin-oxide (ITO) conductive electrodes. The small gap (usually 1 to 5 micrometers) between the ITO electrodes is filled with liquid crystal material. An epoxy rim seal keeps the liquid crystal material in place.

47. There are several types of liquid crystal material, and generally several modes in which each type of liquid crystal material can be used.

48. The types of liquid crystal materials include twisted nematic (TN), Electrically Controllable Birefringent (ECB), cholesteric, smectic, and ferro-

electric, among others. Various modes include 90° twist, super (270°) twist, Polymer Dispersed (PDLC), vertically aligned (VA), In Plane Switching (IPS), Hybrid Aligned (HAN), bi-stable, normally white, and normally black.

49. The industry has migrated from direct driven segmented watch and calculator displays to active matrix thin film transistor (TFT) LCDs. Consumer demand continues to grow for these active matrix type LCDs.

2. Active Matrix Liquid Crystal Displays (AMLCDs)

50. Most LCD monitors and televisions today use AMLCDs with thin film transistors (TFTs). They use TN with a 90° twist, or a vertically aligned (VA) ECB with negative dielectric constant anisotropy operating in the normally black mode, or In Plane Switching (IPS) mode. Common to each of these modes is the fact that the light transmission at each pixel (picture element) is controlled by the voltage across the pixel electrode and a common electrode. In the early 2000's, most liquid crystal displays used the TN mode and were well known:

Color TFT LCDs are turning up everywhere these days. The color TFT display, a light, slender display, with a beautiful image that does not tire the eyes even when viewed for hours at a time, is finding its way into many products, even in demanding environments, like the dashboard of a car. Because the color TFT display is an LCD (liquid

crystal display) panel incorporating thin film transistors, it can reproduce a wider range of colors than can competing technologies. The color TFT shows extremely uniform brightness, with no color degradation or distortion, even in the corners of the screen.

Color TFT Liquid Crystal Displays, (Ex-1031), Yamazaki (1996), (“*Yamazaki*”), p. 1.

The momentum the LCD industry has gained is difficult to supplant by alternative flat panel technologies, even if, on paper, they may have advantages over LCDs.”

Active Matrix Liquid Crystal Displays (Ex-1030), Willem den Boer (2005), (“*den Boer*”), p.7.

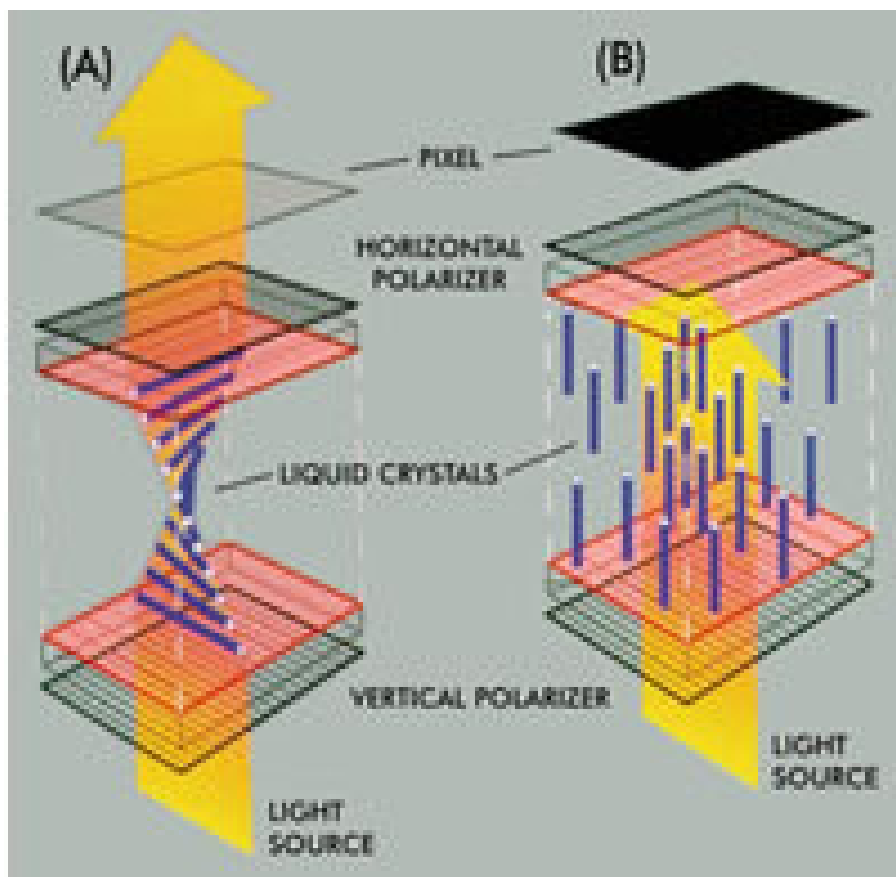
51. The quotes above testify to the fact that by the early 2000s a POSITA was well aware of the basic structure and operating principles of the ubiquitous Active Matrix Liquid Crystal Display (AMLCD). Herein below is a summary of that technology.

52. Liquid Crystal Materials (LCMs) are unusual liquids which exhibit stable states with long range order, wherein the stable state can be determined by the strength of the imposed electric field. These stable states can exhibit differing optical properties. These differing optical properties are exploited to vary the transmission

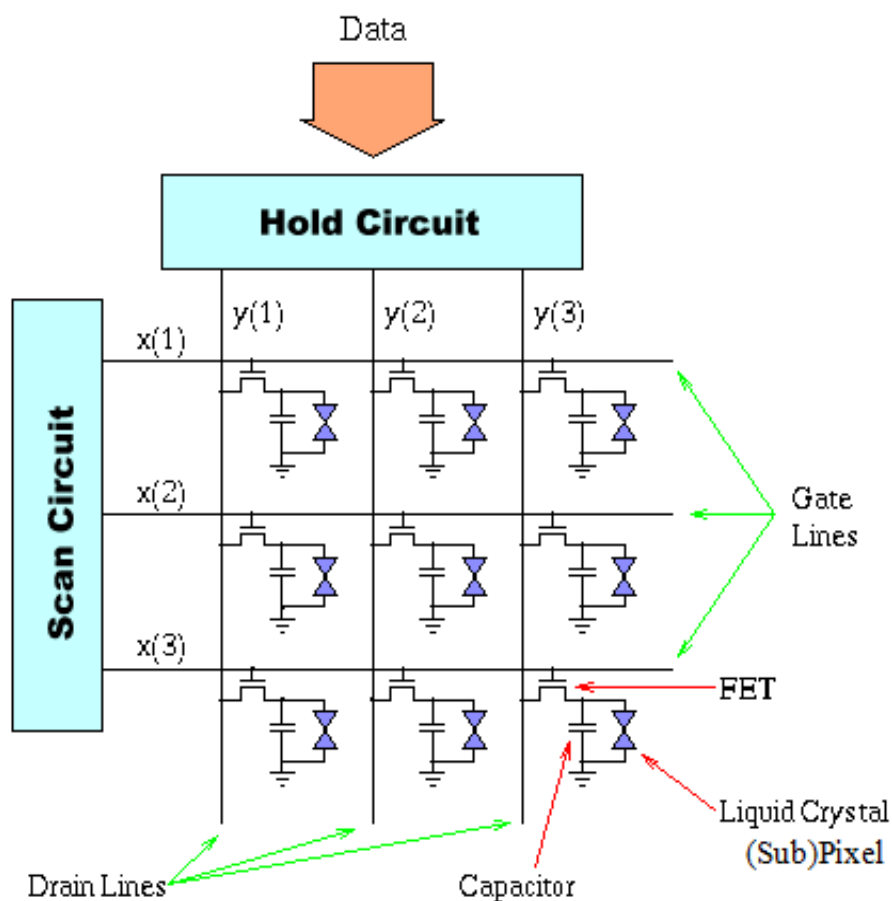
of small segments (pixels or picture elements) of the display by application of an electric field.

53. Typical AMLCD comprises an array of pixels. Each pixel can comprise color sub-pixels, usually red, green and blue. At each sub-pixel is a sample and hold circuit, addressed by a thin film transistor, wherein the voltage across the LCM is held by a storage capacitor.

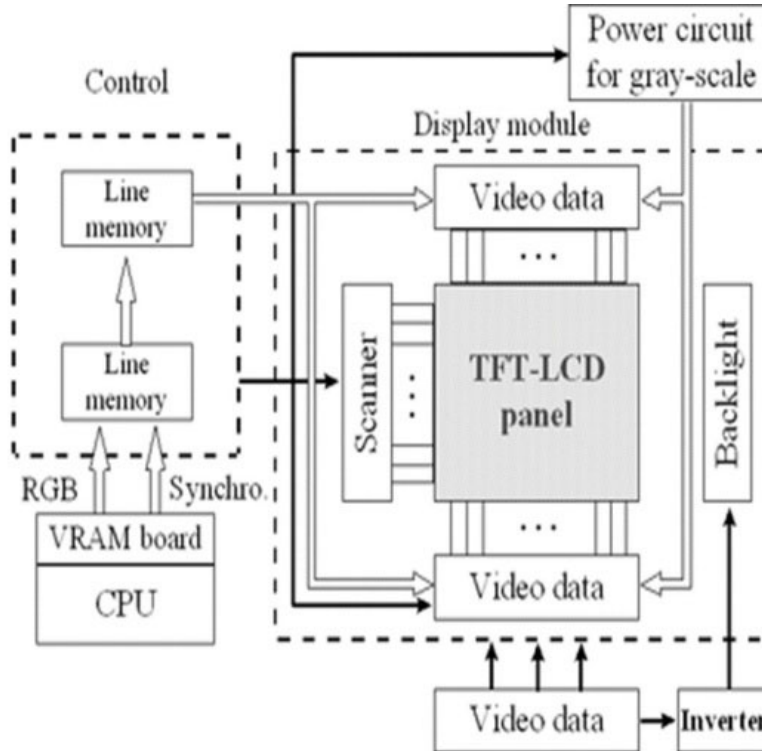
54. Each subpixel acts like a variable shutter, allowing a level of light transmission based on the voltage across the LCM, as shown below. In the figure below, on the left there is no voltage and all light is allowed to pass. On the right, full voltage is applied, and no light is allowed to pass. At intermediate voltages, an intermediate level of light is allowed to pass.



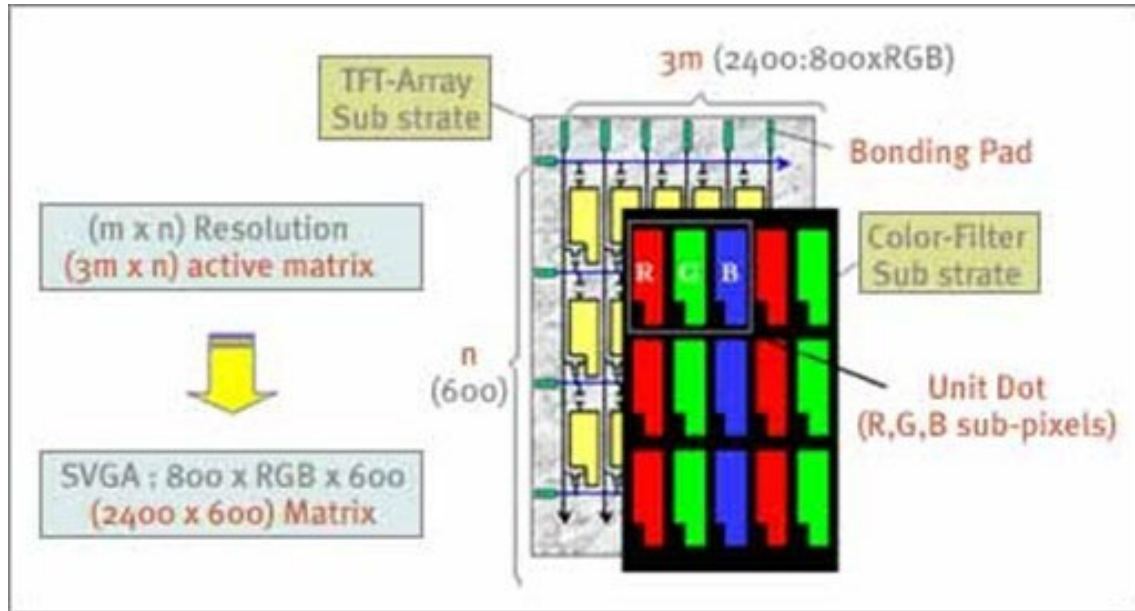
55. Below is a typical electrical diagram of the TFT active matrix showing the drive transistor, the storage capacitor and the liquid crystal element at each sub-pixel:



56. A block diagram of an AMLCD is shown below:

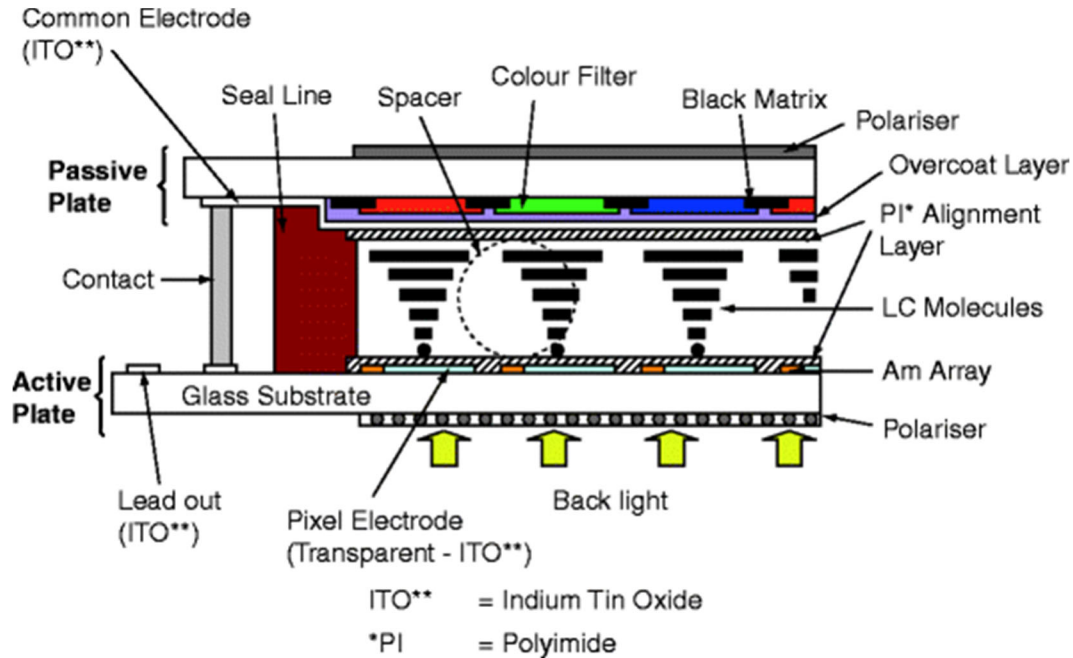


57. Each pixel is usually organized as three sub-pixels: one red, one green and one blue. The colors is determined by the color filter patch over each sub-pixel, as shown below:



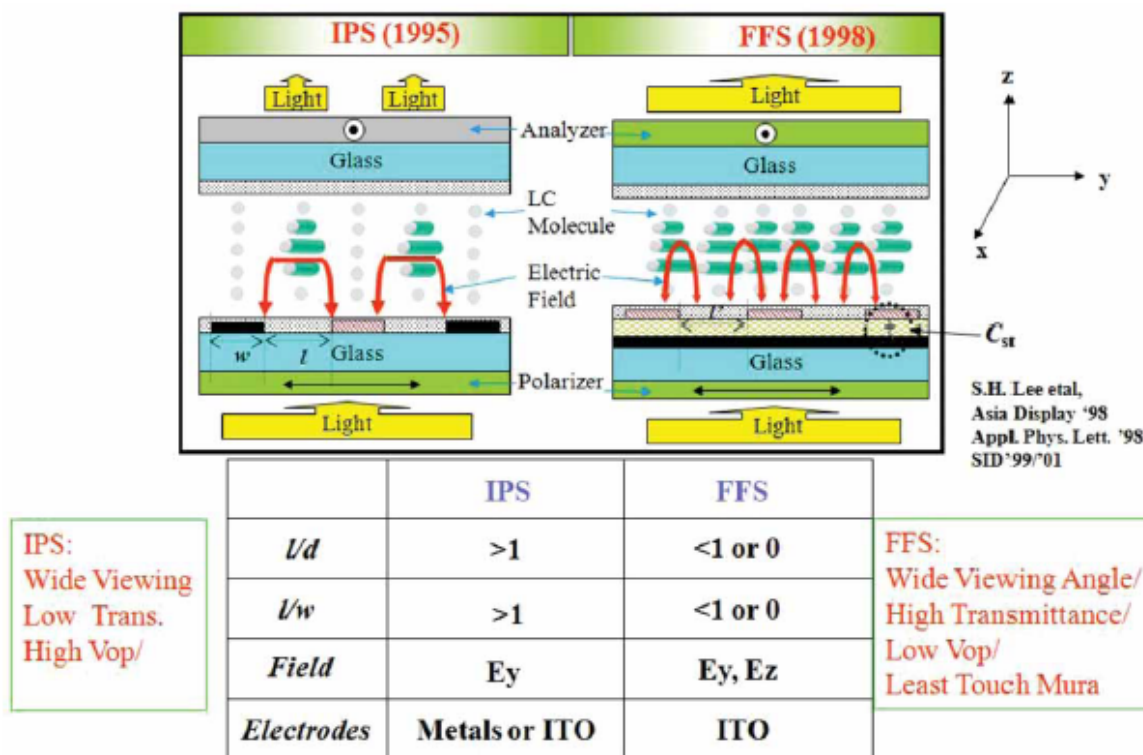
58. The specific color perceived by the human eye (including white) is determined by the proportions of red, green and blue light transmitted by each pixel.

59. As previously mentioned, each sub-pixel circuit comprises a thin film transistor (TFT), a capacitor, and the LCM between the upper and lower pixel electrode. Below is a typical twisted nematic (TN) cross section of a pixel comprising three color sub-pixels:



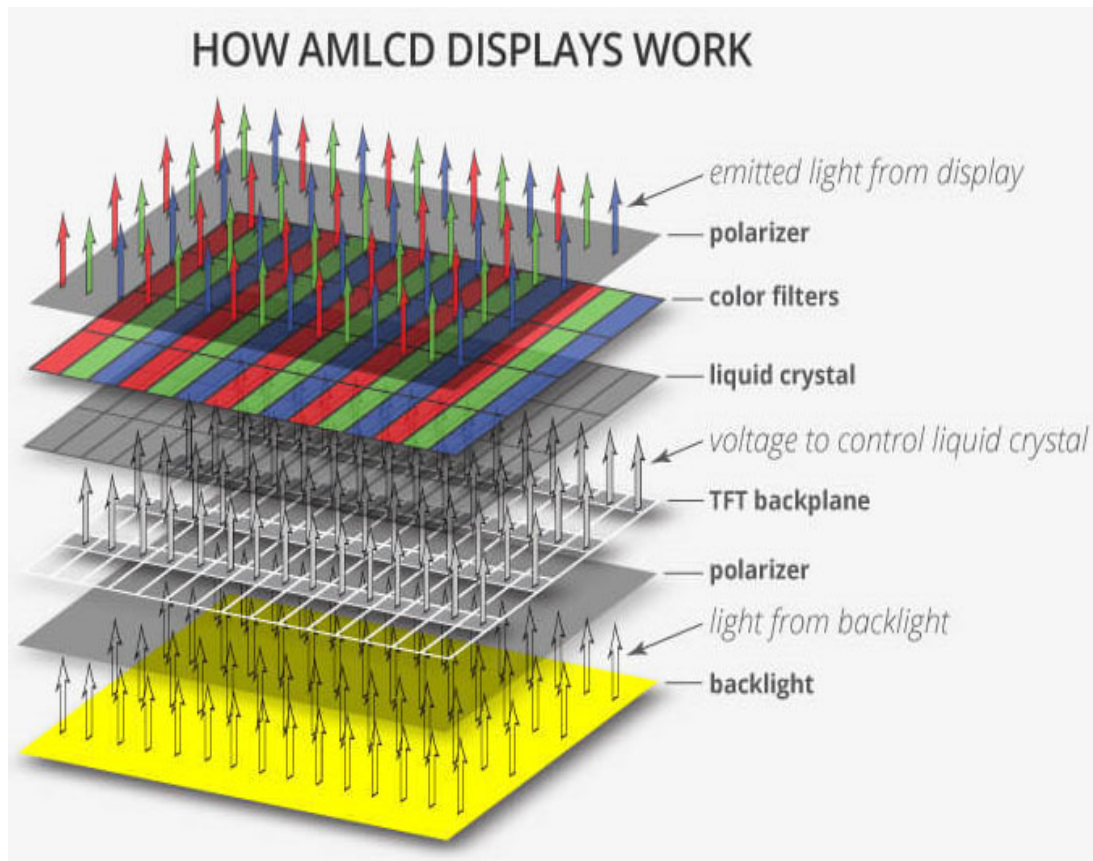
60. Note the indium tin oxide (ITO) common electrode on the bottom of the upper substrate. The common electrode is usually kept at a constant potential. With in-cell touch panels, however, the common electrode can be divided into a multiple separate domains, and each domain is held at the constant potential, until a touch signal is sent to determine if the individual common electrode domain is touched. This interrogation time is usually brief compared to the frame time and may be within a blanking period.

61. Shown below is a second basic type of LCD configuration called In-Plane Switching (IPS) and its close cousin Fringe Field Switching (FFS):



62. In these modes, the pixel electrode and the common electrode are on the same substrate. The pixel electrodes are in pink and the common electrode(s) is in black. As with the TN mode, in-cell touch panels are implemented with the common electrode divided into a multiple domains, and each domain is held at the constant potential, until a touch signal is sent to determine if the individual common electrode domain is touched. This interrogation time is usually brief compared to the frame time and may be within a blanking period.

63. The physical structure of the typical AMLCD module is shown below:



64. Unlike active matrix OLED displays, the AMLCD is a non-emissive technology where the pixels control the amount of light passing through, rather than generating light. Therefore, virtually all AMLCDs comprise a backlight unit (BLU) as indicated in the image above. Active matrix OLED displays have pixels that emit light and have more complex circuitry (multiple transistors) at each pixel, but need no backlight. In-cell touch panels can also be implemented on OLED displays by dividing the common electrode as with AMLCDs.

3. The Backlight Unit (BLU)

65. Each AMLCD module has a BLU located below the AMLCD panel. The BLU provides the light that is modulated by each pixel. There are two generic types of BLUs: direct (or full array) BLUs and edge-lit BLUs. Yamazaki describes the two types shown below. *Yamazaki*, pp. 272-73. The configuration Yamazaki refers to as “Top-down” is known as direct or full array in today’s terminology.

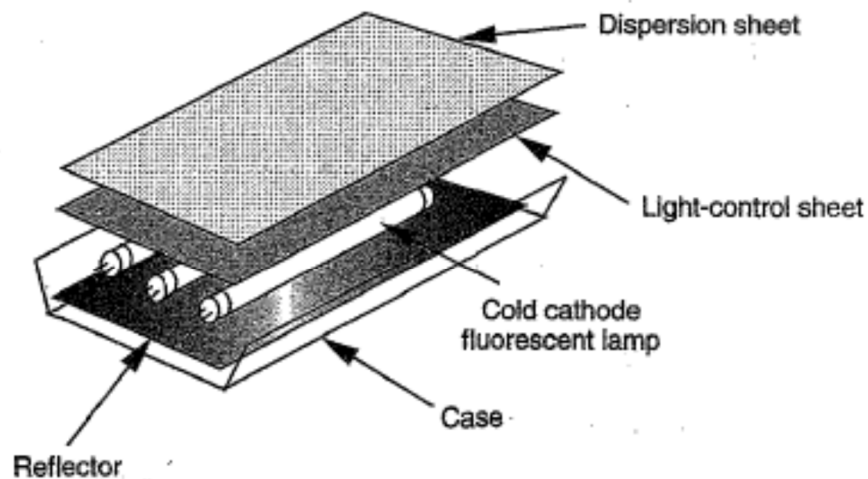


Figure 3.80 Top-down backlight unit

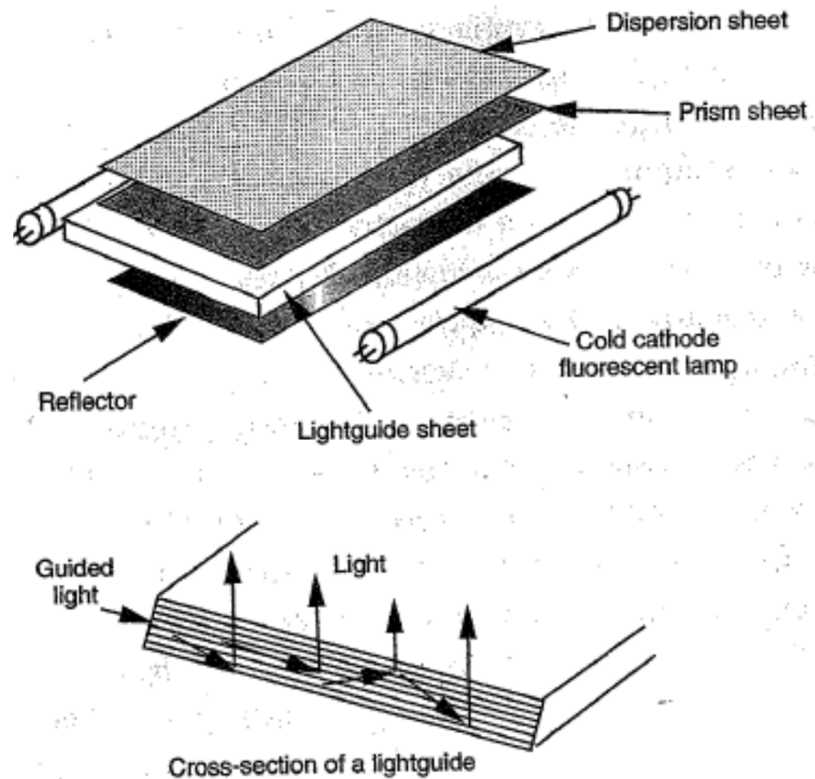


Figure 3.81 Edge illumination unit

66. Full array BLUs have the light source(s) directly underneath the LCD panel with a dispersion (diffuser) sheet between the light sources and the LCD panel. The edge-lit BLUs have the light sources on one or more sides of a light guide or cavity with the light being directed into the light guide and then exiting toward the LCD panel above the BLU.

67. In both configurations, there is a diffuser plate between the light sources and the LCD panel. “Most AMLCDs operate in the transmissive mode. They can be

considered electronically controlled transparencies on a light box – the backlight.”
den Boer, p. 105.

68. Also, in both configurations there is a case holding the BLU components, and a reflector on the bottom of the case.

69. Further, Yamazaki states: “Because they have a direct bearing on the performance of the display unit, backlight units are subject to stringent performance requirements as indicated below...2) *Uniform brightness* A minimum uniformity (minimum brightness divided by maximum brightness) of 0.8 is required.”
Yamazaki, pp. 274-75.

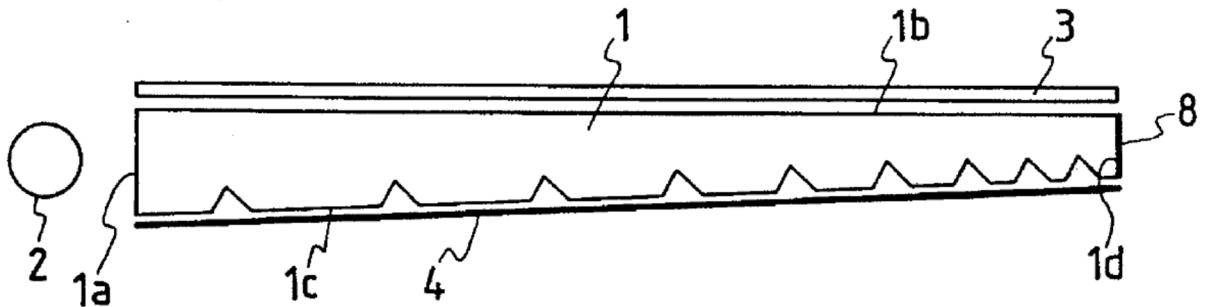
70. Thus, brightness uniformity of the BLU was a well-known, important performance parameter of BLUs, and substantial work throughout the years went into addressing this issue. For example:

[C]oncave portions are arranged to have specific shapes to obtain a bright surface light source with a uniform brightness. A light diffusing material is fulfilled within the concave portions of the light conducting member so that a more uniform brightness can be obtained in an easy manner.

See U.S. Patent No. 5,575,549 (Ex-1032) to Ishikawa, et al. (“*Ishikawa*”), Abstract.

71. And Ishikawa shows a linear (cold cathode fluorescent lamp (CCFL))
light source 2 and a diffuser 3:

FIG. 4

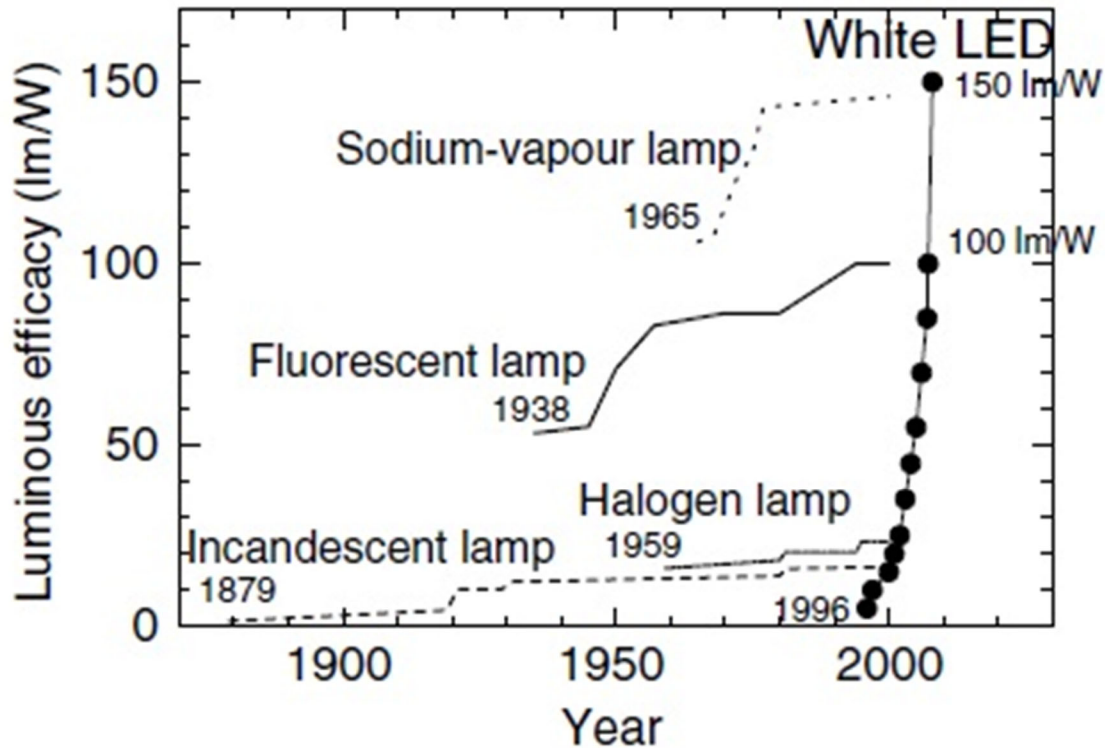


Id., Fig. 4.

72. Further uniformity was a known issue identified in Saizo, Hansen, and Pelka (Exs-1035-37).

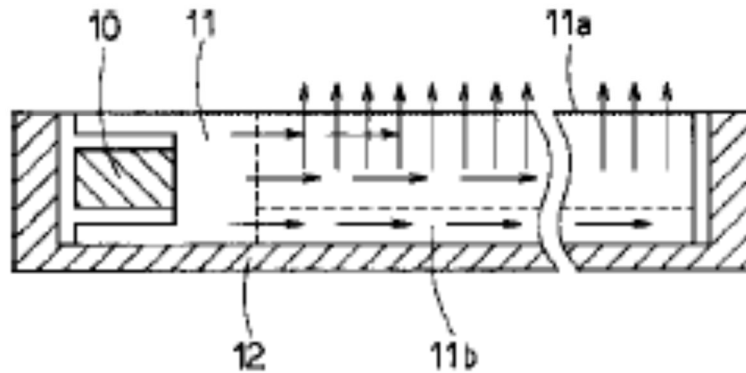
73. In the mid-1990s, LED efficacy and brightness started an exponential rise as phosphor coated GaN blue LED began reaching the market. See the chart below:

<https://phys.org/news/2010-08-white-super-high-luminous-efficacy.html>



74. Starting as early as 1993, JPH06230378 (Ex-1033) to Kisoo, et al. (“Kisoo”) disclosed edge-lit BLUs having a diffuser plate, reflective bottom, a casing and using LEDs as light sources:

【~~FIG~~ 5】



Kisoo, Fig. 5, ¶2.

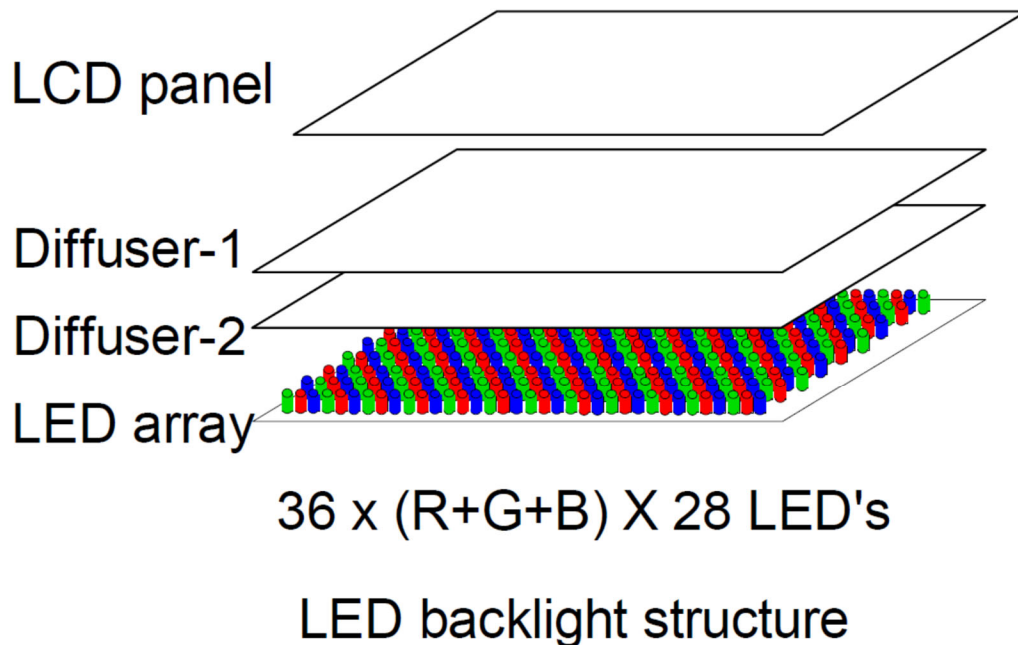
75. The CCFL edge-lit BLU configuration dominated the marketplace throughout the 1990s. However, in the early 2000s there was a conflation of two powerful forces.

76. First, high power, high efficiency LED technology took off, including both color and white LEDs.

77. Second, consumers were becoming dissatisfied with the contrast and dynamic range of AMLCD compared to the much more expensive (low volume) plasma displays. Dynamic contrast ratio technology for AMLCD was developed to selectively dim portions of the screen when those portions had low brightness content. However, this dimming technology was not usable with edge-lit or CCFL BLU configurations. It could only be implemented with direct, full array BLUs using

LEDs instead of CCFLs for light sources. This started the paradigm shift toward LED full array BLUs that is the industry standard today. One of the early transitions from CCFL edge-lit BLUs to LED full array BLUs is shown in Yamada (Ex-1038) from 2000:

Figure 4

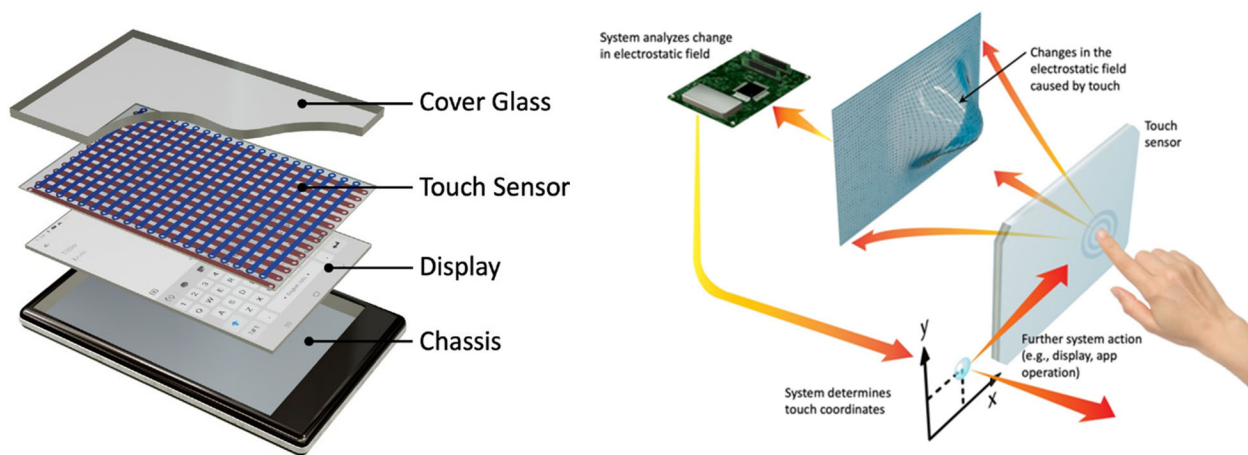


78. Thus, around 2000, full array LED BLUs were well known. These BLUs had Brightness Enhancement Films (BEFs), diffusers, and bottom reflectors.

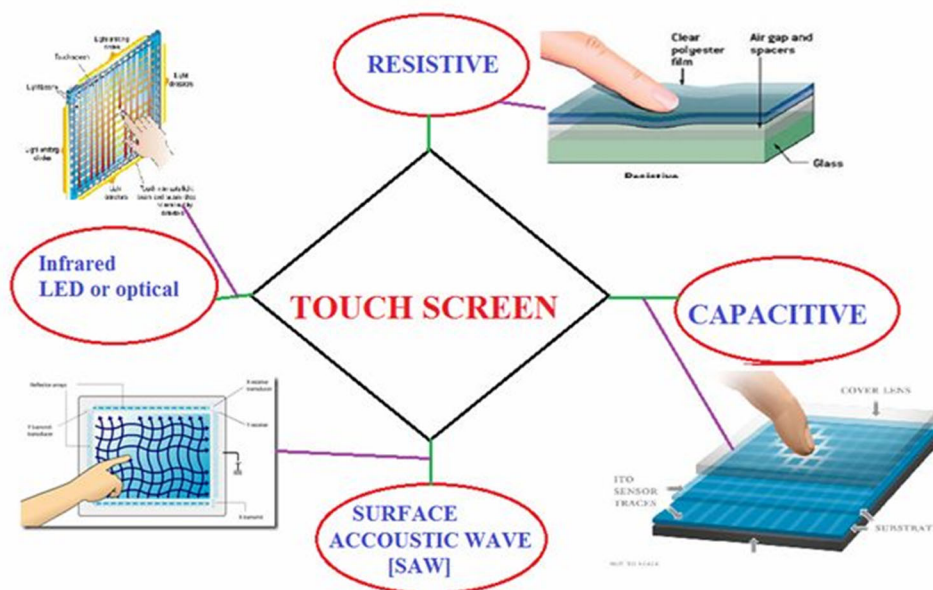
B. Touch Panels

79. The asserted patent generally relates to devices containing a touch-sensitive panel (which may be referred to as a “touch screen”) that allows a user to

interact with an electronic device with a finger or stylus. The electronic device may include a flat panel display (such as an LCD or OLED) and a touch screen. The touch screen may be overlaid on or incorporated into a display screen. A touch sensor is used to determine the location touch as a set of x and y coordinates.



80. Historically, several basic approaches to touch screens have been pursued as shown below:



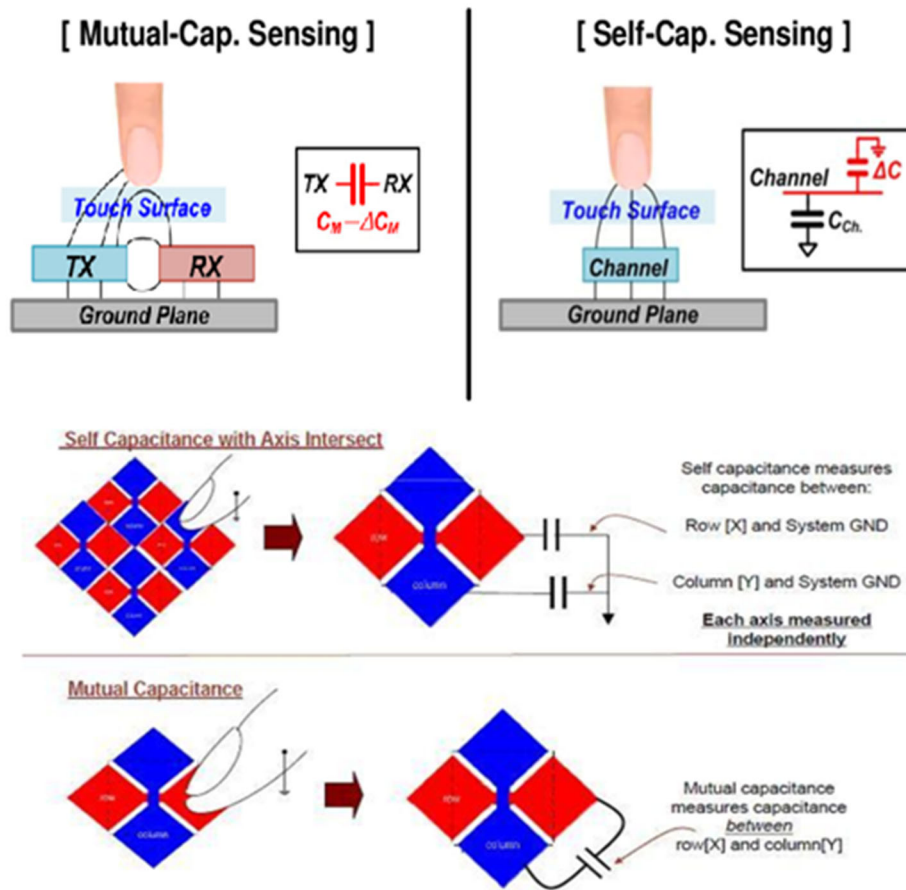
81. By the mid-2000s, touch screens on flat panel displays were in widespread use.

82. TFT LCDs with touch screens have become popular in displays for industrial and retail applications, as well as in PDAs, smart phones, and tablet PC products. They allow easy and fast access to computer information with a more interactive approach than a mouse or a touch pad. Touch panels use "soft-buttons" that can be easily reconfigured with software. Therefore, they give an integrated solution with more design flexibility than a display with a separate keypad or keyboard. The majority of touch-enabled AMLCDs are based on resistive, capacitive, inductive, or surface-acoustic-wave touch technology.

den Boer, 190.

83. Today, capacitive touch screens have become dominant. A capacitive touch system can be designed to detect and report a two-dimensional coordinate (e.g., x, y position) identifying the location of the user's finger or stylus. When a finger touches a capacitive touch sensor it changes the capacitive coupling of the sensor near the touch. This effect is commonly referred to as a change in capacitance within the touch screen at the location of the touch. A touch controller, microprocessor, or other related application specific integrated circuit ("ASIC") may be employed to measure this electrical effect and process information from that measurement to determine the touch's position on the screen.

84. There are two basic forms of capacitance touch screens: self capacitance panels which detect a capacitance change between a sense electrode and ground, and mutual capacitance panels which sense a capacitance change between two electrodes as show following two figures:



85. The simplest type of capacitive touch screen uses self capacitance electrodes in an x-y matrix with a conductor line connecting each electrode to a controller. Such a system is shown in Tang (Ex-1040) below:

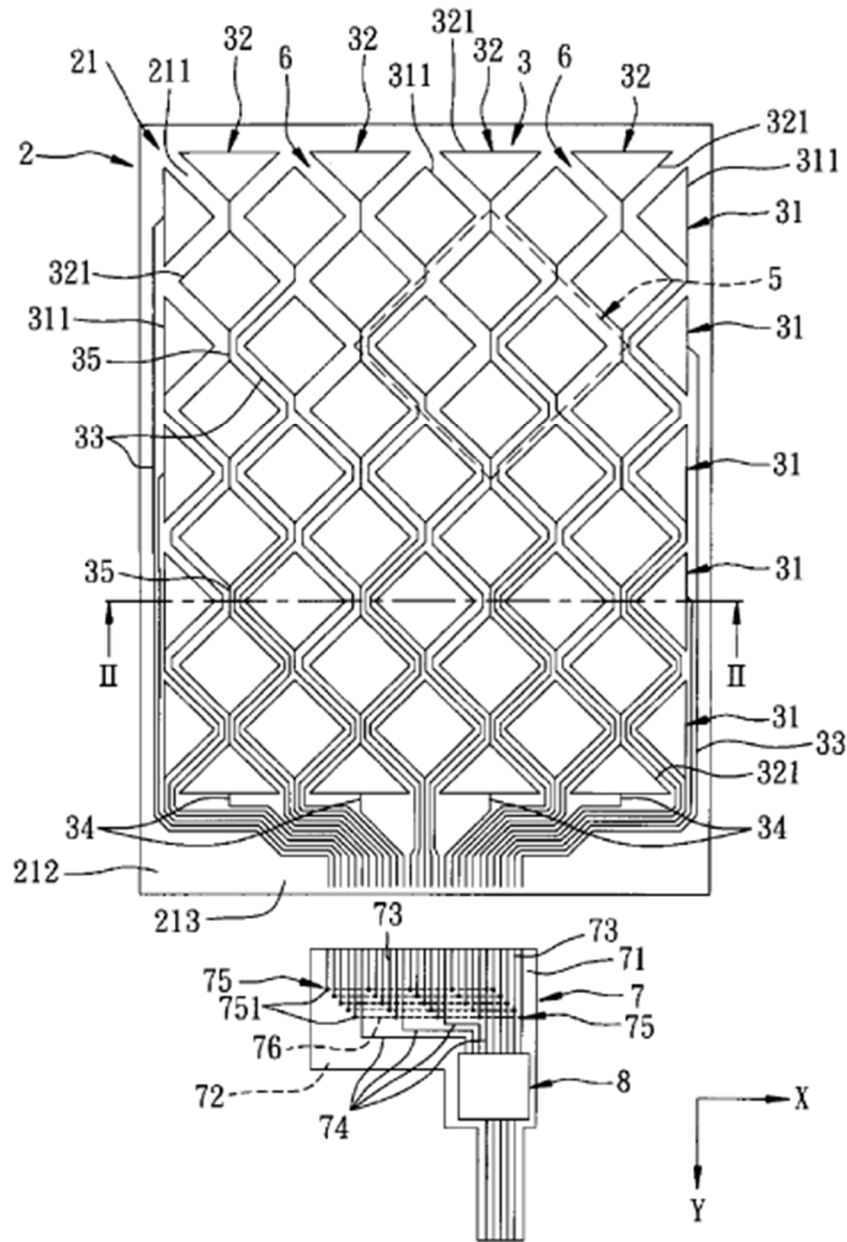
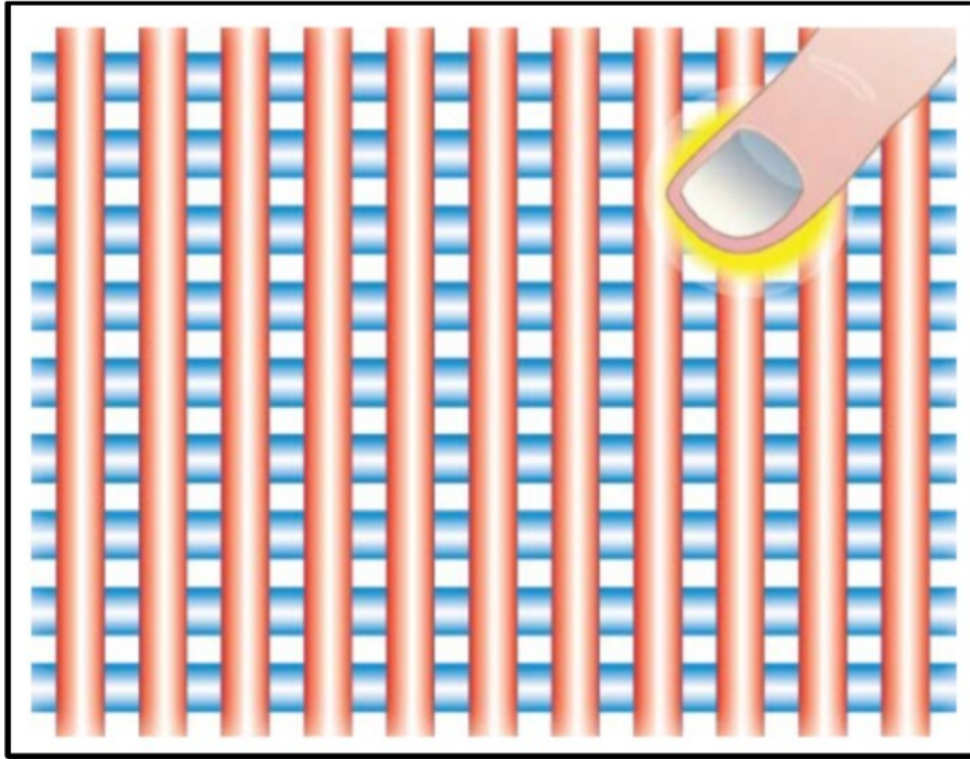


FIG. 1

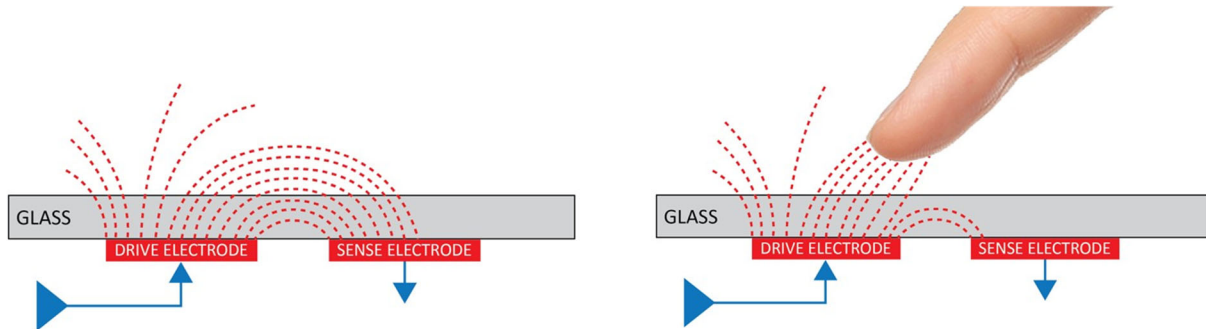
Tang, Fig. 1.

86. Today, the most common type of capacitive touch sensing is “mutual capacitance” sensing. Mutual capacitance refers to the capacitance between a drive electrode (or “drive line”) and a sense electrode (or “sense line”).



87. In a common mutual-capacitance implementation, the touch sensor includes an array of electrodes that are arranged along x- and y-axes to form capacitive nodes where the electrodes intersect, as depicted above. By convention, the transmit or “drive” electrodes are commonly referred to as the X axis, and the receive or “sense” electrodes are referred to as the Y axis. Mutual capacitive sensing uses a transmit-receive process to induce charge across the gap between an emitting electrode and a collecting electrode (the transmitter and the receiver respectively, also referred to as X and Y). As a finger touch interacts with the resulting electric field between the transmitter and receiver electrodes, the amount of charge coupled from transmitter to receiver is changed. Conceptually, when a finger comes near a

capacitive node, it effectively “steals” charge from the drive electrode, which reduces the capacitance of the node in a measurable way, as depicted below:



88. The electrodes used for self or mutual capacitive sensing may be formed in numerous ways. Some electrodes are formed from a transparent conductive material called Indium Tin Oxide (“ITO”). Other electrodes are formed from opaque metallic conductors such as silver or copper. For opaque metals to be usable as touch screen electrodes, they need to be formed into fine mesh patterns that allow light from the underlying display to pass through. In each case, the conductive material is patterned to form electrodes.

89. In order to form the X-Y array of electrodes typically used for mutual capacitive sensing, in which one set of electrodes runs vertically and another runs horizontally, some provision must be made to prevent the two sets of electrodes from making direct electrical contact with each other. One way to accomplish that is by putting the vertical electrodes and horizontal electrodes on separate layers, one

above the other. As an alternative, all electrodes in the array can be deposited in the same layer, and insulating strips or patches can be deposited upon which small connecting links can be formed to connect the vertical or horizontal touch electrodes as seen in U.S. Publication No. 2010/0156810 (Ex-1015) to Barbier, et al. (“*Barbier*”), below:

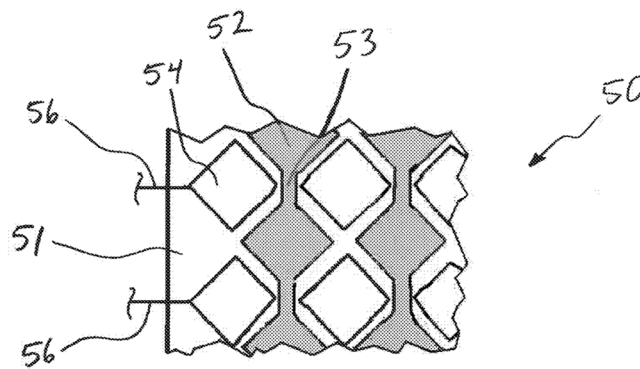


Figure 3A

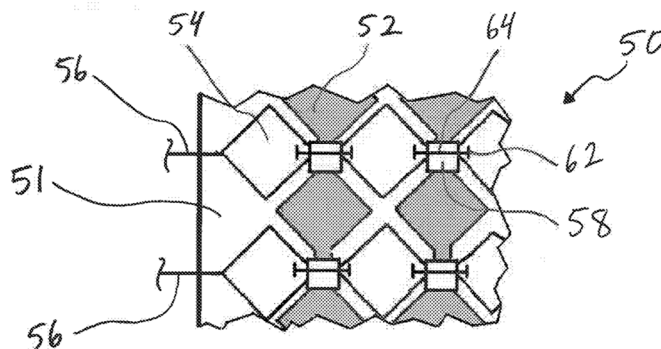
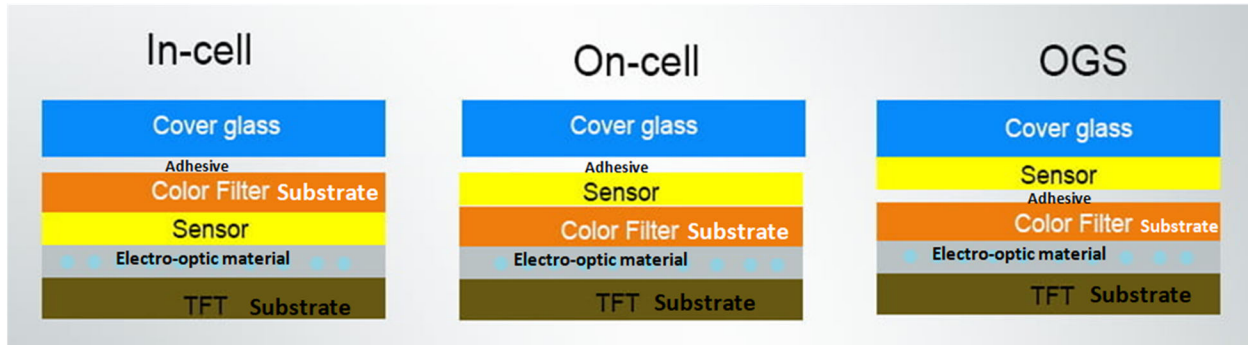


Figure 3B

Barbier, Figs. 3A-B.

90. Touch panels can be implemented in three ways: In-cell, On-cell, or On-Glass-Solution as shown below:



91. The In-cell configuration is the most integrated with the touch sensors located on the lower surface of the top display substrate which places the touch sensors inside the pixels. The On-cell configuration places the sensors on the upper surface of the top display substrate. In the On-glass solution, the touch panel and the display panel are created separately and then cemented together.

C. Integrating Active Matrix Displays and Touch Panels: Touchscreen Displays

92. Touchscreen displays have two primary components: a display panel that displays graphical content, and a touch panel that enables user interaction with the display. Each panel may be based on a variety of underlying technologies—the display may be, e.g., a liquid crystal display (“LCD”), light-emitting diode (“LED”) display, or organic light-emitting diode (“OLED”) display, and the touch panel may

be based on capacitive, resistive, optics, or other sensing mechanisms to sense a user's touch. *Bouten* (Ex-1013), 1:11-17. The display and touch panels can be formed separately and attached, or their component layers integrated together, but the touch panel was conventionally formed or placed on top of the display panel because the touch panel needs to interact with a user's touch. Regardless of the type of display and touch panel used, though, both panels generally required conductive signal lines to connect the panels to controllers or other components typically housed in non-display areas.

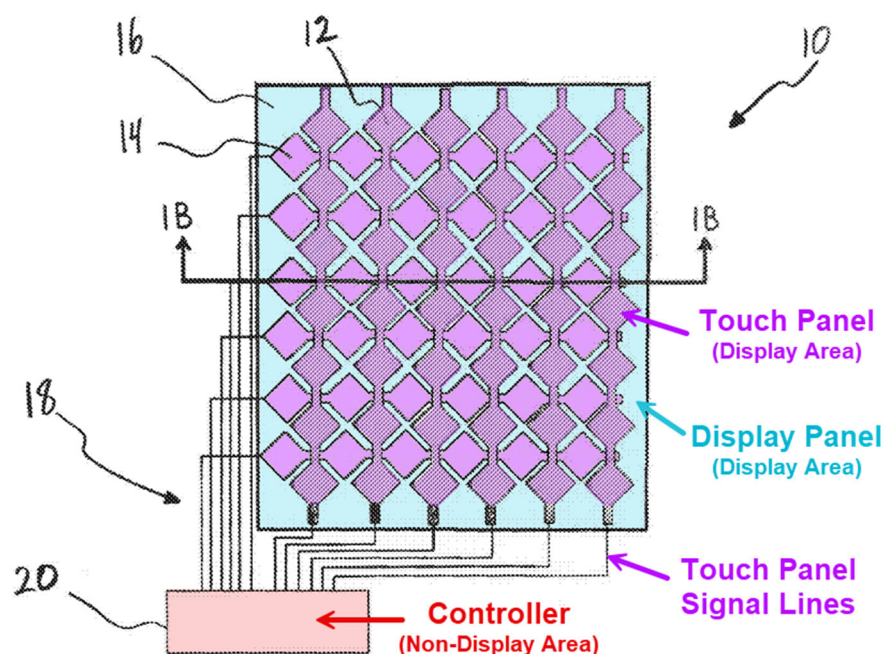
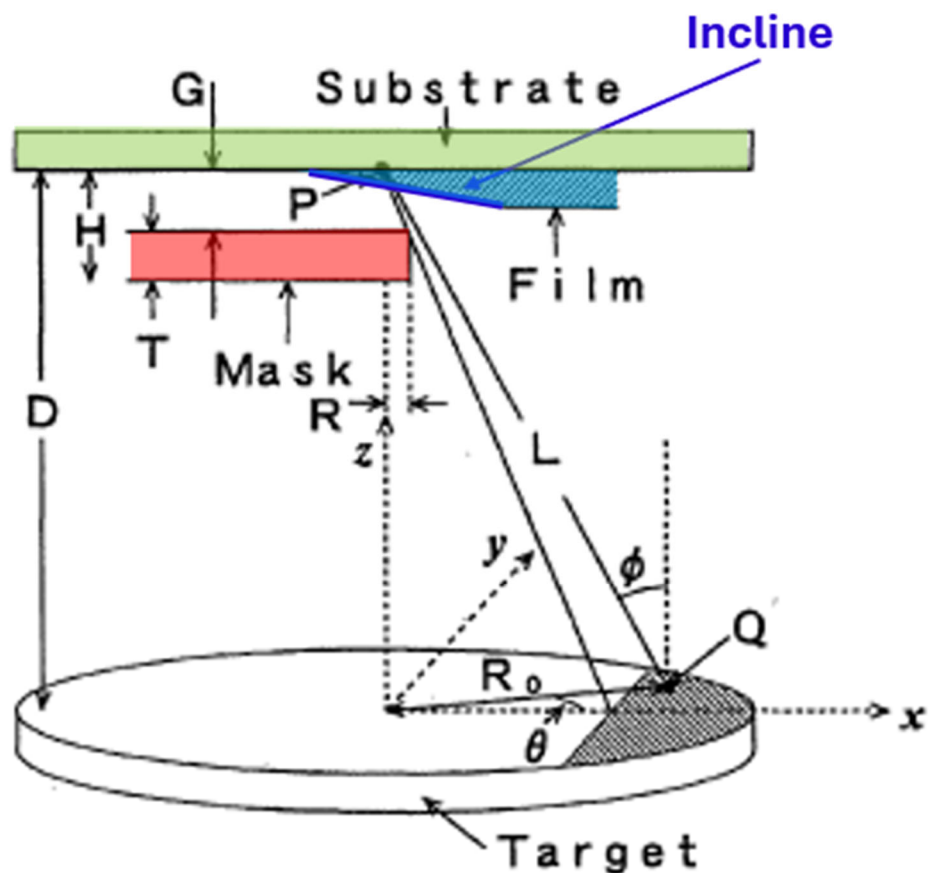


Figure 1A (Prior Art)

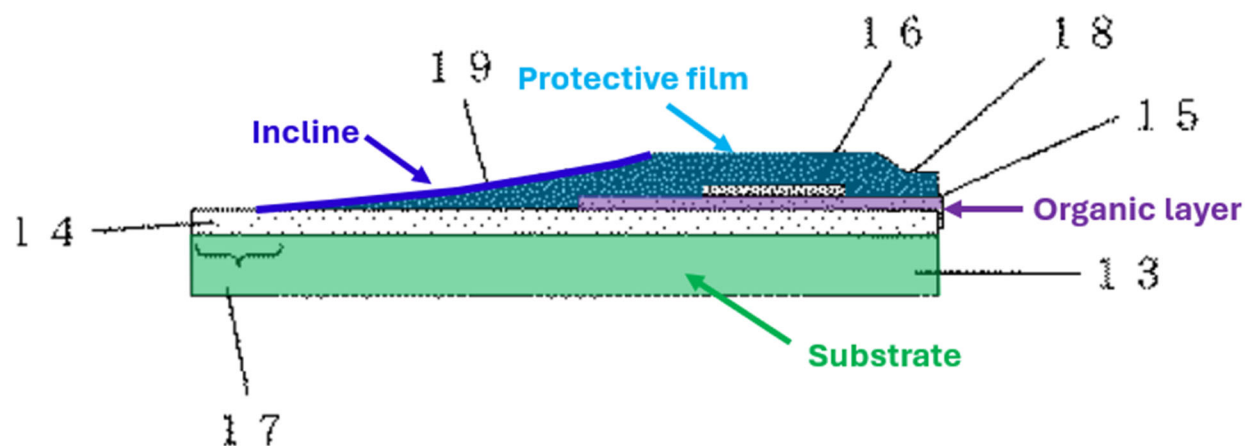
Barbier, Figs. 1A, 2, Abstract, ¶¶1-3, 16; *see also id.*, Fig. 1B, Figs. 3A-B, 4, ¶¶17-19.

93. Of the various types of display panels, however, OLED displays have increased in popularity over the past decade due to their physical flexibility and display properties. *Bouten*, 1:17-22. OLED displays usually include light-emitting diodes of organic material in an array of “pixels” that produce light when electricity is applied to the diodes. *See Lee ’426* (Ex-1029), Fig. 3, ¶¶48, 55, 77-83. OLED displays typically include several common layers: (1) a base substrate serving as the foundation of the display; (2) circuits routing electrical signals to the display’s display pixels formed by OLEDs and other components; (3) the OLED pixels that emit light for displaying images; and (4) protective, buffer, and/or sealing/encapsulation layers to add structural support to the display, “planarize” non-flat layers for subsequent layer formation, and/or to inhibit degradants like oxygen and moisture from entering sensitive components in the display. The sealing/encapsulation layer is particularly important because OLEDs were known to be susceptible to corrosion and degradation when exposed to oxygen and moisture. *Bouten*, 1:23-57. Sealing/encapsulation layers were therefore used to protect the OLEDs from moisture and/or oxygen that may degrade the organic OLED materials and were typically provided as one of the top-most layers of the display panel. *Bouten*, 1:23-57.

94. These layers provide thin film encapsulation, or TFE, and included a well-known and widely used stack of inorganic and organic films that cover (i.e., encapsulate) the OLED display region to protect it. *Id.*, 4:40-55. Conventional encapsulating layer designs deposited larger inorganic layers (films) over smaller organic layers, often producing a stepped incline along the edge of the layered stack. *See e.g., Sano*, Fig. 6; *Imamura*, Fig. 4. A top-most inorganic encapsulation layer (e.g., silicon dioxide, or SiO₂) was deposited through a mask using a plasma enhanced chemical vapor deposition (PECVD) process that created an inclined end in the layer at the edge of the display it covered due to the angular, shadow effect of a mask depositing the inorganic layer:

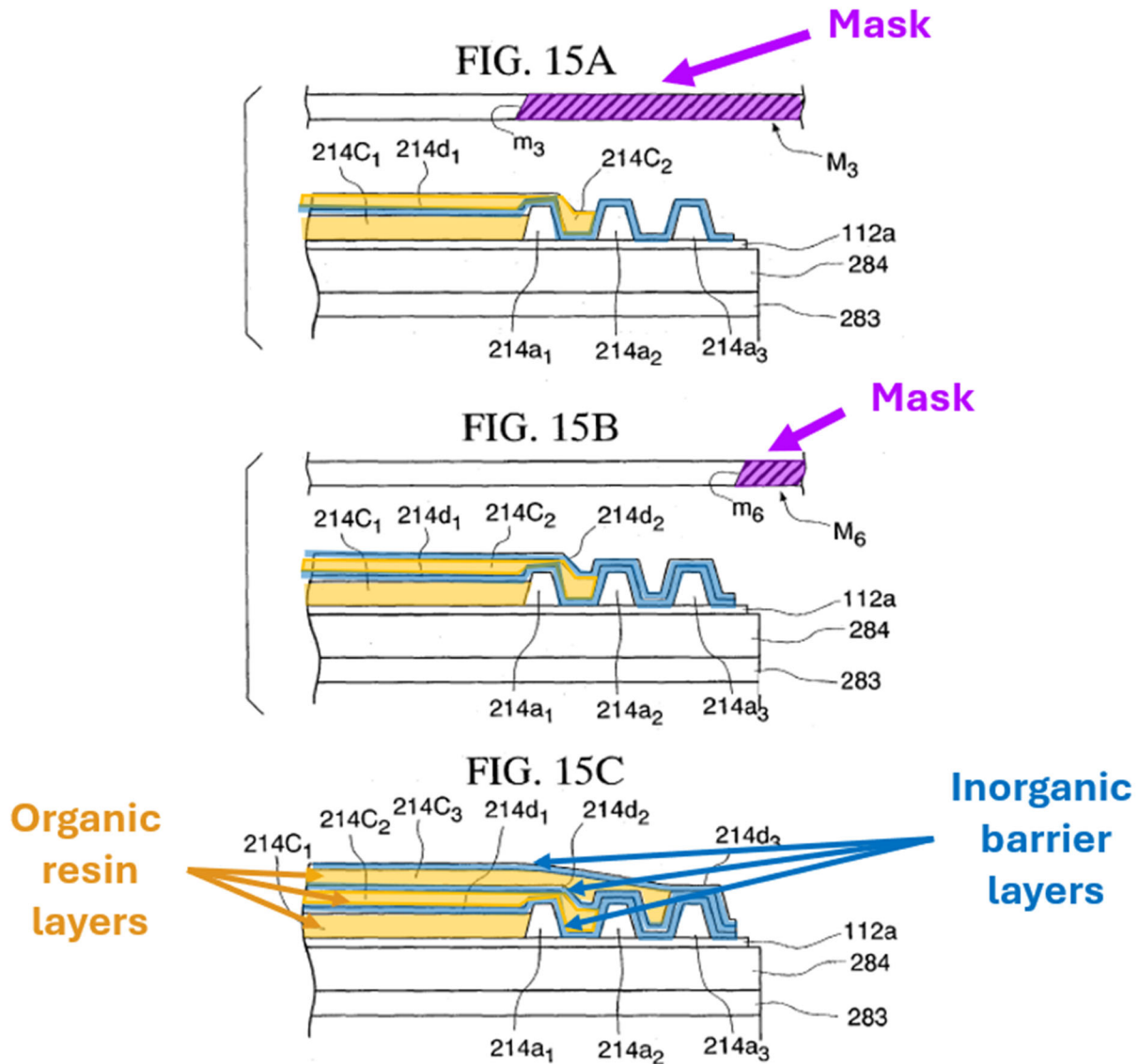


Yamazaki Mask (Ex-1042), §§1-2, 4.1.

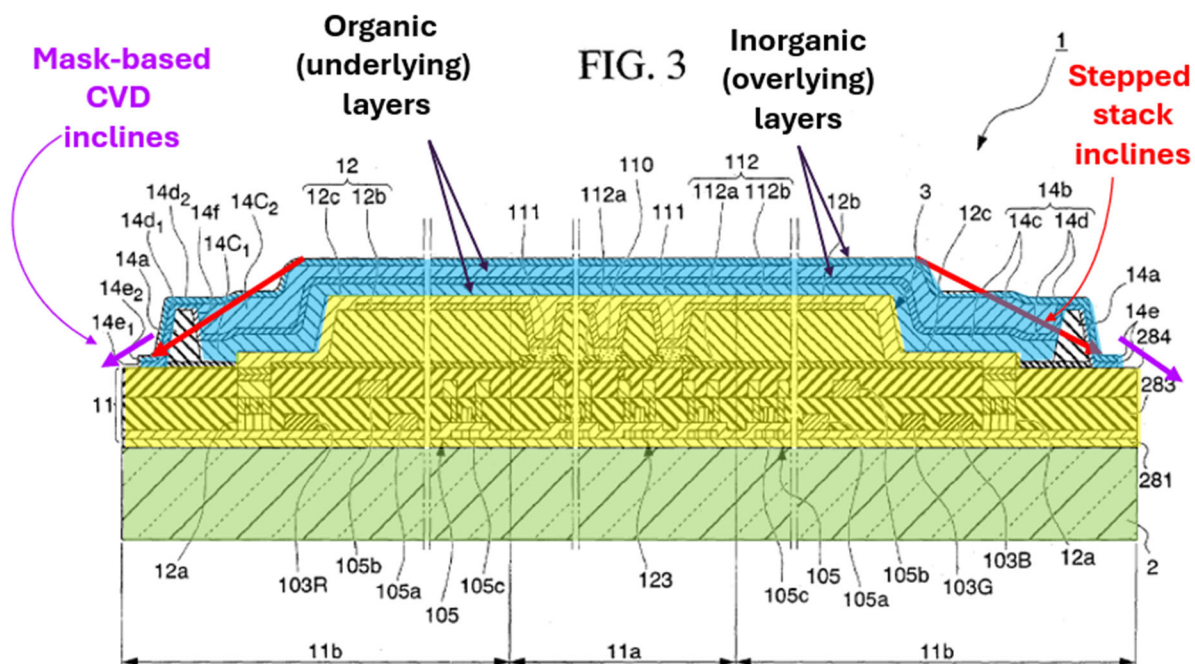


EX-1003, PTAB Case No. IPR2025-01481
Declaration of Richard Flasck in support of Petition for
Inter Partes Review of U.S. Patent No. 10,013,088 B2

Kaneko (Ex-1041), Fig. 4a (annotated), ¶¶65-66, 71. *See also Bouten*, Fig. 5, 5:3-24; *Hashimoto*, ¶¶19, 78; *Imamura '566* (Ex-1051), Figs. 15A-C, ¶¶150-56 (describing a multi-layered sealing membrane comprising organic “flattening resin layers” made of polyacrylic resin and inorganic barrier layers made of silicon dioxide (SiO₂) “or the like”), ¶¶166-68 (disclosing mask-based deposition of the sealing membrane organic and inorganic layers), Figs. 15A-C (annotated below):



95. Conventional encapsulating layer designs included a larger inorganic layers deposited over smaller organic layers, creating a stepped incline along the edge of the layered stack. The mask-based vapor deposition inclines (purple) and stepped inclines (red) are shown below.



Id., Fig. 3 (annotated), ¶114. Organic-inorganic sealing thin films were well known in the art and commonly used to seal OLED or environmentally-sensitive integrated circuit elements. *See, e.g., Chen*, 3:66-4:39; 5:53-6:45; *Bouten*, 4:40-55; *Hayashi*, ¶¶2-6; *Graff*, 1:32-39, 4:23-44, 4:56-63, 6:37-43.

96. It was also common practice to form touch sensor layers directly over OLED encapsulation layers to reduce the overall thickness of the OLED display and touch sensor stacked device suitable for flexible display applications otherwise unavailable in LCD embodiments. *See, e.g., Bouten*, 1:11-57; *Cok*, 1:53-3:8.

VII. '088 PATENT OVERVIEW

A. Specification

97. The '088 patent is entitled “Flat Panel Display with Integrated Touch Screen Panel,” was filed April 20, 2016, and claims priority to earlier U.S. and Korean patent applications potentially dating back to September 14, 2010. Ex-1001, Cover.

98. The '088 patent describes a display with an integrated touch panel formed on a “sealing thin film” (200) or an encapsulation layer of an OLED display. *Id.*, Abstract, 1:59-2:28; 3:13-38; 5:7-53; and Ex-1002, 15-20. The '088 patent discloses that the touch panel’s sensing cells (220) are connected to flexible printed circuit board (FPCB, 300) and “driving integrated circuit” (120) located in non-display areas. *Id.*, 5:7-11, 5:27-30, 6:8-17, Figs. 1, 3, 4. Because the sensing cells (220), FPCB, and driving integrated circuit (120) are formed on different, vertically-spaced horizontal layers, the '088 patent discloses forming the sealing thin film (200) of the OLED display with an inclined surface at its perimeter for the touch panel’s sensing lines (230) to traverse the vertical step difference and connect to the FPCB and driving circuit. *Id.*, 5:18-35, Figs. 3, 4.

FIG. 3

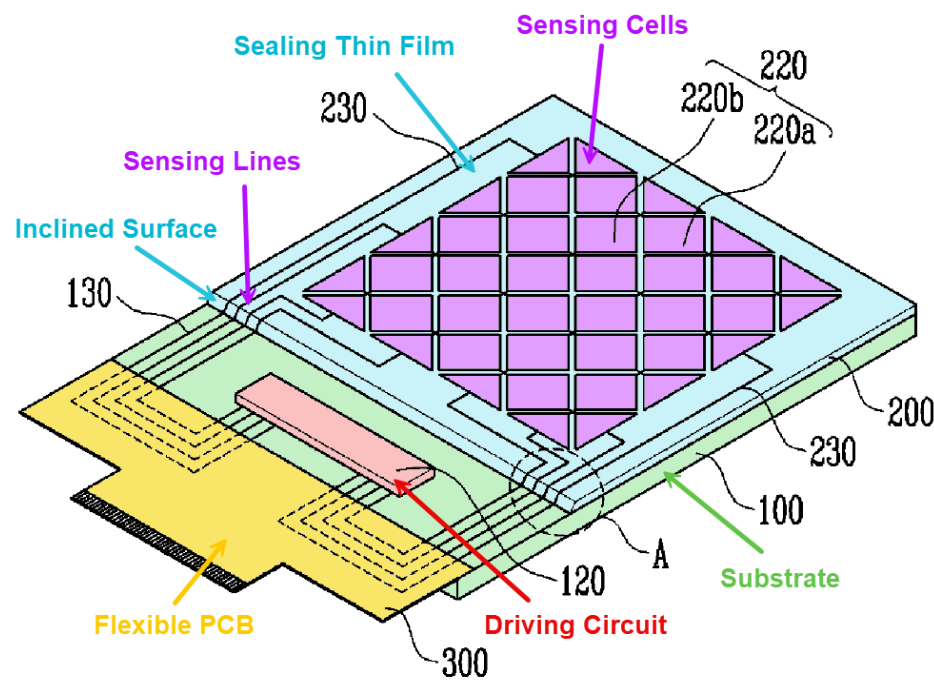
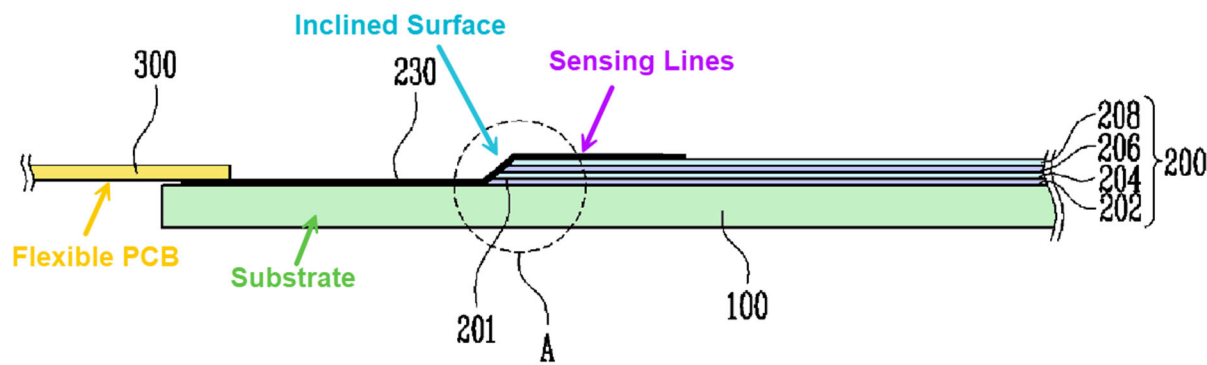
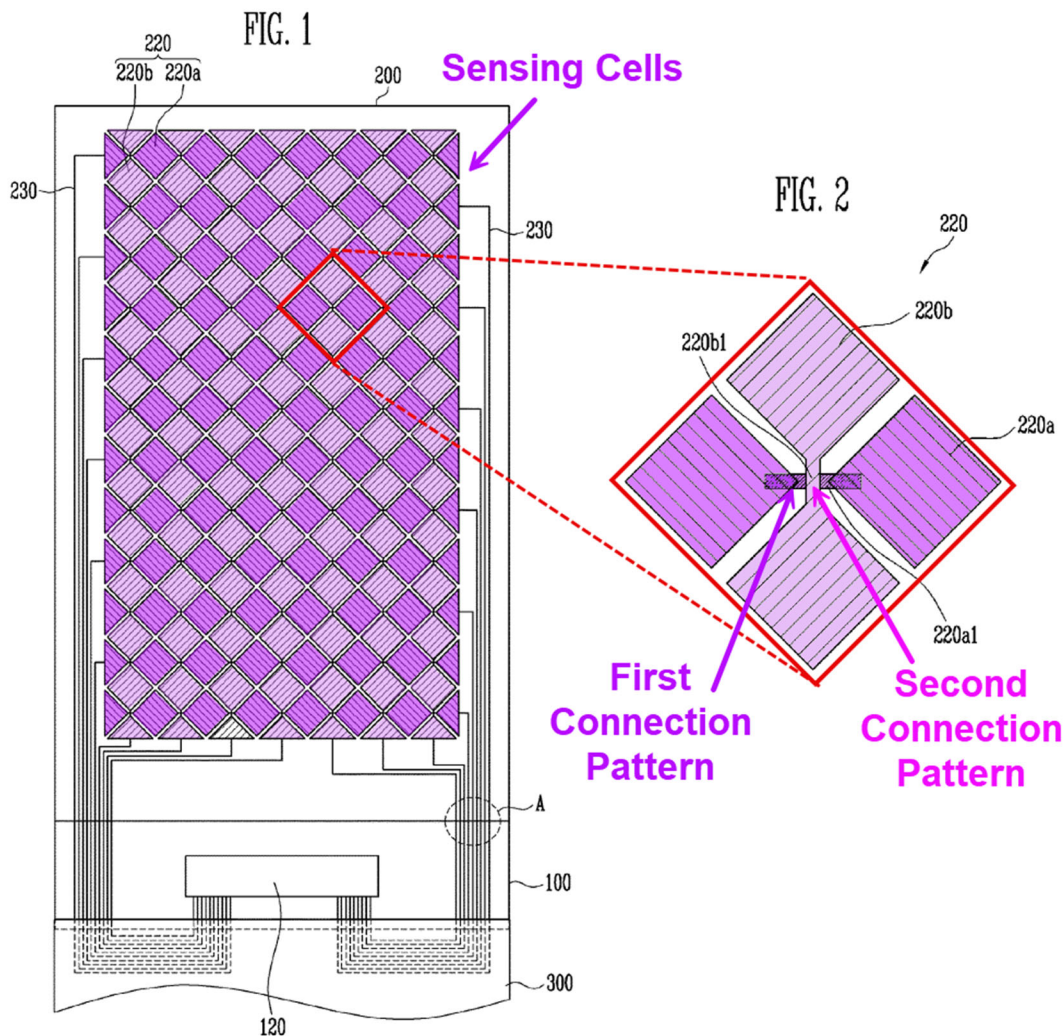


FIG. 4



Id., Figs. 3-4 (annotated).

99. The '088 patent also explains that the touch panel's sensing cells include diamond-shaped sensing cells that are connected to each other in a way that orients the cells in two different directions (e.g., x, y), respectively, with insulation provided between them so that the two sets are not electrically coupled.



Id., Figs. 1-2 (combined, annotated), 3:50-4:19.

B. Prosecution History

100. I have reviewed the prosecution history of the '088 patent at the U.S. Patent office in forming my opinions.

101. The '088 patent is a continuation of U.S. application 13/021,581 (“’581 application”) filed February 4, 2011, and issued as U.S. 9,323,400. Ex-1001, Cover. The '088 patent claims priority to, via its parent '581 application, the Korean patent application KR10-2010-0089955 filed Sep. 14, 2010. *Id.*

102. The original specification and claims of the '088 patent application recited a display with “a pixel area and a second area adjacent” the first pixel area, “an encapsulation layer...including an inclined surface,” and “a plurality of sensing lines on the encapsulation layer” that “extend from the sensing cells along the inclined surface of the encapsulation layer to the second area.” Ex-1001, 1:59-2:28; Ex-1002, 15-20. The Examiner rejected the claims in view of U.S. Application No. 2010/0007616 (“Jang-616”) for certain claimed display elements, and additionally cited U.S. Patent Application No. 2008/0116795 (“Tsuchiya”) to teach the inclined encapsulation layer and U.S. Application No. 2005/0051829 (“Goto”) to teach the arrangement of the sensing lines. Ex-1002, 110-13. But Jang had a different configuration than the intended invention, because its encapsulation layer (300) was placed **on top** of the touch-sensor’s sensing cells, and the examiner at times mapped

Jang's separate **insulating layer** (330) to the claimed "encapsulation layer." *Id.*, Ex-1002, 151-53.

103. Based on my review, the patentee (also, Patent Owner, or "PO"), over several rounds of prosecution, amended the claims several times to overcome the examiner's prior-art mapping, such as: (1) specifying the encapsulation layer "inhibit[s] infiltration of oxygen and moisture into the pixels" (*id.*, 146), (2) reciting a *separate* insulating layer interposed between two touch-sensor layers, (*id.*, 186-89), and (3) changing "encapsulation layer" to "sealing thin film" (*id.*, 232-35). Each time, the examiner maintained or adjusted the rejection in view of the same prior art. *Id.*, 158-75, 203-28, 246-73.

104. The then-Applicant next amended the claims to specifically recite that the "sealing thin film...include[ed] an inclined surface," the sensing cells were "formed over a top surface of the sealing thin film," and the sensing lines "include[d] inclined portion along the inclined surface of the sealing thin film" that "inclined downwardly toward the driving circuit." *Id.*, 278-80. The examiner ultimately allowed the amended claims (after an additional double-patenting rejection was made and terminal disclaimer filed). *Id.*, 322-330 (double patenting rejection), 354-55 (terminal disclaimer), 365 (allowance).

VIII. CLAIM CONSTRUCTION

105. I have applied the plain and ordinary meaning to all terms of the '088 patent as would have been understood by a POSITA on or before September 14, 2010.

IX. SUMMARY OF OPINIONS

106. In my opinion, the claims of the '088 patent are obvious in view of the following combinations of prior art:

Grounds under 35 U.S.C. § 103	Claims	Prior Art
1A	1-13	Chen, Jang, Sano, Sakamoto
1B	1-13	Chen, Matsuo, Sano, Sakamoto
2A	1-13	Imamura, Yang, Sakamoto
2B	1-13	Imamura, Yang, Sakamoto, Chen

X. DETAILED EXPLANATION OF GROUNDS

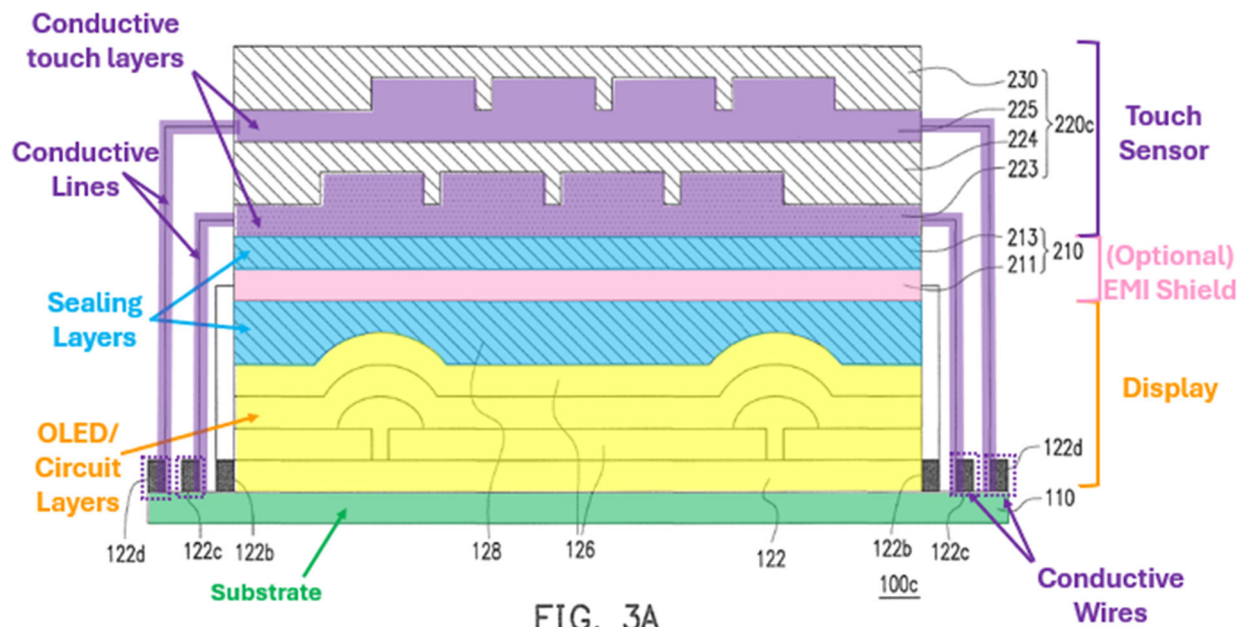
A. Ground 1A: Obviousness in view of Chen, Jang, Sano, and Sakamoto (Claims 1-13)

1. Prior Art

a. Chen (Ex-1005)

107. Chen discloses an OLED display with an integrated touch sensor. *Chen*, Title, Abstract, 1:15-21, 1:40-2:3. Specifically, Chen discloses that the display

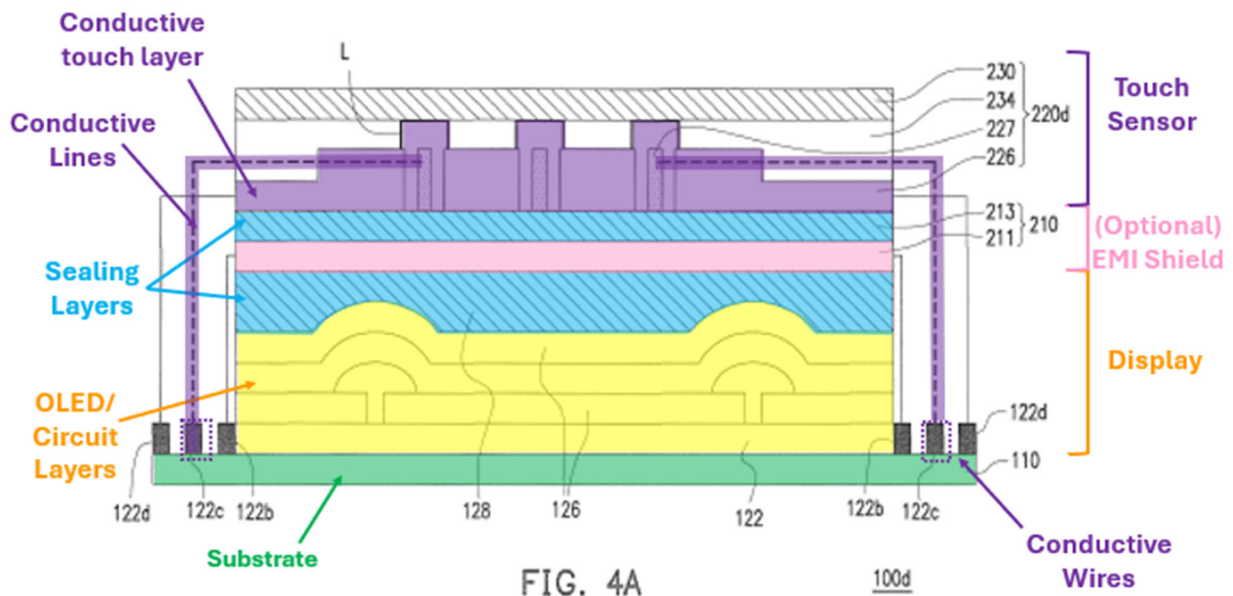
includes a substrate (110), an OLED display layer (120)—with electrodes (126), pixel layers (122), and a “first water/oxygen barrier layer” (128), and a touch-sensing structure (200) in FIGS. 1A, 1B, 3A and 4A:



Chen teaches a “preferable” electromagnetic-interference (“EMI”) shield (210) and expressly depicts conductive lines (purple) that form a connection between conductive wires 122c-d (dotted rectangles) formed on the substrate 110 in advance and connect to touch sensor conductive layers. *Id.*, Fig. 3A (annotated), 2:4-24, 3:37-4:25, 7:1-37, 7:56-8:39 (comparison of Fig. 1, 3A, 4A-B embodiments).

108. Although Chen does not expressly depict a driving circuit in its figures, a POSITA would have understood Chen’s device connects the touch sensor layers

to a driving circuit through the conductive lines and conductive wires annotated above because Chen discloses this result and a similar embodiment achieving that same purpose. *Chen*, 7:13-55 (disclosing, e.g., “conductive layer 225...connected to a...conductive wire 112d which is formed on the substrate 110 beforehand.”), Fig. 4A (annotated), 7:56-8:39 (describing a similar “conductive layer 226...electrically connected to the second conductive wire 122c on the substrate 110, as shown by dotted lines in Fig. 4A.”).



109. Chen also discloses that the touch sensor is formed using two conductive layers, which provide touch sensor pads (223b, 225b) connected to electrode series (223a, 225a) in two directions D1 and D2:

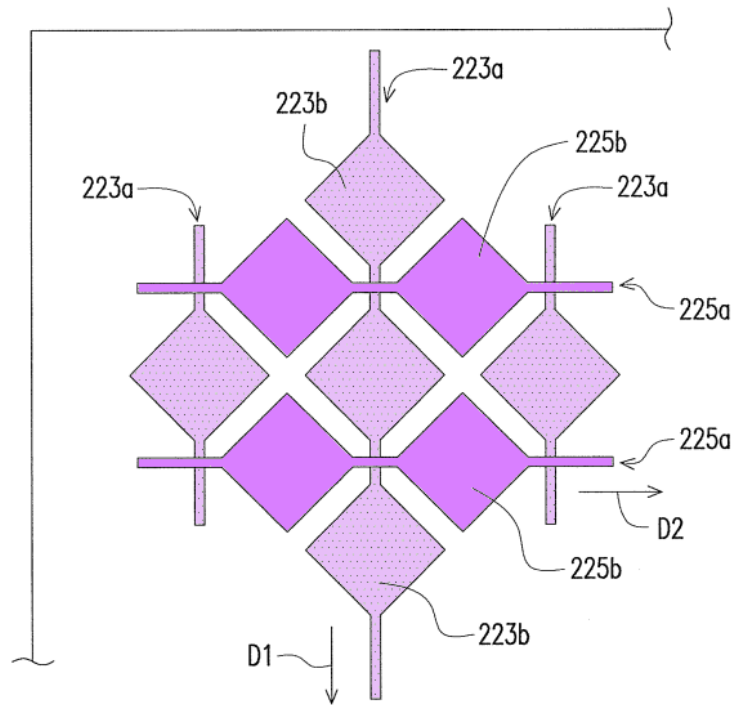


FIG. 3B

Id., Fig. 3B, 3:46-65, 7:13-55.

110. Chen additionally teaches that “a first water/oxygen barrier layer 128 can be disposed on the OLED display layer 120 to prevent oxygen and moisture from entering into the OLED display layer 120.” *Chen*, 3:17-26 and 8:37-51, 3:65-4:15, 4:40-44; 5:12-27, 5:53-6:14; and FIGS. 1A, 1B, 2, 3A and 4A. Chen’s touch sensor is formed over the first water/oxygen barrier layer 128. *Id.*

111. Furthermore, in light of a step difference between the touch-sensing structure 200 and its associated second and third conductive wires 122c and 122d on

the substrate 110 in the Chen's design, Chen discloses a step difference between the touch-sensing structure 200 and its associated second and third conductive wires 122c-d formed on substrate 110 and teaches a downward wiring design by forming conductive lines from the touch-sensing structure 200 on the top above the OLED display layer 120 to the second and third conductive wires 122c and 122d on the substrate 110 in light of this step difference. *Chen*, 7:17-8:26 and Figs. 3A, 4A.

b. Sano (Ex-1007)

112. Sano discloses an “organic EL display device” with a “sealer” (300) to protect the “organic EL elements” from “quickly deteriorat[ing]...when it is exposed to moisture and oxygen contained in the open air.” *Sano*, Abstract, ¶¶7-8, 53. Specifically, Sano discloses that the sealer (300) has a stack of alternating buffer (e.g., 311, 312) and barrier (e.g., 321, 322) layers, in which the barrier layers “are patterns larger in formation area than the buffer layers and cover the respective buffer layers to shield them from the open air,” including the peripheral edges of the buffer layers. *Id.*, ¶¶71-72, 106-08, 133, 158, 171, 173, 215. By arranging larger inorganic layers over smaller organic layers, Sano's “sealer” includes a step-based “moderately inclined” edge 300S:

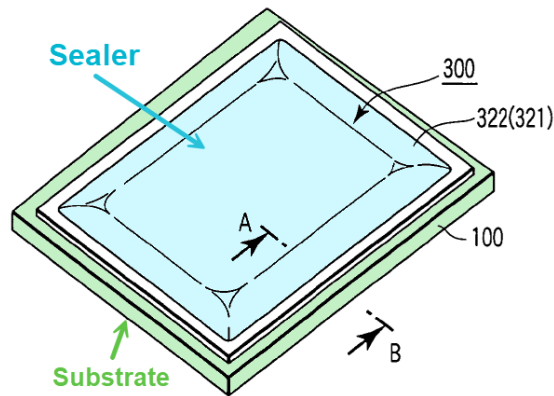


FIG. 3

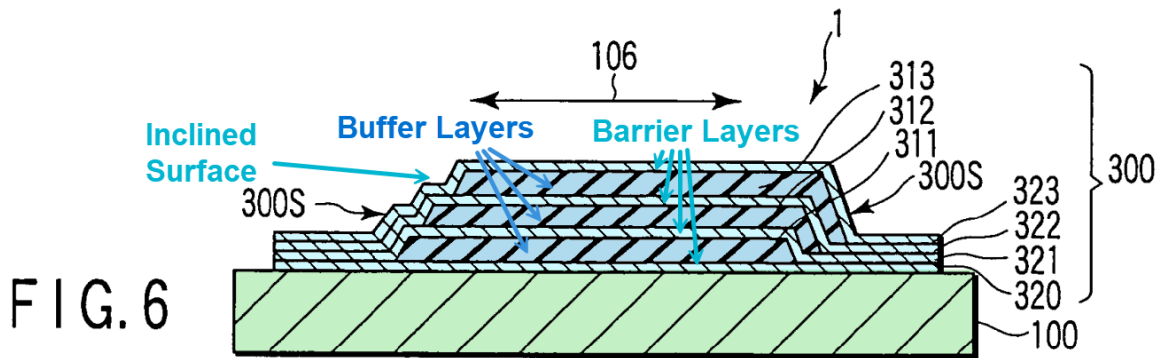
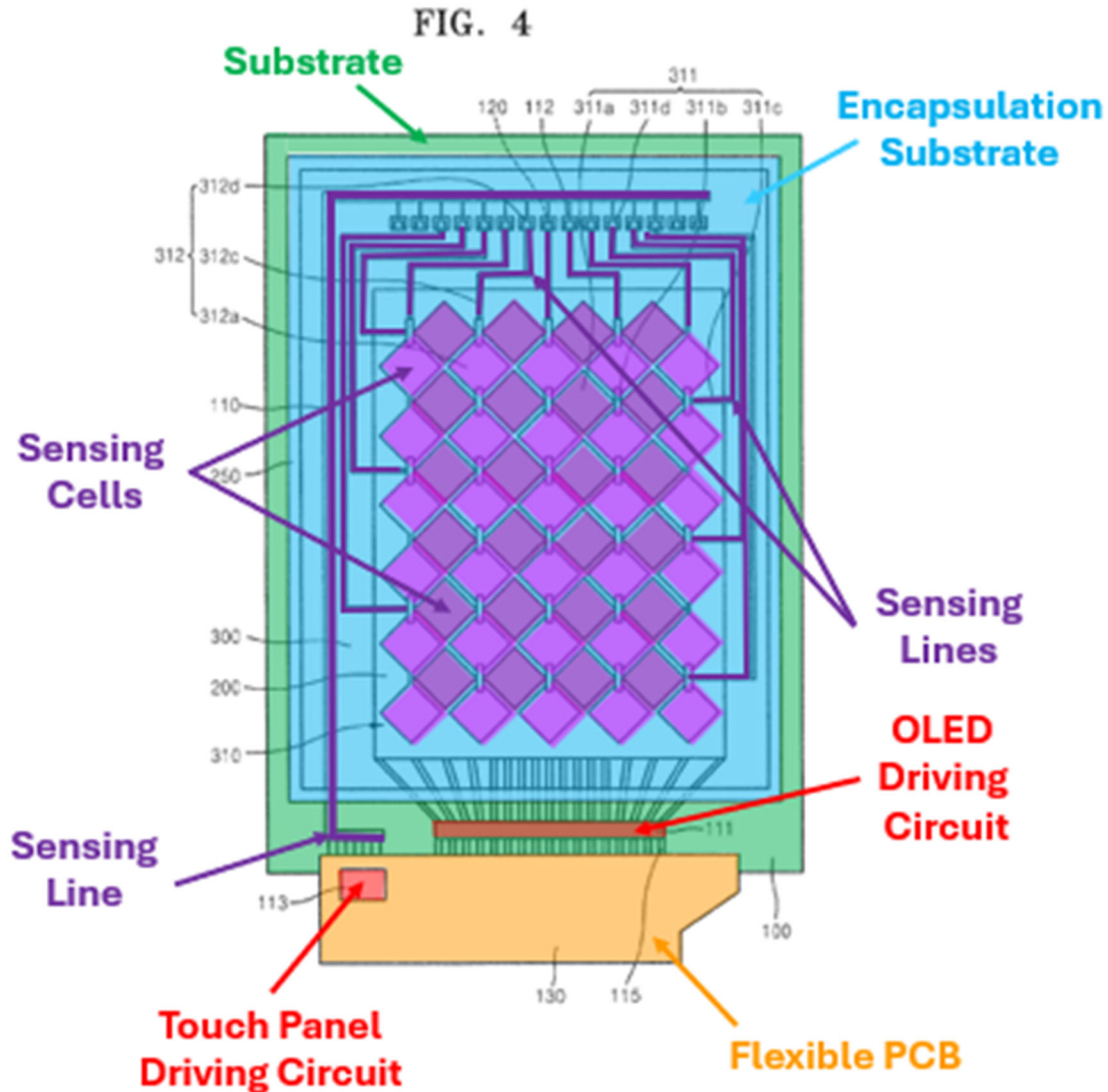


FIG. 6

Id., ¶¶107-08, 133, 158, 171, 173, 215. In fact, Sano notes that buffer layers should be arranged to avoid too “steep[] [an] inclined surface,” which could “cause a coverage failure” of the barrier layer and thus exposure of the OLEDs to oxygen and moisture through defects in the buffer layers. *Id.*, ¶¶106, 169. A POSITA would have also understood that Sano’s inorganic layers 321-23 would have an inclined surface at their end due to the vapor deposition and mask-based fabrication method discussed above §VI (technology overview).

c. Jang (Ex-1006)

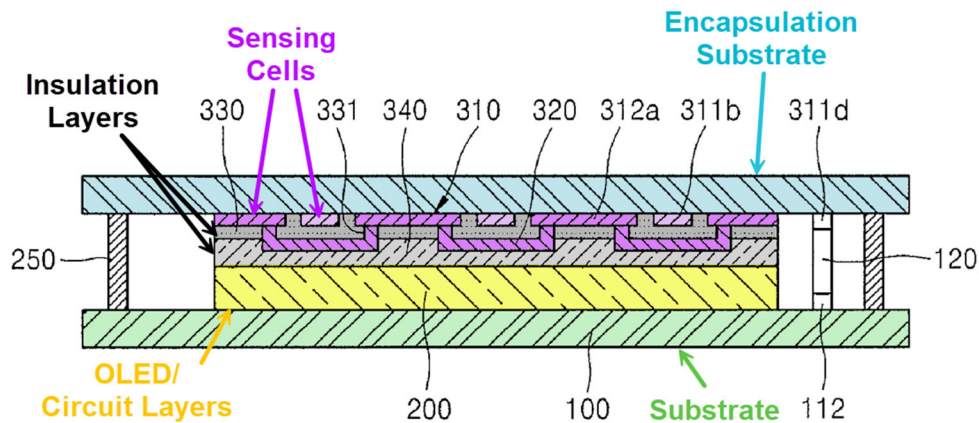
113. Jang discloses an organic-light-emitting-display device (OLED) with a touch-sensor panel. *Jang*, Abstract, ¶¶8, 9, 61, 70-71. Like Chen, Jang discloses that the OLED display has a substrate (100), an array of OLEDs, a touch panel with first and second sensors (311, 312), and an encapsulation substrate (300). *Id.*, ¶¶61, 70-72, cl. 1. Jang also explains that the sensors connect to a touch panel drive integrated circuit (TDI 113) through extending units (e.g., 311c, 312c) (“sensing lines”), data line 110, and flexible printed-circuit board (“PCB”) (130):



Id., Fig. 4, ¶¶52, 68, 70, 72, 81-88. A POSITA would have looked beyond Chen's configuration to the alternatives disclosed in Jang and Jang '041 (Ex-1043). Jang '041 incorporates Jang's disclosure in its entirety. *See Jang*, Cover (filed as U.S. Application No. 12/350,101); *Jang '041*, ¶1 (incorporating the same). In one

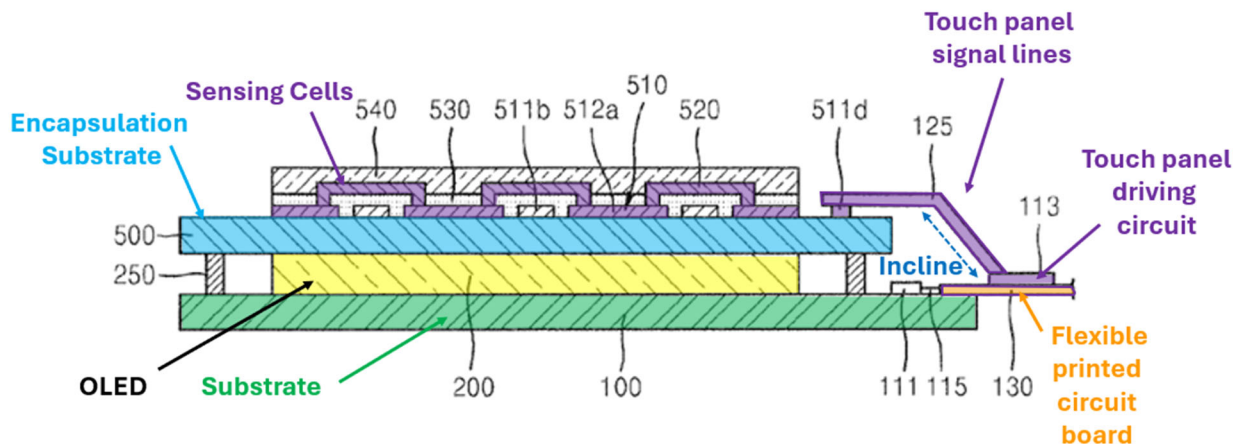
configuration (unlike Chen), Jang's encapsulation substrate is above the display and touch sensors:

FIG. 5

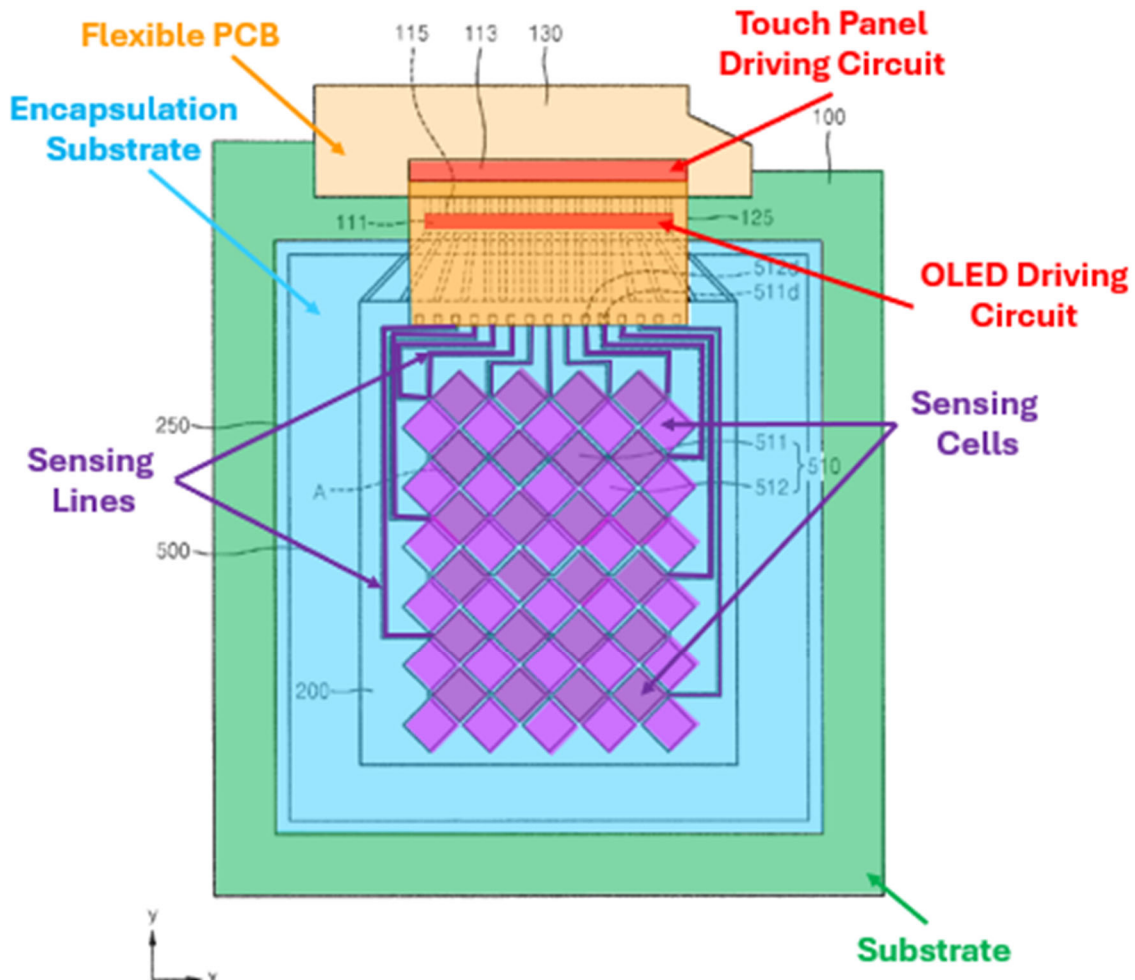


Jang, Fig. 5, ¶¶53, 65-66, 69.

114. But in a readily apparent alternative configuration, Jang places the encapsulation substrate below the touch sensors and above the display:



Jang '041, Fig. 10 (annotated), ¶¶121-26. In this touch panel-over-encapsulation configuration, sensing lines are connected through a flexible printed-circuit board (“PCB”) (130) by the inclined TDI connector 125:



Jang '041, Fig. 9 (annotated), ¶¶120-24.

115. Jang’s alternative configurations highlight two methods for electrically connecting a touch panel’s capacitive sensing cells to peripheral drive circuitry without permeating the encapsulation layer (which would provide an inlet to the

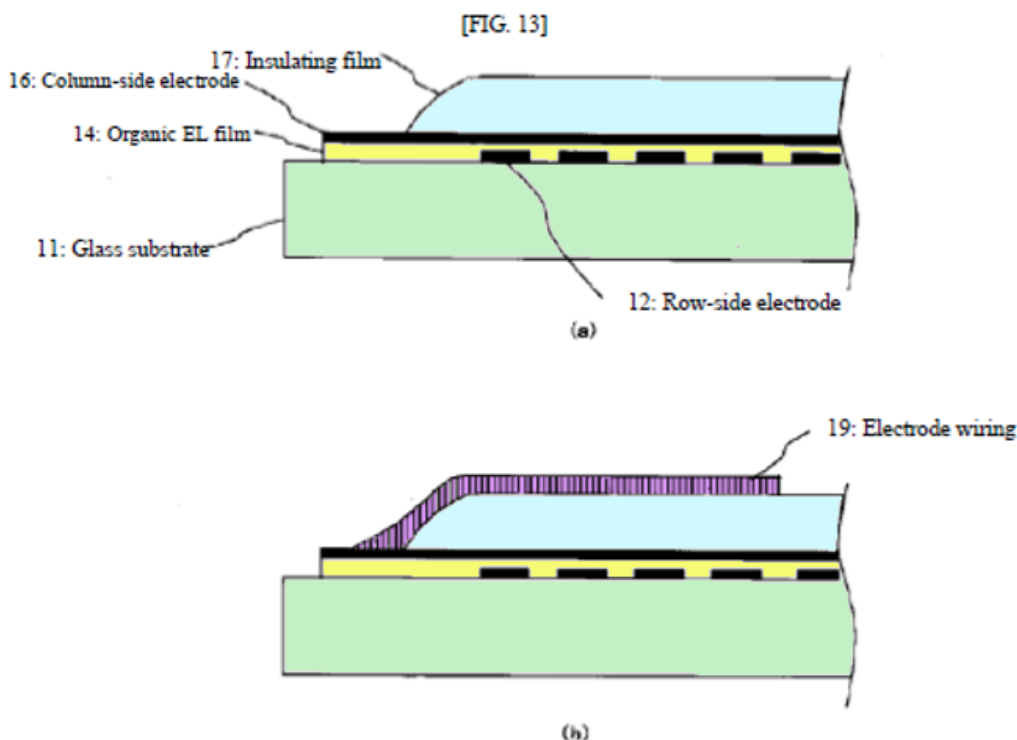
water and oxygen the layer intends to bar): (1) route conductive wires over top of the encapsulation layer down to the circuitry on a base substrate, or (2) encapsulate the touch panel sensing cells with the OLED and access the circuitry on the base substrate through internal conductive member 120. A POSITA would have found Jang's configurations obvious variants of each other because they use the same components according to their predictable uses to solve a common problem—electrically connecting top-formed touch panel capacitive sensing cells to lower controlling drive circuitry—and obvious to try provided their design tradeoffs.

116. The touch panel-over-encapsulation layer design thins the entire height of the OLED/touch panel display by consolidating the drive circuitry into one location and employing thin-layer deposition methods, which leads to reduced fabrication costs of less circuitry and using conventional (cheaper) flexible printed circuit boards predisposed to this design. *Jang '041*, ¶¶7, 118, 125-26.

d. Sakamoto (Ex-1008)

117. Sakamoto discloses an organic electroluminescent (“EL”) display with conductive lines formed along the slope of a side surface of an intervening insulating layer, therefore connecting a first portion at a higher elevation to a second portion at a lower elevation over a sloped side surface of an insulating film. *Sakamoto*, ¶¶2, 8, 10, 15, 22, 23 and Figs. 3, 6, 12, 13a-b, 19. Specifically, Sakamoto teaches forming

and running electrode wiring 19 over the gentle slope of its insulating film 17 to interconnect two parts of the electrodes at different elevations. *Id.*



Id., Figs. 13(a)-(b), ¶¶8, 10, 23.

e. Chen, Sano, Jang, and Sakamoto are Analogous Art

118. In my opinion, Chen, Sano, Jang, and Sakamoto are analogous to the '088 patent because they disclose organic light emission display devices (a common field of endeavor) and are directed toward improving otherwise inefficient and unreliable OLED designs (reasonably pertinent to solving the same problem). *See '088 patent*, 3:24-28 ("Conventionally, in the organic light emitting display, a glass substrate having a cavity or plate pattern is joined with the substrate 100 under a

vacuum atmosphere so as to prevent the organic light emitting elements from being exposed to moisture and oxygen.”)

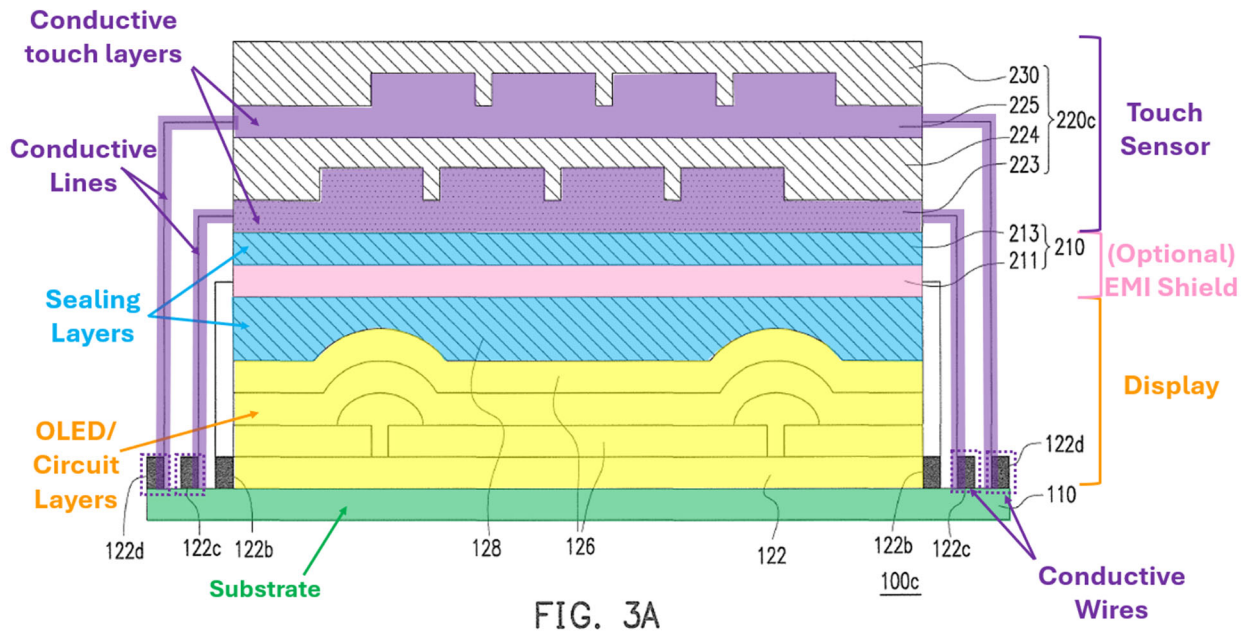
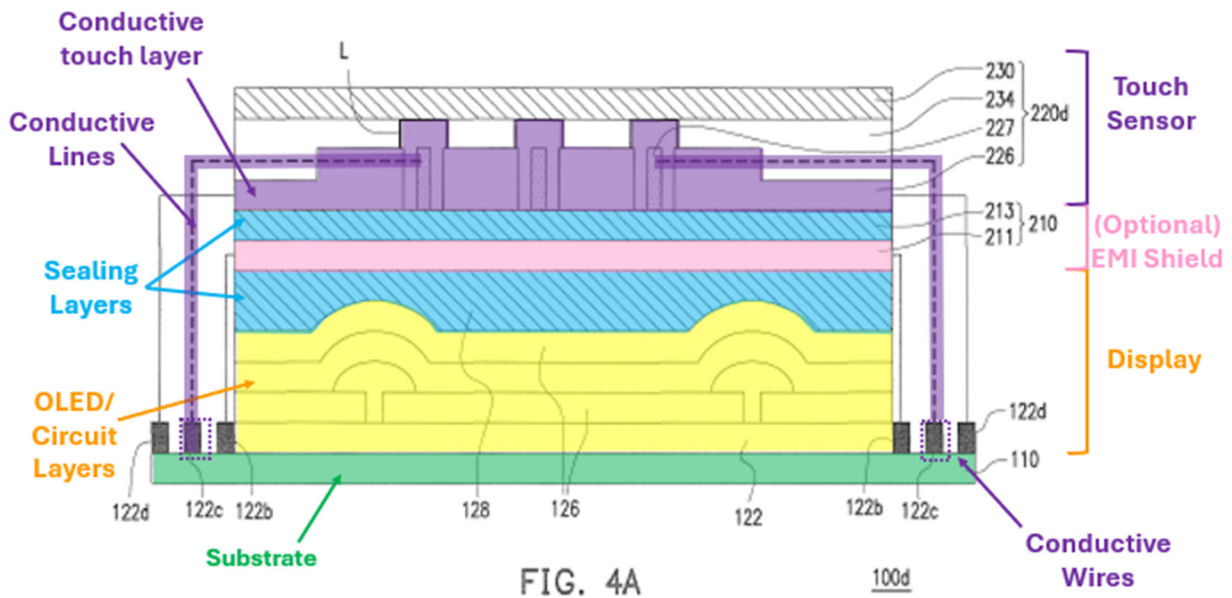
119. For example, Chen discloses an OLED display that includes a substrate (110), an OLED display layer (120)—with electrodes (126), pixel layers (122), and at least a “first water/oxygen barrier layer (128)...disposed on the OLED display layer 120 to prevent oxygen and moisture from entering into the OLED display layer 120.” *Chen*, Title, Abstract, 1:15-21, 1:40-2:3, 3:9-26, FIGS. 1A, 1B, 3A and 4A. Sano discloses an “organic EL display device” with a “sealer” (300) to protect the “organic EL elements” from “quickly deteriorat[ing]...when it is exposed to moisture and oxygen contained in the open air.” *Sano*, Abstract, ¶¶7-8, 53. Jang recognized the need to “prevent or reduce impurities from penetrating into the...organic light emitting display device” and further discloses an organic-light-emitting-display device (OLED) that has a substrate (100), an array of OLEDs, and an encapsulation substrate (300). *Jang*, Abstract, ¶¶8, 9, 61, 64, 70-72, cl. 1. Sakamoto discloses an organic electroluminescent (“EL”) display with conductive lines formed along the slope of a side surface of an intervening insulating layer, therefore connecting a first portion at a higher elevation to a second portion at a lower elevation over a sloped side surface of an insulating film. *Sakamoto*, ¶¶2, 8, 10, 15, 22, 23 and Figs. 3, 6, 12, 13a-b, 19.

120. Because the Chen, Sano, Jang, and Sakamoto references are reasonably pertinent to facing the same problem in a common field of endeavor as the '088 patent, it is my opinion that they qualify as analogous art.

f. Motivation to Combine

(i) Combining Chen with Sano, Jang, and Sakamoto

121. Chen discloses OLED touchscreen components including an OLED-display protected by a “sealing” layer, a touch-sensor panel formed on top of the sealing layer, and conductive lines connected to the substrate to transmit signals from the touch-sensor panel. §X.A.1.a (Chen). Chen’s inventors chose to disclose the tiered design of layers for an “OLED touch-sensing display apparatus” but does not detail its practical, physical layout, motivating a POSITA to look at other prior art to implement Chen’s design in practice, such as: how the sealing layers are formed or structured including the structures of the borders of sealing layers in practical implementations of its layered structures as disclosed in, e.g., Figs. 3A-4A (annotated below), or how the conductive lines (122c, d) are arranged on the substrate (100), or how conductive lines are structured as required to connect the touch sensors (223, 225) on the sealing layer of the OLED display to conductive wires 122c-d which in turn are further connected to drive circuitry *Chen*, 1:16-56.



As a specific example, Chen discloses a step difference between the touch-sensing structure 200c and its associated second and third conductive wires 122c and 122d formed on the substrate 110 and teaches a downward wiring design by forming

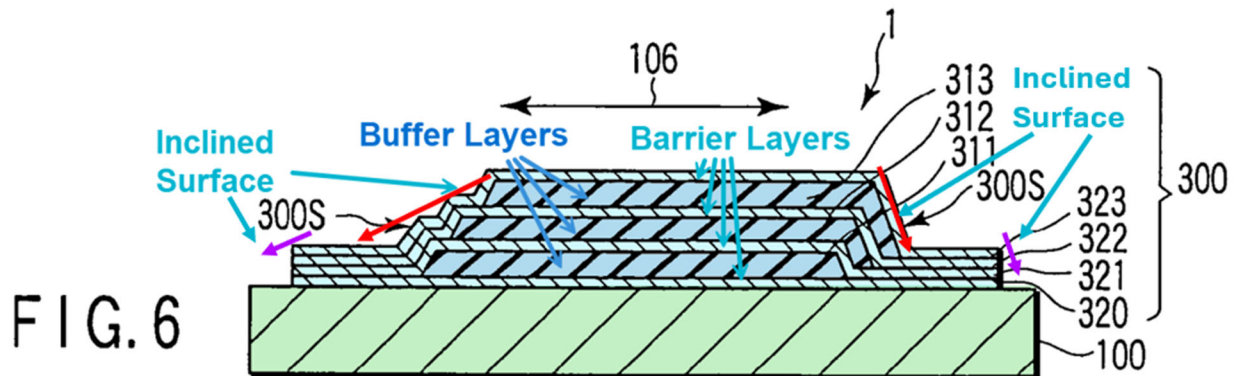
conductive lines from the touch-sensing structure 200c on the top above the OLED display layer 120 to the second and third conductive wires 122c and 122d on the substrate 110. *Chen*, 7:17-8:26 and FIGS. 3A and 4A. A POSITA would have understood *Chen*'s conductive lines connected to the touch-sensing structure 200 above the sealing layer 128 must have a portion over the sealing layer 128 in order to connect to the touch-sensing structure 200 on the sealing layer 128 and have another portion over the substrate 110 in order to connect to the conductive wires 122c-d on the substrate. However, *Chen* omits implementation details disclosing how the downward wiring can be structurally formed over the step difference.

122. In my opinion, a POSITA would have been motivated and guided by *Chen*'s teachings to look to other prior art to understand how to implement *Chen*, such as how to form a protective sealing layer, how the conductive wires 122c-d should be arranged on the substrate, and what they should be connected to should be connected to when implementing *Chen*'s downward wiring shown in Figs. 3A and 4A. As a starting point, a POSITA would have recognized that *Chen*'s conductive wires 122c-d—first formed together with active array device 122 on substrate 110—and connected to additional layers formed above, would have required fabricating some type of structure to route the electrical connections of the higher layers back

down to the drive circuitry on the lowest substrate to communicate with and operate the multilayer OLED/touch panel display. *Chen*, 5:42-52.

123. To implement *Chen*'s sealing layer, a POSITA would have first turned to a reference such as *Sano*, which teaches forming a sealing layer from stacked layers of alternating (organic) buffer and (inorganic) barrier materials to inhibit oxygen and moisture from degrading the OLEDs. §X.A.1.b (*Sano* overview). Providing a multilayered, alternating sealing layer was common, because any individual barrier layer may contain defects that would otherwise allow degradants to pass through (*see Sano*, ¶¶8); stacking barrier layers separated by buffer layers inhibited degradants much better than a single-layer barrier structure. *See, e.g., Hayashi* (Ex-1019), ¶¶6-10; *Affinito* (Ex-1020), Abstract, 2:54-3:19; *Graff* (Ex-1021), 3:16-43, 3:51-4:5. Indeed, *Chen* itself envisions the sealing layer (128) "can be an inorganic thin film, an organic thin film, **or a combination thereof**." *Chen*, 3:66-67 (emphasis added); *See also id.*, 3:37-6:61. *Sano* also teaches multiple barrier layers and specifically discloses that each barrier layer is formed larger than its underlying buffer layer so that the barrier layer coats or seals even the edges of the buffer layers to create a complete seal ending in an inclined surface (red) at the edge of the buffer and inorganic sealing. In addition, the formation of alternating

barrier and buffer layers also creates an inclined surface at the edge of each barrier/buffer layer (purple):



Sano, Fig. 6 (annotated), ¶¶71-72, 106-08, 133, 158, 171, 173, 215.

124. A POSITA would have been motivated to modify Chen in view of Sano to provide a complete sealing layer that would inhibit degradants from reaching the OLEDs. Chen, for instance, simply shows the OLED's sealing layer stacked on top of the OLEDs, leaving the sides unsealed and exposed as indicated by dashed in boxes in the annotated Fig. 3A below:

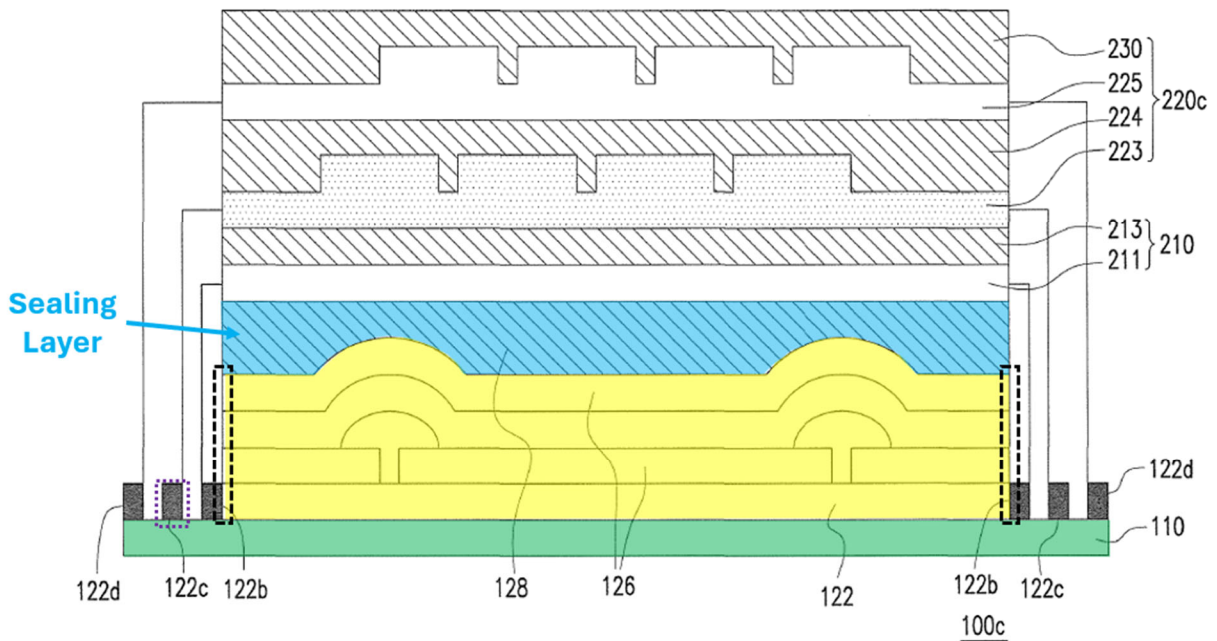


FIG. 3A

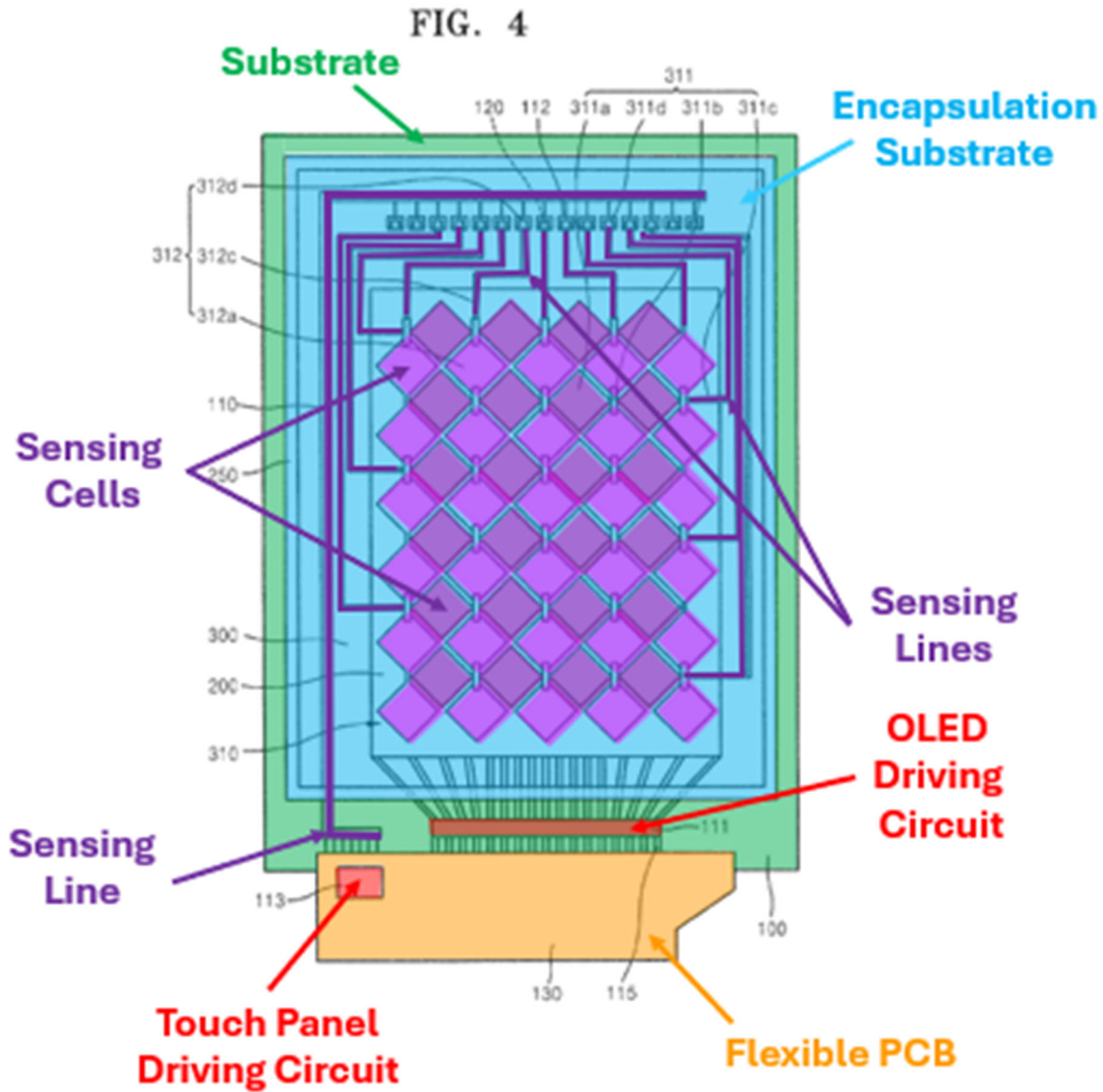
Chen, Fig. 3A (annotated).

125. Moreover, a POSITA would have been motivated to implement *Chen*'s sealing layer (128) as a multilayered structure of alternating buffering and barrier layers—as taught by *Sano* and as was well-known in the art—to ensure degradants would not reach the OLEDs. Specifically, *Chen* and *Sano* share a goal: achieve an optimal, robust seal for an OLED formed under an encapsulation layer—*compare Sano*, ¶¶158, 171-72 (describing the need for “peripheries...reliably covered” and “coverage failure...prevented” to achieve “good display performance...for a long period of time”) *with Chen*, 4:26-39 (describing the need for an OLED device that is “well protected”). However, *Sano* also accounts for an ideal bond with the layers

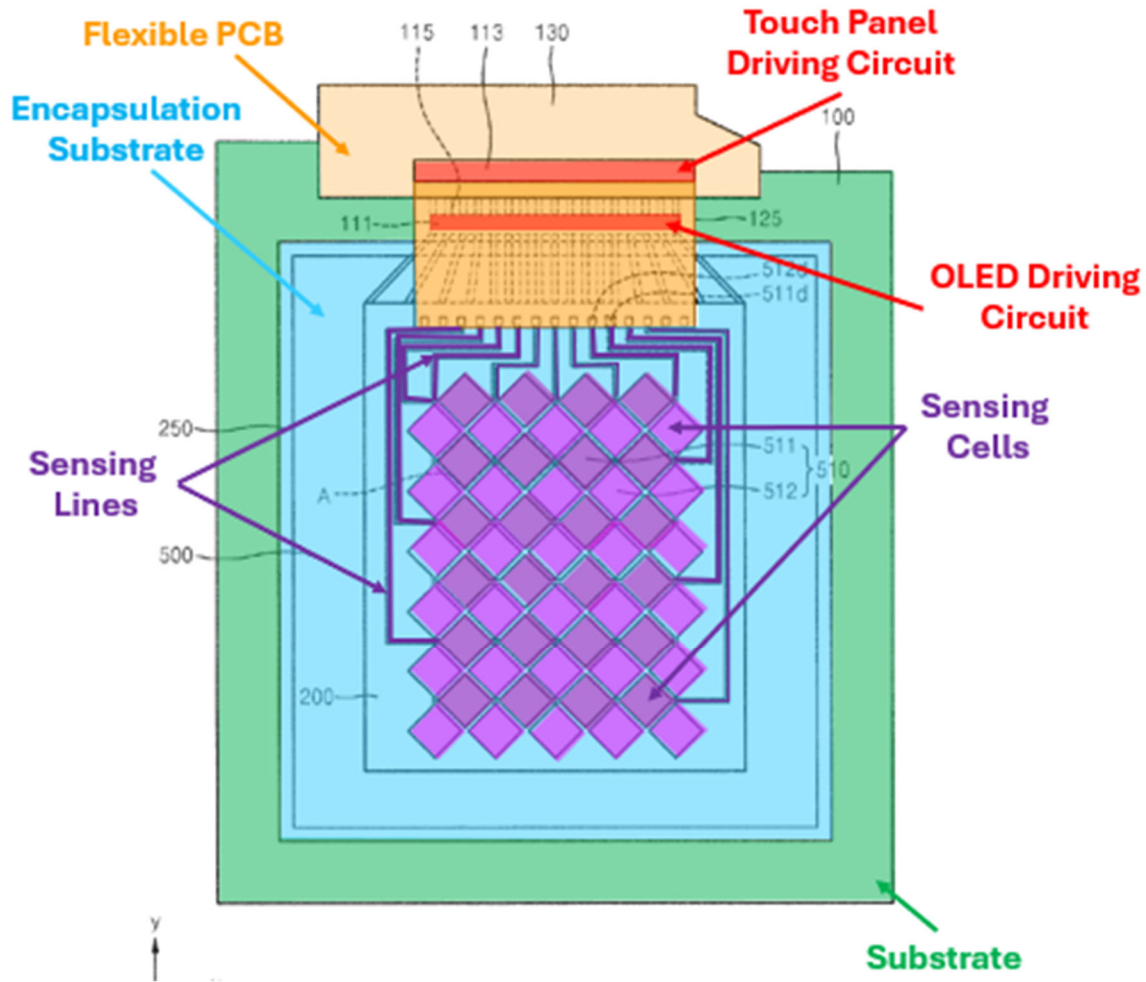
formed *above* the encapsulation layer. *Sano*, Fig. 2, ¶¶104-05 (teaching ideal adhesive bonding characteristics for a “sealing member 200” formed *above* sealer 300 that preserves the robust OLED encapsulation to prevent deterioration of the OLED *below* sealer 300). A POSITA would have further recognized that fabricating Chen’s layers using Sano’s encapsulation technique would have incorporated Sano’s conventional mask-based deposition method that re-use a mask for the layers, which would have led to increased manufacturing efficiencies and lowered costs. *Sano*, ¶105.

126. In my opinion, a POSITA would have had a reasonable expectation of success in making this modification because Chen already taught providing a sealing layer for protecting the OLED structure from moisture and oxygen—which would merely be extended to completely cover the OLEDs in view of Sano—and Sano expressly taught the alternating buffer and barrier structures, as well as the processes to layer them, to form a more impenetrable sealing layer.

127. As for implementing Chen's touch structure with sensing lines (conductive lines) and a driving circuit, a POSITA would have understood typical touch structures include central touch areas with electrodes connected to sensing lines in a surrounding peripheral region electrically connected to a driving circuit formed on a substrate or flexible printed circuit as I explained above. §VI (technology overview). A POSITA would have been further motivated to turn to a reference such as Jang, which expressly discloses a layout of these elements: how sensing lines are arranged for a touch-sensor panel, what other components those lines are connected to, and that the touch sensor electrodes require connection to sensing lines continuing toward the periphery of the touch panel for further connection to controlling drive circuitry. For instance, Jang expressly describes how electrically-conductive lines ("sensing lines") connect the on-display touch-sensor components to terminals at the periphery of the touch panel and further to a conventional flexible PCB and driving circuit located away from the display to drive the touch sensors, and analyze the signals in response to a user's touch. *See, e.g., Jang*, Fig. 4 (annotated), ¶¶71-72, 83-87.



See also Jang '041, Fig. 9 (annotated), ¶¶120-24.



128. But Jang also expressly discloses that providing a flexible PCB “to provide an integrated interface for enabling a touch panel function” also “effectively reduce[s] manufacturing costs, and...improve[s] the ease of manufacture and the user’s convenience.” *Jang*, ¶¶87-88. A POSITA would have therefore been motivated to implement Chen’s invention consistent with the three-dimensional layout taught by Jang—because it was known that touch-sensor lines must typically connect the on-display touch sensor to off-display terminals for further connection

to lower substrate terminals (e.g., bonding pads) leading to a controlling driving circuit through a flexible PCB to both process touch signals and drive the display.

129. A POSITA would have had a reasonable expectation of success in modifying Chen in view of Jang because Jang provides an express disclosure of what a POSITA would have understood is implicit in Chen—specifically, that the conductive lines connected to the touch electrode series formed above an OLED sealing layer at a higher elevation with respect to the substrate electrically connect down to the conductive wires formed on the substrate at a lower elevation and further connect to, by the conductive wires formed on the substrate, circuitry at that lower elevation layer. In other words, Jang provides additional, express guidance as to how to implement Chen’s invention on a physical display touch panel.

130. But a POSITA would have appreciated that neither Chen nor Jang resolve one detail: how the touch panel sensing lines on the substrate at one elevation are connected, over a step, to the touch-sensor components on the sealing layer at a different elevation. Chen, for instance, simply draws a conductive line extending over a step between the touch-sensing structure 200 at a high elevation and its associated second and third conductive wires 122c and 122d on the substrate 110 at a lower elevation. *Chen*, Figs. 3A (reproduced below and annotated), 4A.

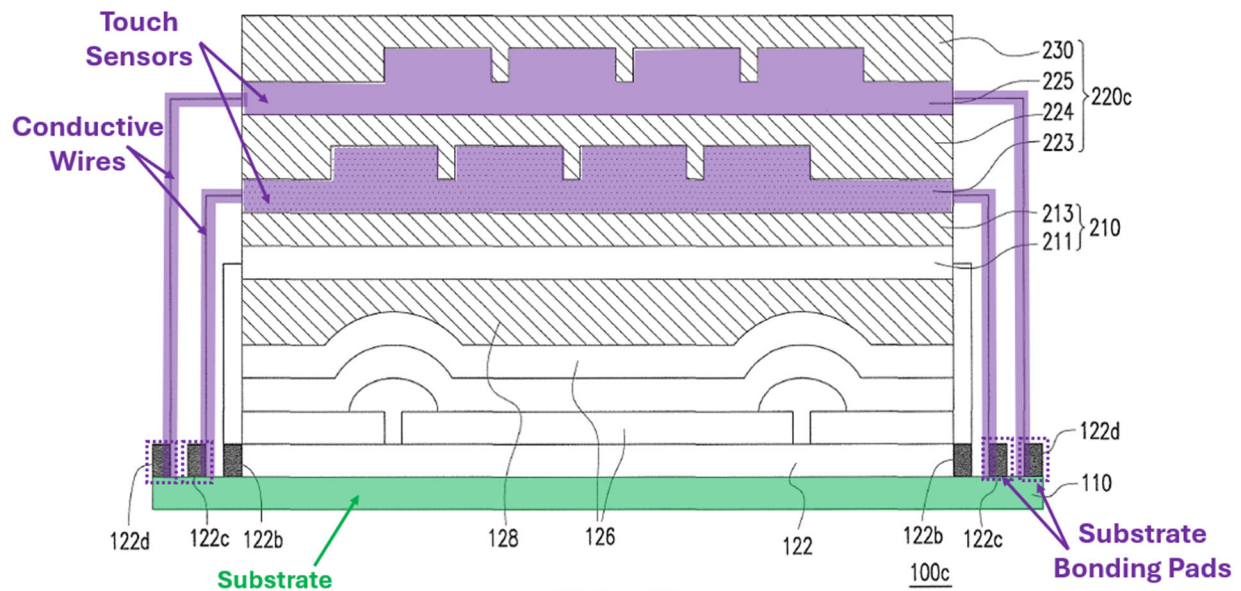
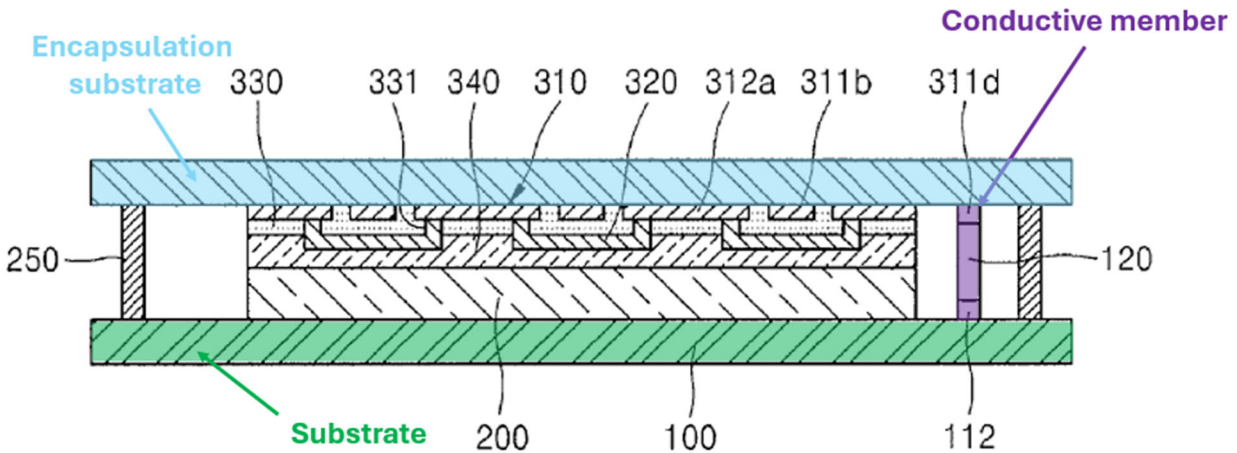


FIG. 3A

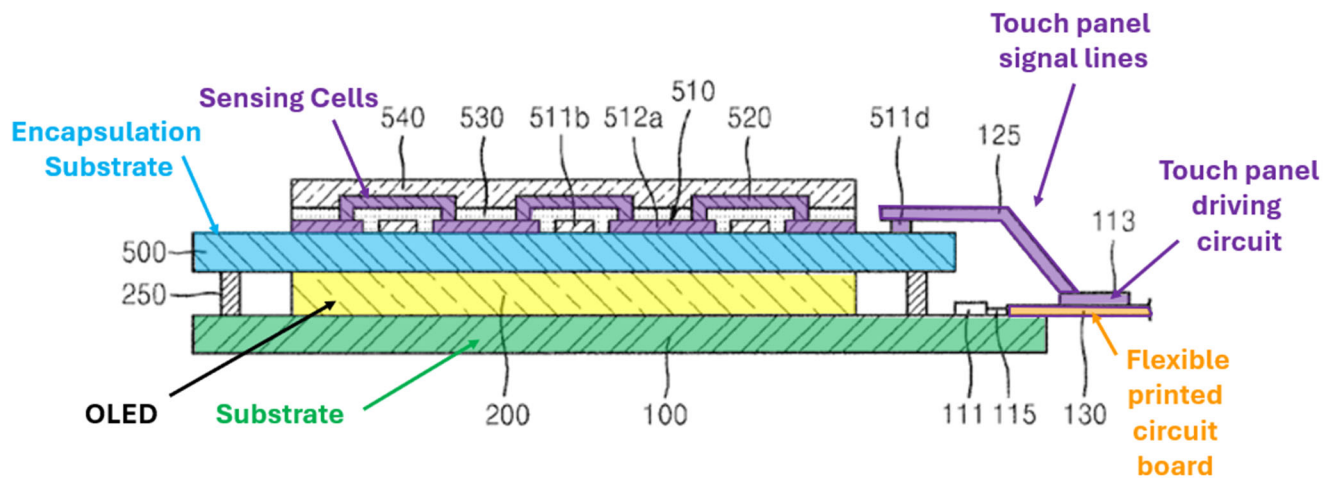
Chen, Fig. 3A (annotated); *see also* Fig. 4A. And *Jang* discloses in connection with its integrated touch-sensing OLED display in Figs. 3A-E and 4-5 that touch panel related conductive components on the upper encapsulation substrate 300 (blue) above the OLED display structure 200 are electrically connected to the substrate contact units 112 for data line 110 on the lower substrate 100 (green) by providing direct connection member 120 to bridge the elevation gap between the touch panel formed on upper substrate 300 on top of the OLED display 200 and substrate contact units 112 and data line 110 on the lower substrate 100:



Jang, Fig. 5 (annotated above), ¶¶69-71, 82. The substrate contact units 112 are individually connected to data line 110 which is connected to the flexible PCB 130. *Id.* A POSITA would have known *Jang*'s sensing line connections in Fig. 5 would not have been applicable to *Chen*'s structure because they are formed sequentially on a same substrate, so the surface of the upper conductive layer does not face to the lower conductive layer, and would have therefore sought another known method to complete the connection.

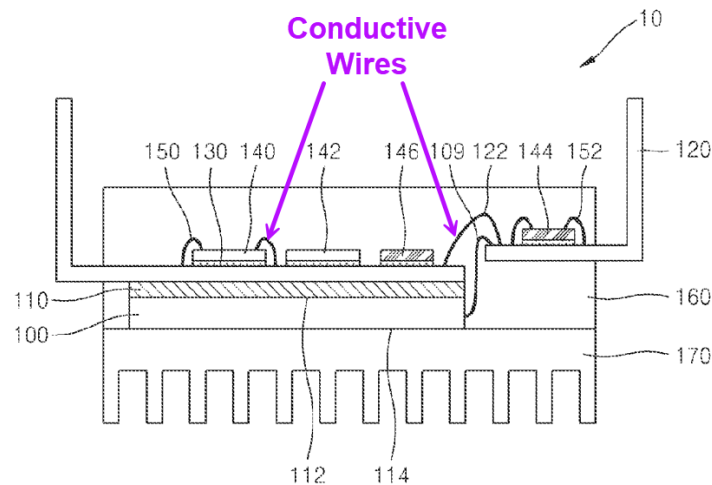
131. A POSITA would have understood that there are three primary ways the electrically-conductive sensing lines in *Chen*'s arrangement would have connected conductive components on two, vertically-spaced horizontal layers at different elevation levels (e.g., the lower layer including the substrate 110 and associated conductive elements such as conductive wires 122c-d on the substrate 110; and the higher touch-sensor components in conductive layers 223, 225 above

the sealing layer 218 in Chen's Fig. 3A, above). First, the conductive elements such as conductive wires 122c-d on the substrate (which further connected to the drive circuit) may be wire bonded to the touch sensors (e.g., connecting by a loose wire).
See Jang '041, Fig. 10 (annotated), ¶¶122-26:



See also, e.g., Shigihara (Ex-1023), 15:11-15, 16:17-21, Figs. 12, 14; *Lim* (Ex-1022), 10:59-62, Fig. 4D, and Fig. 1 (annotated):

FIG. 1



However, wire bonding struggles to meet the demands of advanced microelectronics packaging requiring reductions in wire size, cost and bond pad pitch yet increases in I/O (input/output) numbers, the need for advanced fabrication equipment, and ultra-precise finishing processes and materials. *Zhong* (Ex-1047), 10. Further, wire bonds can deflect to the point of shorting a bottom wire. *Yao* (Ex-1048), 1359.

132. Second, the lower layer conductive elements such as conductive wires 122c-d on the substrate may use a vertical contact hole/via through an insulating layer filled with conductive material to connect to the touch sensors formed on a different, higher horizontal layer. *See, e.g., Chandrasekaran* (Ex-1024), 4:48-59, and Fig. 5 (annotated):

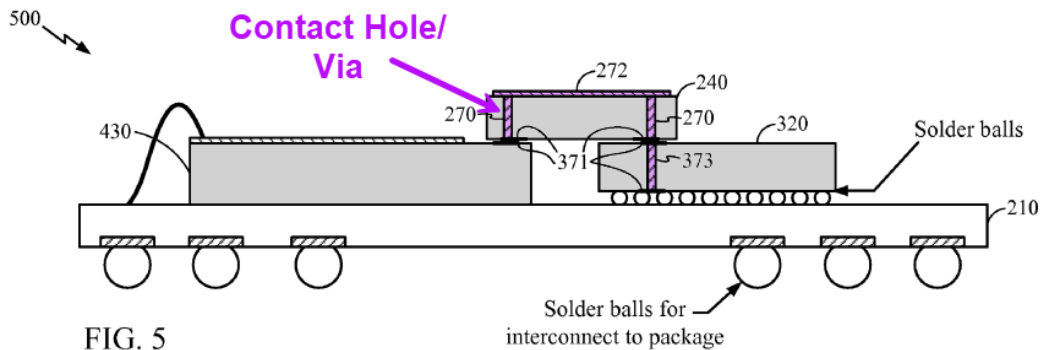
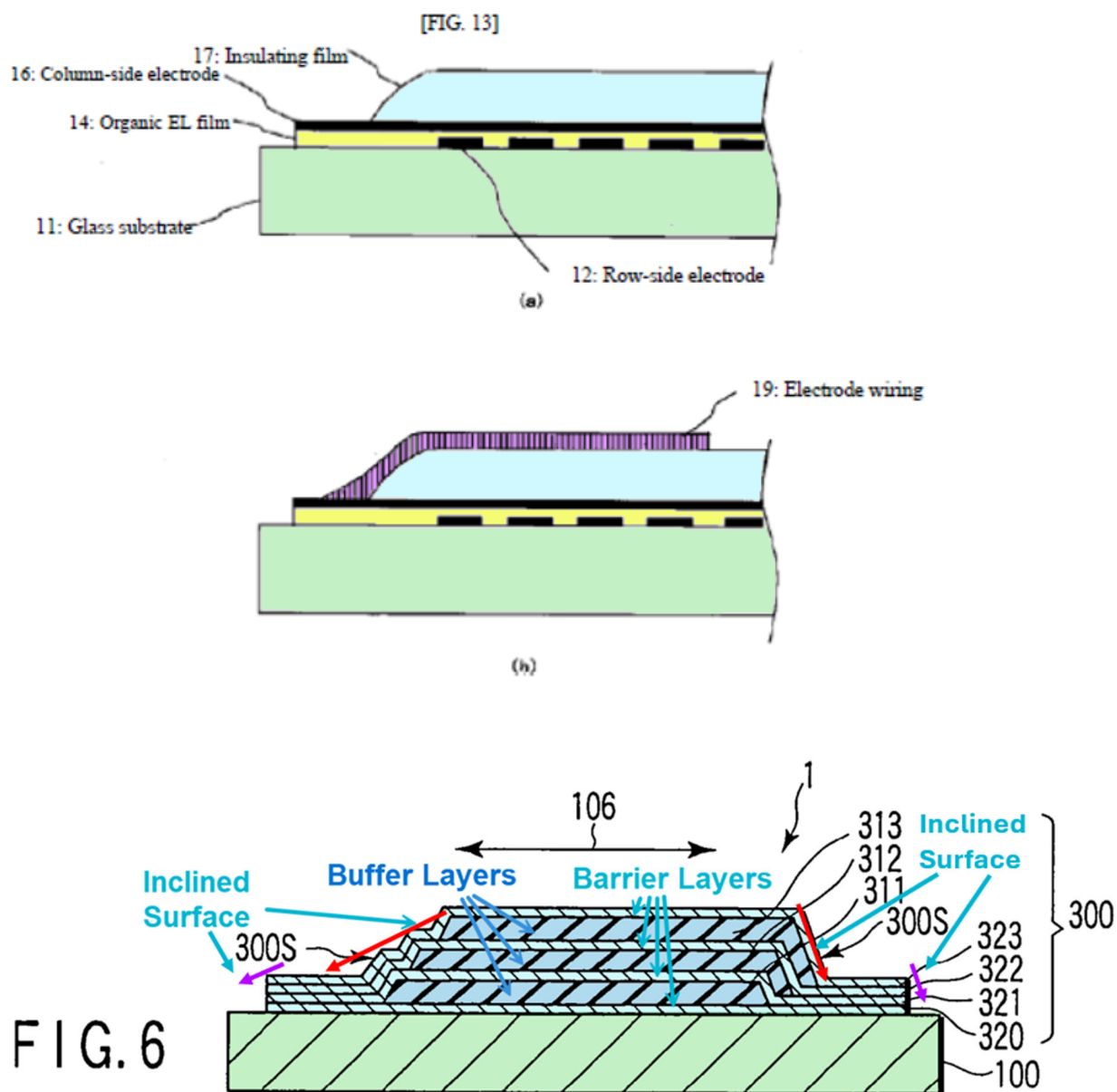


FIG. 5

Detrimentially, this bonding method requires three steps aggregating into a total (higher) fabrication sum absent from other methods: (1) formation of the through-Silicon Vias for vertical interconnects, (2) wafer thinning and backside processing steps, and (3) chip stacking. *Velenis* (Ex-1049), 2. Because through-holes are used, chip warpage causes alignment issues and the holes themselves cause chips to fracture and further frustrate the use of this fabrication method for many applications. *Tu*, (Ex-1050), 518-19, 521.

133. Third, the sensing lines may simply be deposited on the side or end surface of the layers between the conductive elements (e.g., Chen's conductive wires 122c-d in Fig. 3A) and touch sensors (e.g., Chen's conductive layers 223, 225 in Fig. 3A) to provide connections between components at different elevations where the sensing lines may run over both the sealing layer and substrate to go down over an inclined side or end surface to provide the desired connections. *See, e.g., Hashimoto*



134. Any of the above limited number of ways of connections would be suitable, known, and routine options to a POSITA implementing the design concepts taught by Chen (e.g., Fig. 3A), making such a modification at a minimum obvious to try, as a POSITA would have recognized a need to connect Chen's conducting

wires on the substrate to the touch sensors on the sealing layer using sensing lines, and the most straightforward options and challenges to connect the two were all known as I discussed above.

135. But, upon implementing a multilayered sealing layer consistent with both Chen and Sano, a POSITA would have been particularly motivated to use a deposition approach to form a sensing line along the surface of the sealing layer. A POSITA would have understood, for instance, that wire bonding was an older process that required more physical space for the wires, dedicated bonding and alignment tools which would limit scalability and device density, and precludes sealing thin films (which may crack easily under the pressure of bonding) because bonded wires require a thicker encapsulation substrate for support. *See, e.g., Jang '041*, Fig. 10 (encapsulation substrate supporting connector 125). And conductive via connections would require more space for the non-conductive planarizing layer for a conductive connection to pass through, and would also require a multi-step patterning, such as etching, gap-filling, and trench-deposition process to form the conductive via connection plug that would penetrate the encapsulation layer (defeating its very purpose to block water and moisture).

136. A POSITA would have recognized that depositing a sensing line on the surface of an encapsulation layer like Sano's would have been the most

straightforward and would have required the fewest processing steps, improving scalability and manufacturing costs over the other two approaches as described above. §X.A.1.c (Jang overview). Moreover, Sano expressly teaches sizing each buffer and barrier layer in a way that produced a “moderate” inclined surface further including another inclined surface at the end of the inorganic encapsulation layer resulting from the known deposition process to ensure that subsequent material layers would be deposited without breaks, meaning a POSITA would have understood that Sano’s inclined surface would enable depositing an uninterrupted, uniform thickness sensing line along the incline. *See, e.g., Chen*, 5:53-6:61 (describing CVD- and PECVD-based layer formation); *Sano*, ¶133; *Kiyose* (Ex-1044), ¶¶65-66 (a “sloping portion...eliminates factors that prevent sufficient electrical conductivity” because “thickness...[is] ensured”). And Sakamoto showed that such a deposition process had been used in OLED displays to connect conductive elements on vertically-varying horizontal layers. *Sakamoto*, Fig. 13, ¶¶8, 23.

137. A POSITA would have had a reasonable expectation of success in directly depositing a conductive line between Chen’s conductive wires on the substrate and the touch-sensor components on the sealing layer because depositing conductive lines on the surfaces of intervening layers were known, and Sano taught

a sealing layer that would have enabled the deposition of an uninterrupted connection.

138. Further, a POSITA would have recognized that Chen's fabrication method is predisposed to deposition over the sealing layer because Chen forms the drive circuit-connected conductive members that further connect to "conductive wires" 122b-c "during formation of the active array device 122 on the substrate 110," or "in advance" of forming the touch panel conductive layers. *Chen*, 7:38-55. Further, Jang discloses that the sensing lines are coplanar with the sensing cells. *Jang*, Fig. 4 (connecting 311a to 311c, 312a to 312c); *Jang '041*, Fig. 4 (showing same).

139. Thus, a POSITA would have understood that Chen's conductive wires 122c-d on the substrate 110 were made before the intervening encapsulation layers and sensing cells of the touch structure 200a formed above at the higher elevation relative to the substrate 110, and Jang connects the touch sensing lines to touch sensing cells on the same layer at the higher elevation. Accordingly, in facing a need to provide electrical connections over the elevation difference, a POSITA would have found it obvious to simply connect the two different layer elevation points by depositing the sensing lines over the intervening barrier layers as Sano and Sakamoto depict because this was a commonly-known design and technique in the field.

140. For example, *Hara* (Ex-1046) teaches electrically connecting a front (lower) panel 1 to an external driving circuit through a connector 6 formed on a back (upper) panel 2 of interconnected “EL display panels” by forming metal wires 5 over a “tilted end face”:

FIG. 1

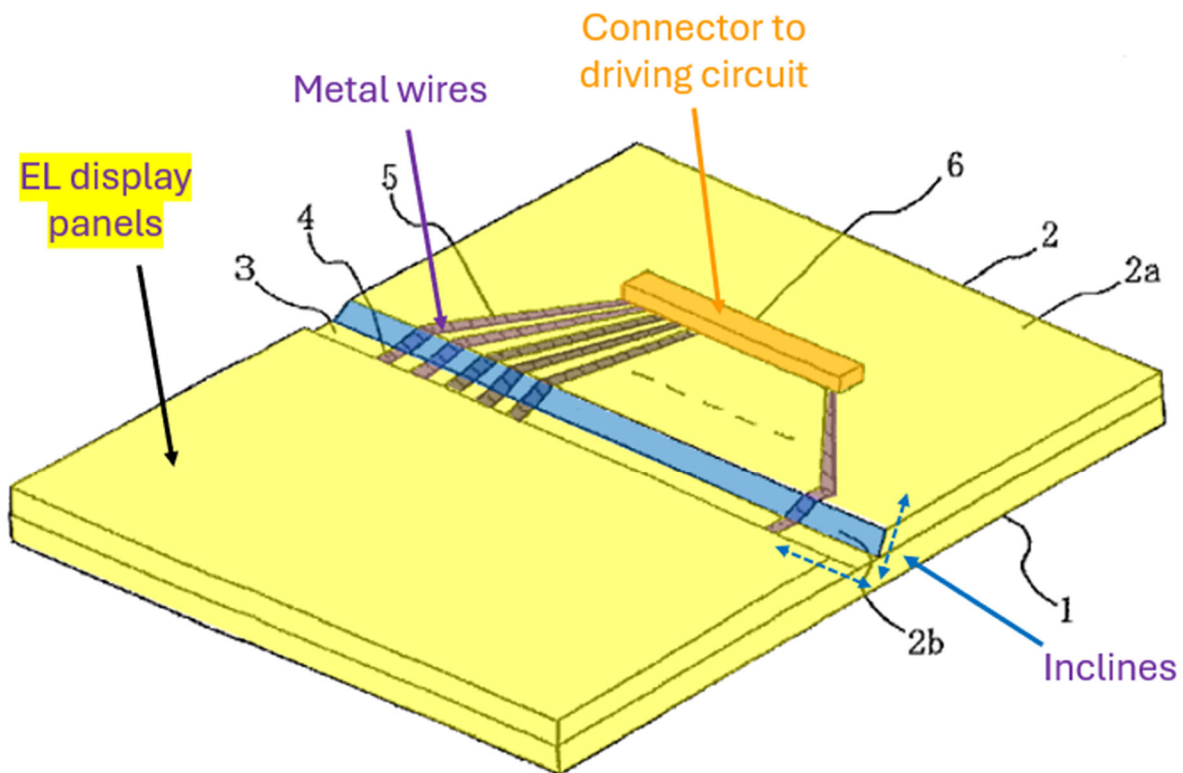
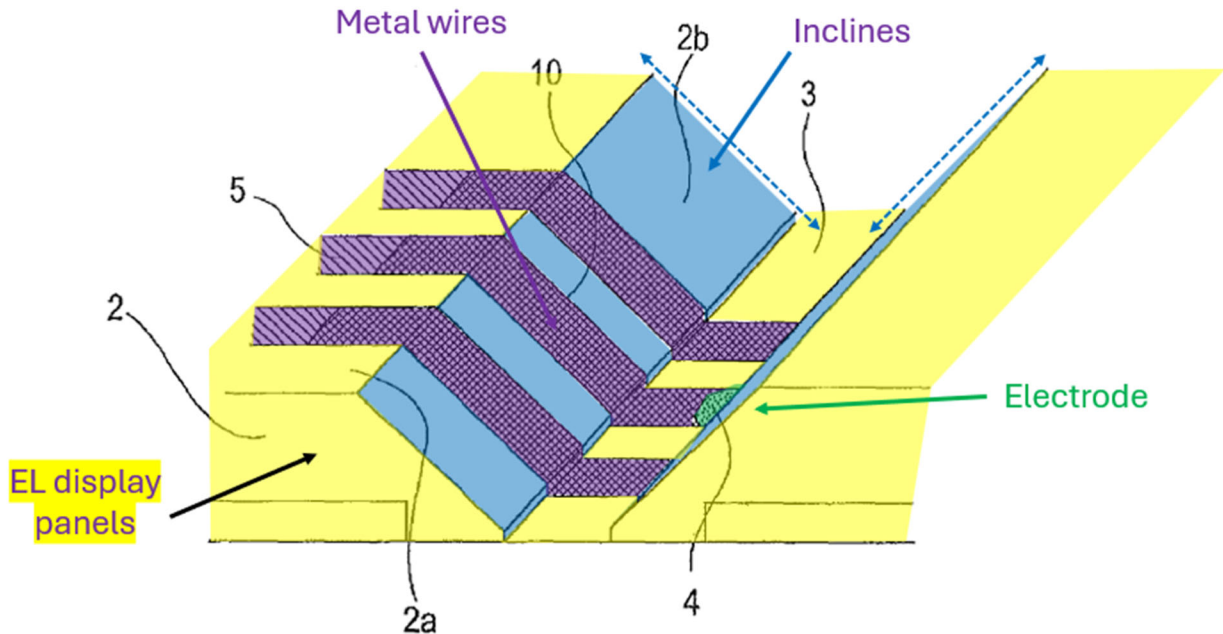


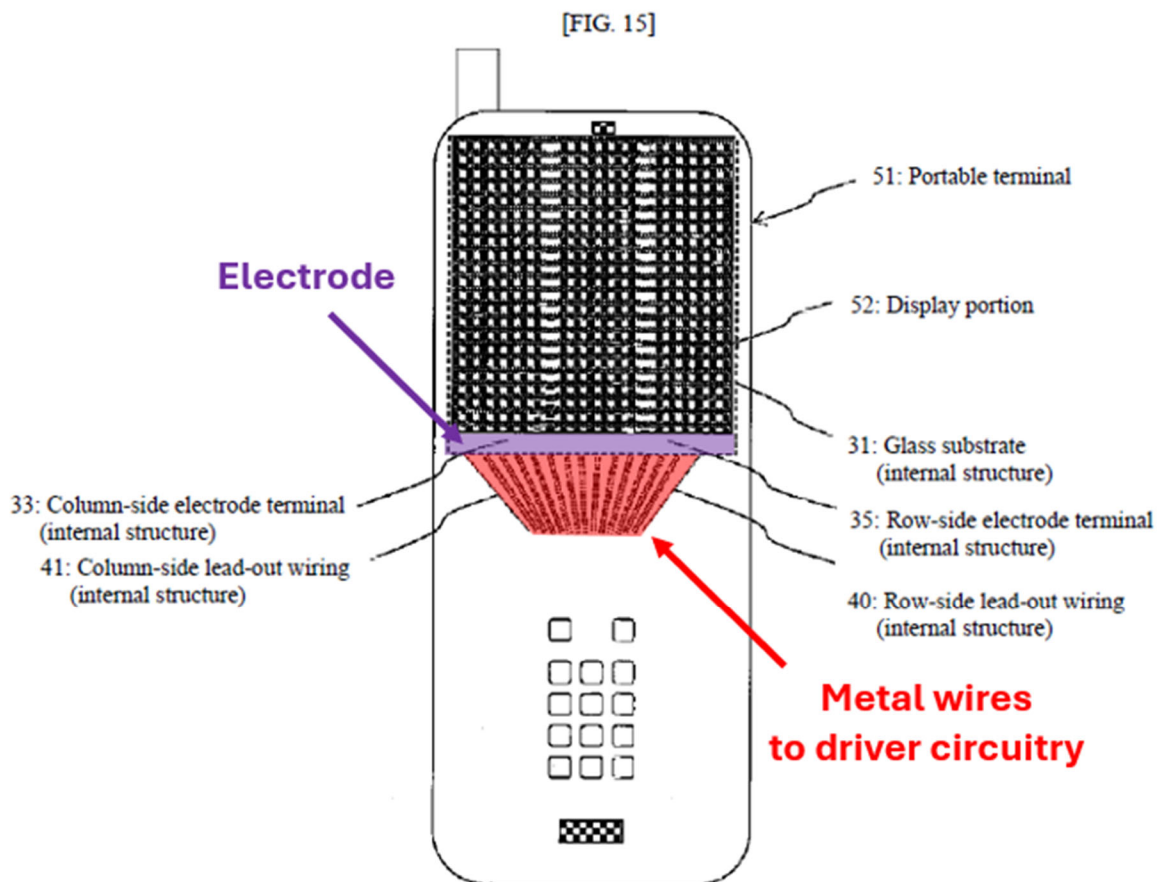
FIG. 5



Hara Figs. 1, 5, 6:14-35, 6:52-7:3, 8:9-54. *Hara* discloses several predictable benefits to an inclined interconnection, including: easy and controllable conductive paste fabrication, uniform thickness quality control that increases the connection reliability, and using conventional aluminum or ITO-based materials with low-resistance characteristics that preserve uninhibited electrical flow. *Id.*, 9:1-10.

141. A POSITA would have recognized that Sakamoto's design and application to a mobile phone—a mere rearrangement of the same components and device characteristics as *Hara*'s inclined-edge EL displays—is predisposed to benefit from the features *Hara* discloses for the same inclined design implemented

in a small portable device—Sakamoto’s mobile phone—because the mutual design allows connecting electrodes in very narrow portions concealed by Sakamoto’s narrow display bezel to make “unnoticeable joint parts of the [EL] panel” and “provide an image display element capable of having a stable connection performance even when a large current is flowed through the connection part.” *Hara*, 9:58-67; *Sakamoto*, ¶¶4-5, 23, 25-26



Sakamoto, Fig. 15 (annotated).

(ii) Combining Sano with Chen, Jang, and Sakamoto

142. Additionally or alternatively, and as guided by the teachings of Chen on the step difference and the needed downward wiring for connections over the step difference, it is my opinion that a POSITA would have been motivated to start with Sano and then combine Sano with Chen, Jang, and Sakamoto for another reason. Sano discloses an OLED display that is sealed from environmental degradants; Sano does not explain the display with any form of user input. Sano's display either has no user input, or relies upon external inputs (like a keyboard and mouse). However, touch-panel displays were growing in popularity as of 2010, and a POSITA would have been motivated to modify Sano to incorporate a touch panel into Sano's display to provide a direct form of user input. *See, e.g., Barbier*, Cover, ¶1 (filed in 2008 and noting "touch-sensing systems are becoming more prevalent as a means for inputting data" in at least "mobile phones, and numerous other applications"); *Hotelling* (Ex-1018), Cover, ¶5 ("Touch screens, in particular, are becoming increasingly popular because of their ease and versatility of operation as well as to their declining price."); *Chih-Yung* (Ex-1027), Cover, ¶6 (filed in 2008, and explaining that a "capacitive touch panel is advantageous in the design of dust-preventing, anti-fire, anti-scratch and high resolution"); *Kang* (Ex-1039), Cover, ¶7 (filed in 2009 and disclosing that "[a]pplications of the touch screen panel are

expanding widely because it can replace an input device that is coupled to and operates the image display device such as a keyboard, a mouse, or the like”).

143. Therefore, a POSITA would have turned to other prior-art references, such as Chen, Jang, and Sakomoto to identify the structures of the touch panel (e.g., Chen) and how they should be integrated into the display (e.g., Chen, Jang, and Sakomoto). Indeed, Chen expressly teaches that its touch panel is intended to be integrated with the encapsulation layers of an OLED display panel—like Sano’s—to create an integrate structure where “production costs can be reduced, and the manufacturing process can be simplified.” *Chen*, 8:49-51. A POSITA would have further looked to Jang and Sakomoto to provide additional details on how to implement Chen’s downward wiring for connecting, over Chen’s step difference, the on-display touch-sensor panel to off-display driving circuits—including by forming the touch-sensing lines to traverse the inclined surface of Sano’s encapsulation layer, for the same reasons I explained above when starting with Chen to provide an encapsulation layer with an inclined surface. *See* §X.A.1.f(i) (Combining Chen with Sano, Jang, and Sakamoto).

144. Finally, a POSITA would have had a reasonable expectation of success in making this modification because the modification merely involved forming additional touch-panel-related layers on Sano’s display, Chen taught the layers

required, and Jang and Sakamoto provided additional guidance on how to implement Chen's touch sensors. Moreover, integrating a touch-sensor panel into a display was a routine and well-known process as of 2010. *See, e.g., Kang*, ¶3 (“The present invention relates to a touch screen panel provided in an image display device”); *Tang*, ¶64 (“the capacitive touch panel of this invention can be integrated with a color pixel layer of an organic light-emitting diode (OLED) display”).

2. Independent Claim 1

a. 1[pre]: A display comprising:

145. In my opinion, if limiting, Chen discloses 1[pre].

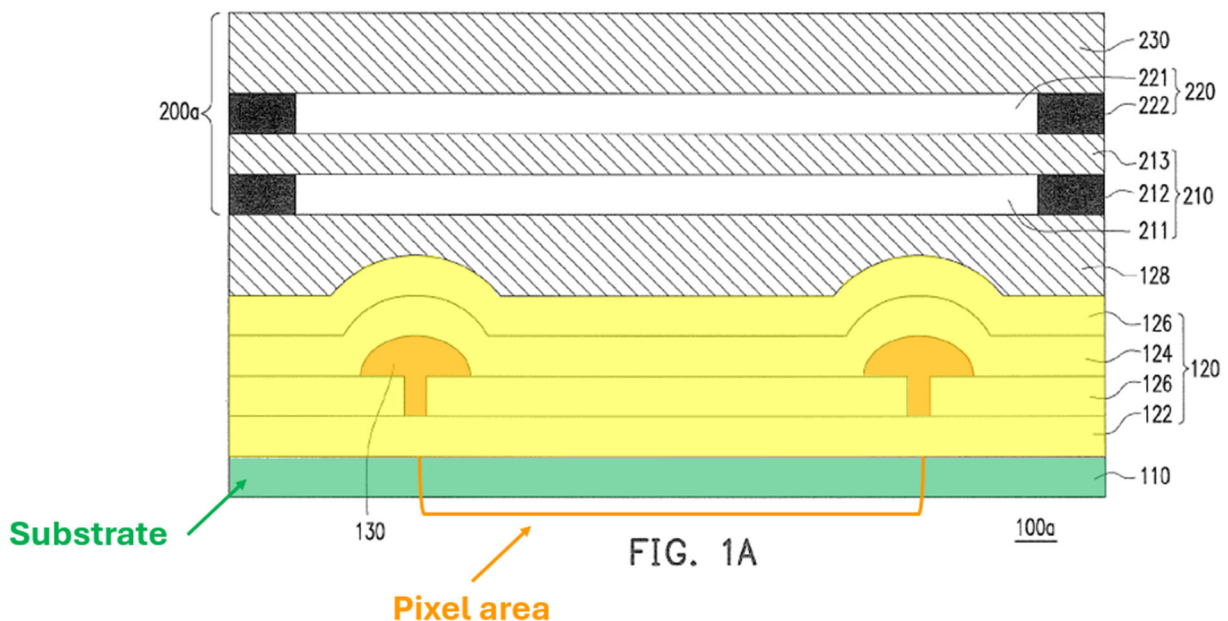
146. Chen discloses “[a] touch-sensing display apparatus.” *See, e.g., Chen*, Abstract, 1:16-21, 1:61-2:24, 2:64-3:36.

b. 1[a]: a substrate including a first area having a pixel area and a second area adjacent to the first area;

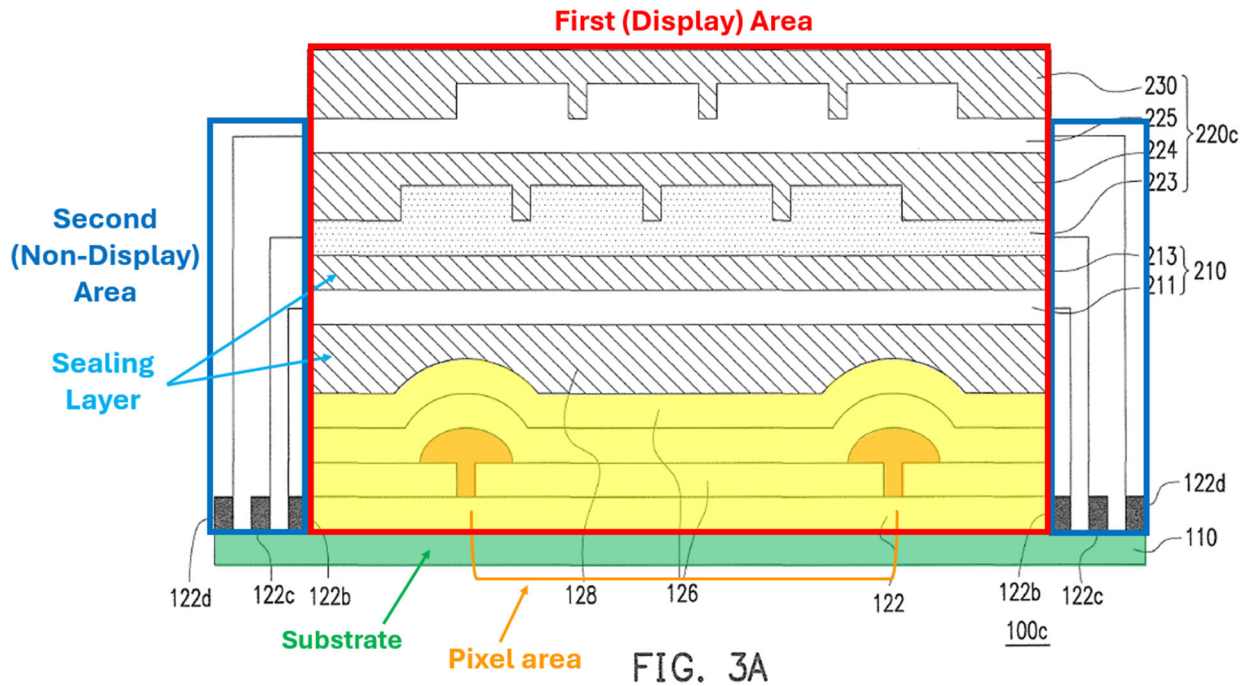
147. In my opinion, Chen, alone or combined with Jang, discloses or suggests 1[a].

148. Chen discloses that the display includes a substrate (110) with an “OLED display layer 120...disposed on the substrate 110,” and “the OLED display layer 120 further includes a pixel defining layer 130” and shows a plurality of OLED pixels for the OLED display. *Chen*, 2:66-3:26; *see also, e.g., id.*, Fig. 1A. Each pixel

area of the display device in Fig. 1A includes an organic light emitting layer 124 between the two and bottom OLED electrode layers 126 to emit light for the display images. *Id.* Chen therefore discloses a substrate that includes a first area having a pixel area (130).

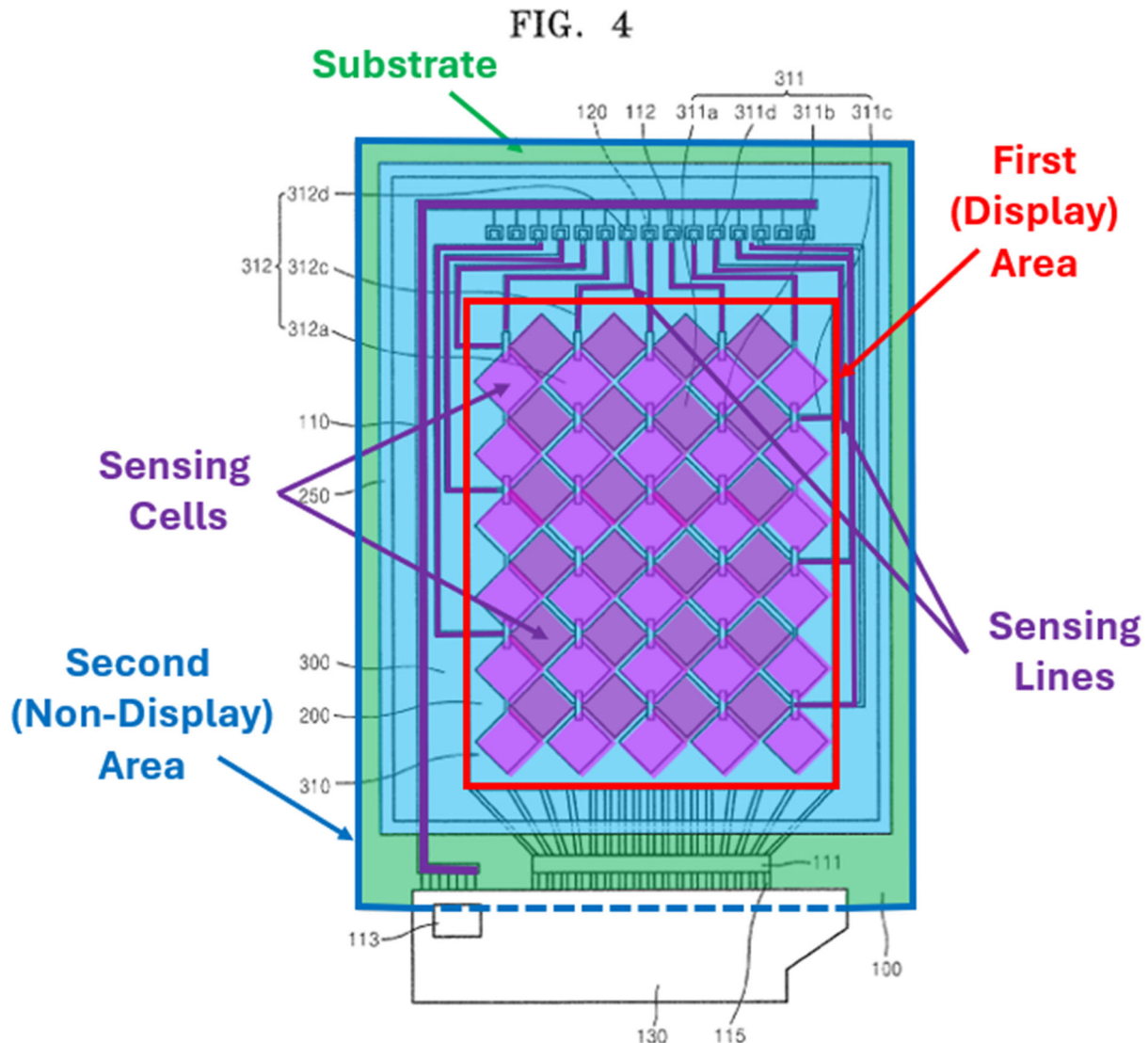


149. Chen also discloses that conductive wires (122c, d) are “formed on the substrate 110,” and depicts them in a non-display area (the “second area” as claimed) that is different from but adjacent to the display area (the “first area” as claimed). *Chen*, Fig. 3A, 7:13-55.



Although disclosed as part of a different embodiment, a POSITA would have understood that each of Chen's embodiments would have conductive lines to attach the conductive touch-sensor components to processor components in a non-display area to process touch-sensor signals and control the display.

150. Jang further confirms how a POSITA would have understood the arrangement Chen discloses as I explained in §X.A.1.f (motivation). Specifically, unlike Chen's cross-sectional views, Jang provides a top-down view that shows touch sensing lines (311c, 312c) that connect on-display touch sensors to off-display processors located on a lower substrate. *See, e.g., Jang, Fig. 4.*



151. A POSITA would have understood that, when implementing Chen's invention, Chen's display would have a first display area with the display and touch-sensor components, and a second non-display area adjacent the first display area with the processing elements and conductive lines connecting the on-display and off-display components, consistent with Jang. §X.A.1.f (motivation).

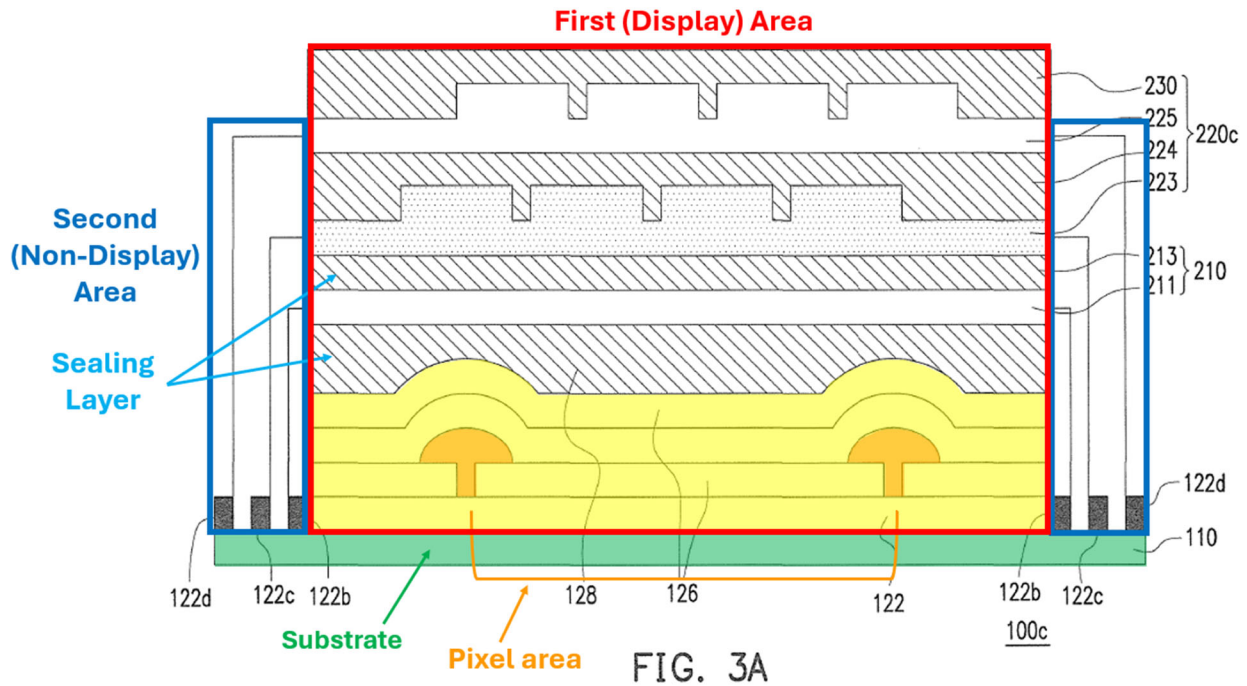
c. 1[b]: a plurality of pixels in the pixel area of the substrate;

152. In my opinion, Chen, alone or in combination with Jang, teaches 1[b] for the reasons I explained in §X.A.2.b (1[a]).

d. 1[c]: a sealing thin film covering the first area of the substrate and including an inclined surface at an end of the sealing thin film to inhibit infiltration of oxygen or moisture into the pixels;

153. In my opinion, Chen in view of Sano teaches or suggests 1[c].

154. Chen discloses “a first water/oxygen barrier layer 128 can be disposed on the OLED display layer 120”—e.g., in the “first area of the substrate,” as claimed—“to prevent oxygen and moisture from entering into the OLED display layer 120.” *Chen*, Fig. 3A, 3:9-26, 3:46-51; *see also* Fig. 4A.



Chen, Fig. 3A (annotated). *Chen* further discloses that “[p]referably” the device can include an EMI layer, and that the “barrier layer 128 and the EMI shielding layer 210 can be individually disposed or be disposed in a reverse manner,” meaning only one or the other may be provided, or their arrangement may be reversed. *Chen*, 3:43-65. Thus, a POSITA would have understood that when forming a display without the EMI shielding layer, *Chen*’s sensing-circuit layer (220c) would be formed directly on top of a top surface of the barrier layer (128). Moreover, when reversing the stacking order of the barrier layer (128) and EMI shielding layer (210), a POSITA would have understood again that *Chen*’s sensing-circuit layer (220c) would be formed directly on top of a top surface of the barrier layer (128).

155. A POSITA would have been guided by Chen’s sealing layer structure) while recognizing Chen depicts the edges of the OLED layers (Fig. 3A, in yellow) as being uncovered by the sealing layer (128) and would have turned to other prior art, such as Sano, to understand how to implement Chen’s sealing layer structure to fully protect the underlying OLED structure as I explained in §X.A.1.f (motivation).

156. Sano teaches forming a sealing layer (300) like Chen’s water/oxygen barrier layer (128) as a plurality of alternating buffer layers (e.g., 311, 312, 313) and barrier layers (e.g., 321, 322, 323), in which the barrier layers “are patterns larger in formation area than the buffer layers and cover the respective buffer layers to shield them from the open air,” including the peripheral edges of the buffer layers. *Sano*, ¶¶71-72, 106-09, 133, 158, 171, 173, 215. Sano notes that this arrangement produces a “sealer” with a “moderately inclined” edge:

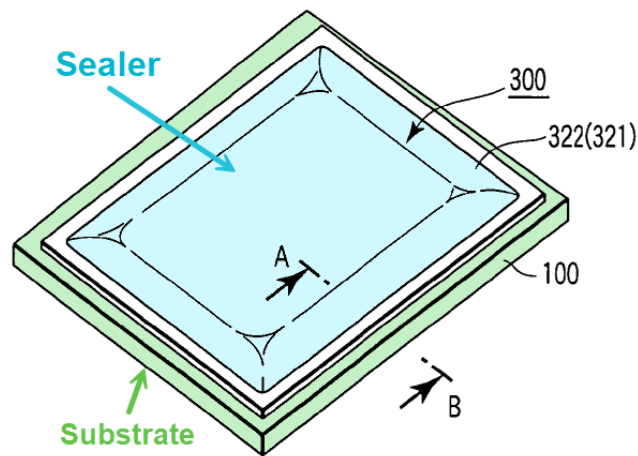
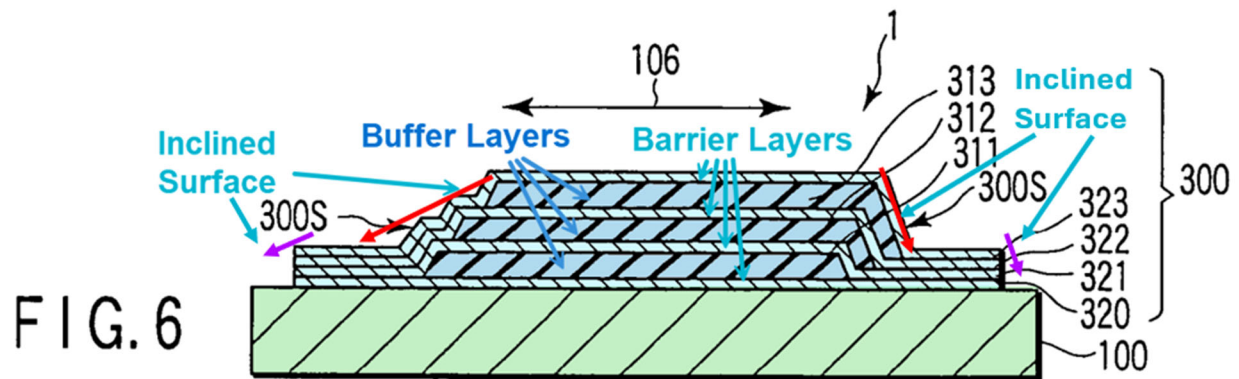
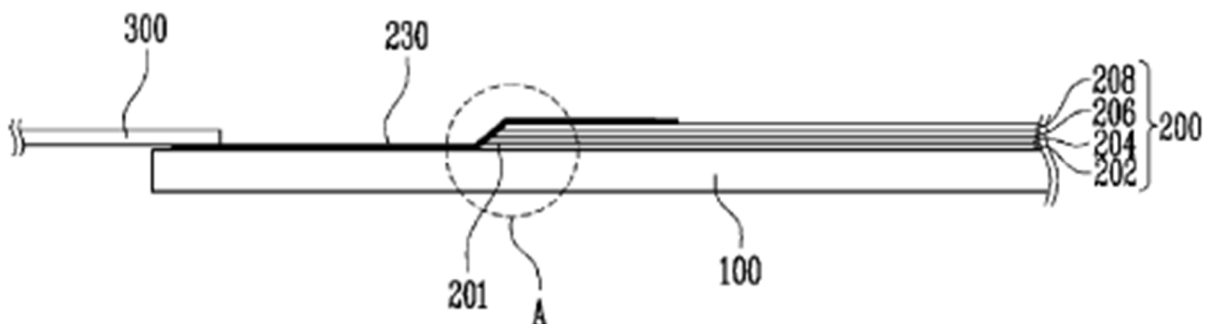


FIG. 3



Id., Figs. 3, 6 (annotated), ¶¶107-08, 133, 158, 171, 173, 215.

157. By my review, limitation 1[c] recites the claimed “sealing thin film covering the first area of the substrate and including an inclined surface at an end” which is somehow “to inhibit infiltration of oxygen or moisture into the pixels.” Ex-1001, cl. 1. Adding ambiguity, the ’088 patent discloses the end is located relative to “portion A” for an altogether different purpose: “to prevent the sensing lines passing through the end portion from being broken.” *Id.*, Fig. 4, 2:44-45, 4:46-51, 5:31-35.



158. Therefore, in my opinion, a POSITA would have understood that Sano's sealer 300 begins and terminates at two opposite ends, includes stacked layers 311-13 and 320-23 making up an "inclined surface 300S" (which would be the claimed, "inclined surface") and that 300S is located at both ends of it sealer because those inclines occur at a peripheral ("end") portion of the sealer—as opposed to the middle display region portion—to ensure "the periphery of each buffer layer can be reliably covered, thus preventing the occurrence of a coverage failure, which can in turn **prevent moisture, oxygen, and the like from entering each organic EL element.**" *Sano*, ¶¶108, 172 (emphasis added). A POSITA would therefore have recognized Sano's sealer ends in inclines to achieve the intended purpose of the claimed design: preventing water and oxygen infiltration and avoiding disconnection of an upper conductive layer.

159. Further, a POSITA would have recognized Sano's sealer barrier layers 321-23 end with inclines (which would be the claimed, "inclined surface") because the inorganic layers are formed using masks that create inclined *edges* during fabrication. *Id.*, ¶¶14-15; 71, 83-84; §VI (technology overview).

160. A POSITA would have understood that, when implementing Chen's invention in view of Sano, Chen's sealing layer (128) would cover the OLEDs completely to protect the edges of the OLEDs from degradants as I explained in

§X.A.1.f (motivation). A POSITA would have also been motivated to form Chen's sealing layer (128) from a plurality of alternating buffer and barrier layers in which the barrier layers are deposited to cover even the edges of the buffer layers, consistent with Sano as I explained in §X.A.1.f (motivation). In doing so, a POSITA would have appreciated that the sealing layer (128) would have an inclined surface at the ends of its barrier and buffer layers, consistent with Sano as I explained in §X.A.1.f (motivation).

e. 1[d]: a plurality of sensing cells formed over a top surface of the sealing thin film to sense a touch;

161. In my opinion, Chen discloses 1[d].

162. Chen discloses a touch sensing structure or a sensing-circuit layer (220c) comprising first (top) and second (bottom) patterned conductive layers (223, 225) each of which has a plurality of sensing cells in the form of touch sensor pads (223b, 225b) for touch sensing that are connected by a series of touch electrodes along two different directions D1, D2. *Chen*, Abstract, Figs. 3A, 3B, 4A, 7:13-55. Chen also discloses the sensing-circuit layer (220c) is formed over (e.g., above) a top surface of the water/oxygen barrier layer (128):

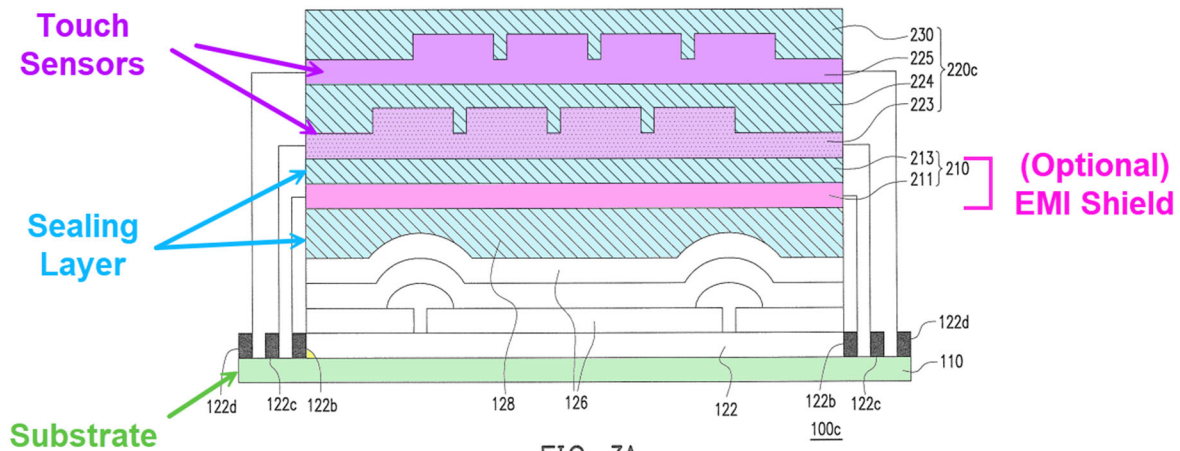


FIG. 3A

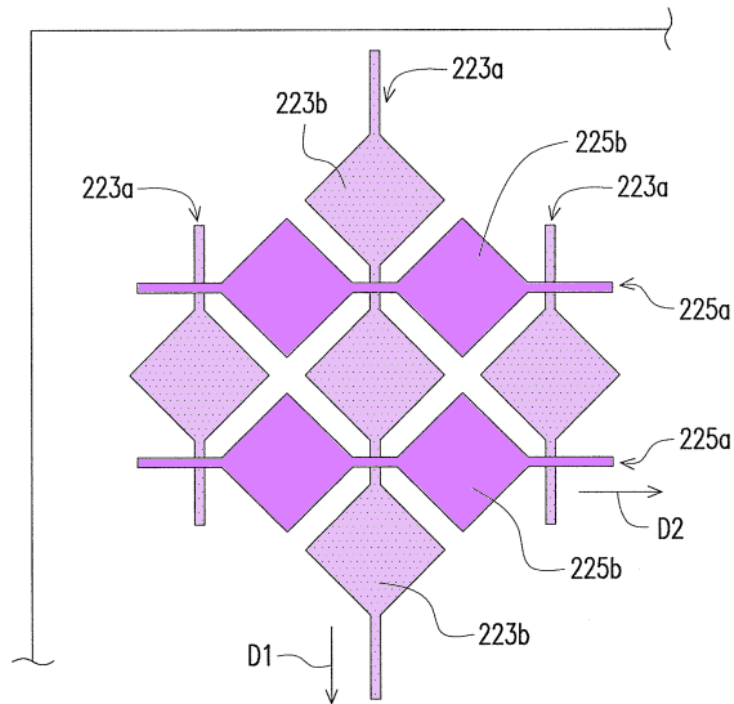


FIG. 3B

Id., Figs. 3A, 3B (annotated), 7:13-55. To the extent this limitation 1[d] may be construed to mean forming the sensing-circuit layer (220c) directly on top of a top

surface of the barrier layer (128), Chen's "barrier layer 128 and the EMI shielding layer 210 can be individually disposed or be disposed in a reverse manner," meaning only one or the other may be provided, or their arrangement may be reversed. *Chen*, 3:62-65. Thus, a POSITA would have understood that when forming a display without the EMI shielding layer, Chen's sensing-circuit layer (220c) would be formed directly on top of a top surface of the barrier layer (128).

163. Also, when reversing the stacking order of the barrier layer (128) and EMI shielding layer (210), a POSITA would have understood again that Chen's sensing-circuit layer (220c) would be formed directly on top of a top surface of the barrier layer (128).

f. 1[e]: a plurality of sensing lines coupled to the sensing cells, the sensing lines comprising a first portion and a second portion;

164. In my opinion, Chen, alone or in combination with Jang, discloses or suggests 1[e]. Referring to the above discussion in 1[a] and 1[d], Chen discloses first touch electrode series 223a and second touch electrode series 225a extend along first and second directions D1 and D2 to electrically connect to first touchpads 223b and second touchpads 225b as touch sensing cells along directions D1 and D2, respectively. *Chen*, Figs. 3A-B, 7:1-55. The first touch electrode series 223a and second touch electrode series 225a at the peripheral of the touch area in Chen are

part of the claimed sensing lines to be coupled to the sensing cells defined by the first touchpads 223b and second touchpads 225b. *Id.*

165. In my opinion, Chen discloses, or at least renders obvious, first and second patterned conductive layers (223, 225) are coupled to a plurality of conductive lines (or “sensing lines,” as claimed) that are connected to touch electrodes further connected to “conductive wires” 122c-d formed on the substrate (110). *Chen*, 7:13-8:38, Figs. 3A, 3B. A POSITA would have understood Chen discloses or at least renders obvious that the conductive lines have at least two portions: one portion (223a, 225a) at the end of the series of touch sensor pads (223b, 225b) as a first portion in the conductive layers (223, 225), and another, second portion (shown as solid lines on left and right sides of the multilayer stack for the touch sensing structure and OLED structure in Fig. 3A) formed over the substrate as an extension of the first portion that includes a part to bridge over the step difference between the conductive layers (223, 225) and the substrate (110) to reach conductive wires 122c-d formed on the substrate (110).

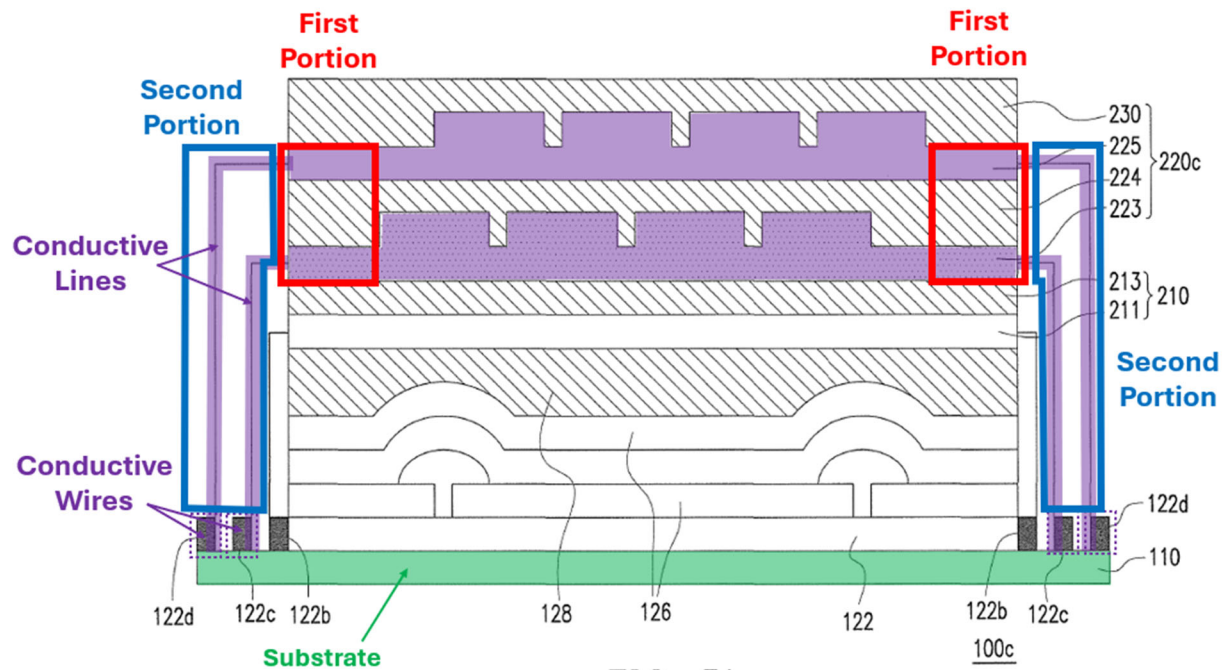


FIG. 3A

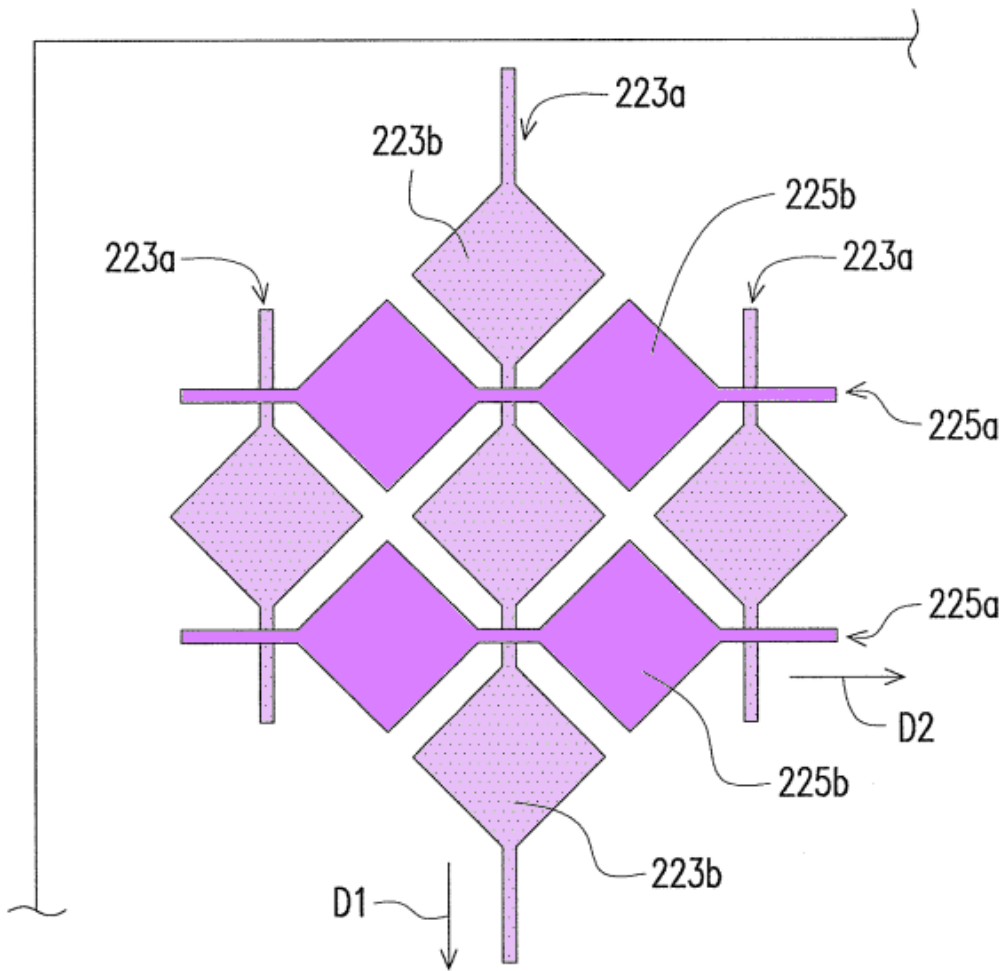


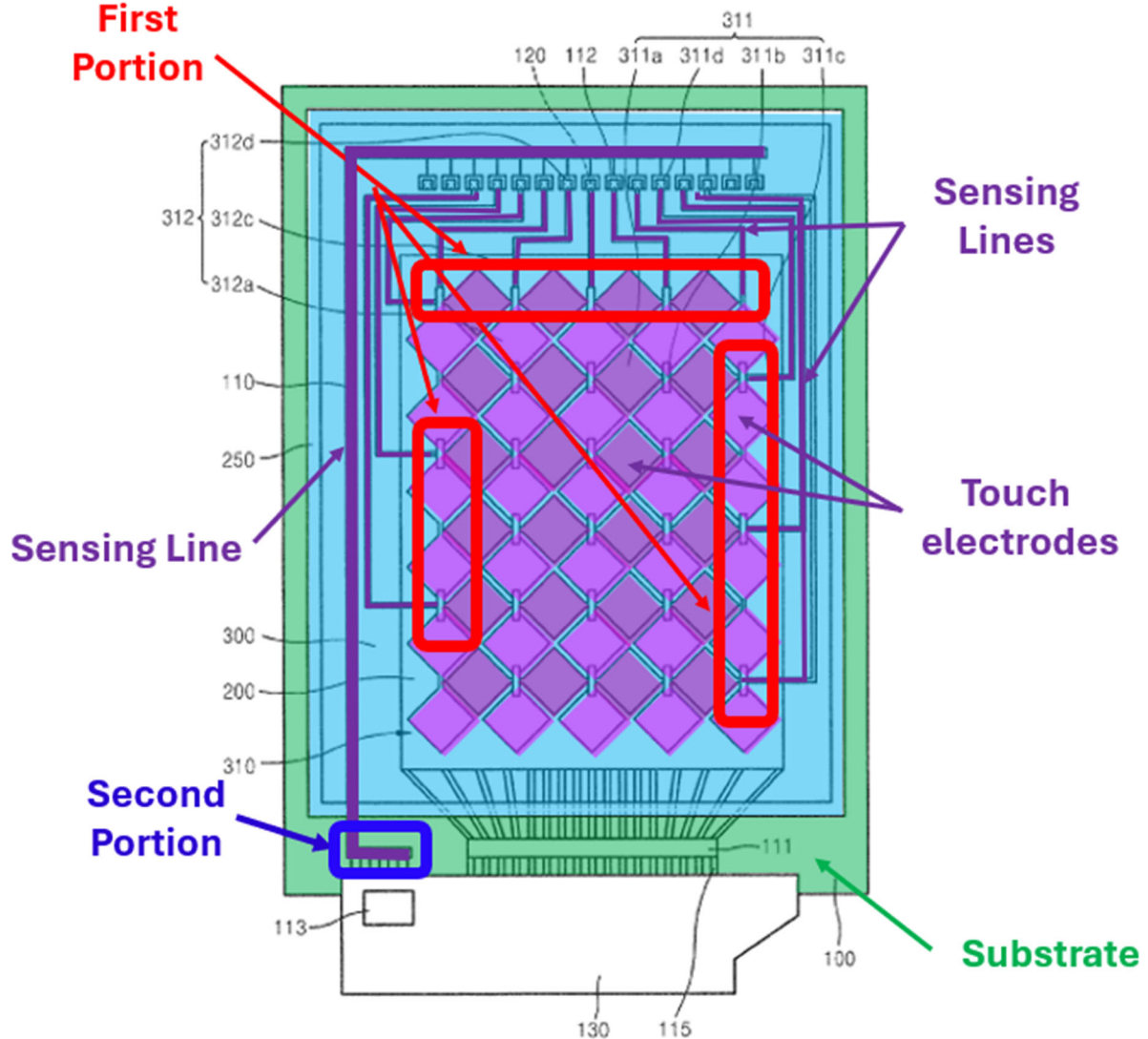
FIG. 3B

Id., Figs. 3A (annotated to highlight conductive line connections to Chen's conductive layers 223, 225), 3B (annotated to highlight Chen's electrode series 223a, 225a corresponding to conductive line connections at conductive layers 223, 225, respectively), 7:13-55.

166. A POSITA would have understood the first portion of the sensing line is located over the top of the sealing layer to connect to the touch electrodes or touch sensing cells over the top of the sealing layer and the second portion of the sensing line would be over the substrate in order to provide electrical connections to the substrate by the conductive wires 112c-d on the substrate 110 as Chen's layers depict. and the second portion of the sensing line would be over the substrate as Chen's layers depict. *Id.*, Fig. 3A (depicting layered connections); *see also* Fig. 4A.

167. Jang further confirms how a POSITA would have understood Chen's vertically-spaced horizontal OLED/touch panel layers. as I explained in §X.A.1.f (motivation). Specifically, a POSITA would have looked for variations to Chen's one arrangement in the alternatives provided by Jang as described above. §X.A.1.c (Jang overview). Jang provides a top-down view that shows sensing lines (311c, 312c, 110) like Chen's conductive lines (311c, 312c) connecting to touch sensors ("first portion," 311c, 312c in red) formed in a same layer as the touch sensors and another portion ("second portion" in blue) in form of data line 110 that runs over the substrate to connect to a PCB.

FIG. 4



See, e.g., Jang, Fig. 4 (annotated), ¶¶72, 82.

168. A POSITA would have therefore understood Chen's disclosure as providing conductive lines having at least two portions: one connecting to the conductive layers 223, 225 ("first portion"), and another that traverses over the

substrate to connect to conductive wires 122c-d and off-display processing components (“second portion”), consistent with Jang. §X.A.1.f (motivation).

169. A POSITA would have further recognized that Chen first forms active array device 122 and conductive wires 122c-d on the substrate 110 and then forms additional layers above, which requires fabricating some type of structure to route the electrical connections of the higher layers back down to the drive circuitry on the lowest substrate to control the entirety of the multilayer OLED/touch panel display. *Chen*, 5:42-52; §X.A.1.f (motivation).

g. 1[f]: a driving circuit electrically connected to the sensing cells via the sensing lines; and

170. In my opinion, Chen in view of Jang teaches 1[f].

171. Although Chen does not expressly explain what the conductive wires (122c, d) and conductive lines are connected to, a POSITA would have understood that they necessarily connected to driving and/or processing components and circuitry to deliver electricity to the touch sensors and evaluate electrical signals in response to a user’s touch.

172. Jang, for instance, teaches that conductive lines connect to two driving circuits: (1) a display-drive integrated circuit (111, “DDI”) connected to a flexible PCB (130) to “drive the display unit 200” by input/output lines (115); and (2) sensing

integrated with the DDI (111) to consolidate and receive all touch sensing and display signals in a single driver circuit. *Id.*, ¶88.

173. When implementing Chen’s invention, therefore, a POSITA would have been motivated to connect Chen’s touch electrode-connected conductive lines connected to conductive wires (122c, d) which are further connected to a driving circuit—whether a touch-panel-drive integrated circuit located on a separate PCB, or one integrated with a display driver on the substrate—to drive the touch sensors and respond to a user’s touch as I explained in §X.A.1.f (motivation). But a POSITA would have been especially motivated to integrate the touch-panel-drive integrated circuit with the display-drive integrated circuit to “further reduce the manufacturing costs” and improve both the steps for “manufacture and user’s convenience.” *Jang*, ¶88; *see also Cok* (Ex-1014), 2:47-51 (describing the need to “reduce[] redundant components” in OLED display and touch screen devices, which “reduces cost, improves optical qualities, and is more robust”).

h. 1[g]: an insulating layer,

174. In my opinion, Chen discloses or suggests 1[g]; *see also* my explanation regarding 1[l], below. §X.A.2.m.

175. Chen discloses that the display includes an insulating layer—which may also act as another a water/oxygen barrier layer—first water/oxygen barrier

insulation layer 224—positioned between first and second patterned conductive layers (223, 225):

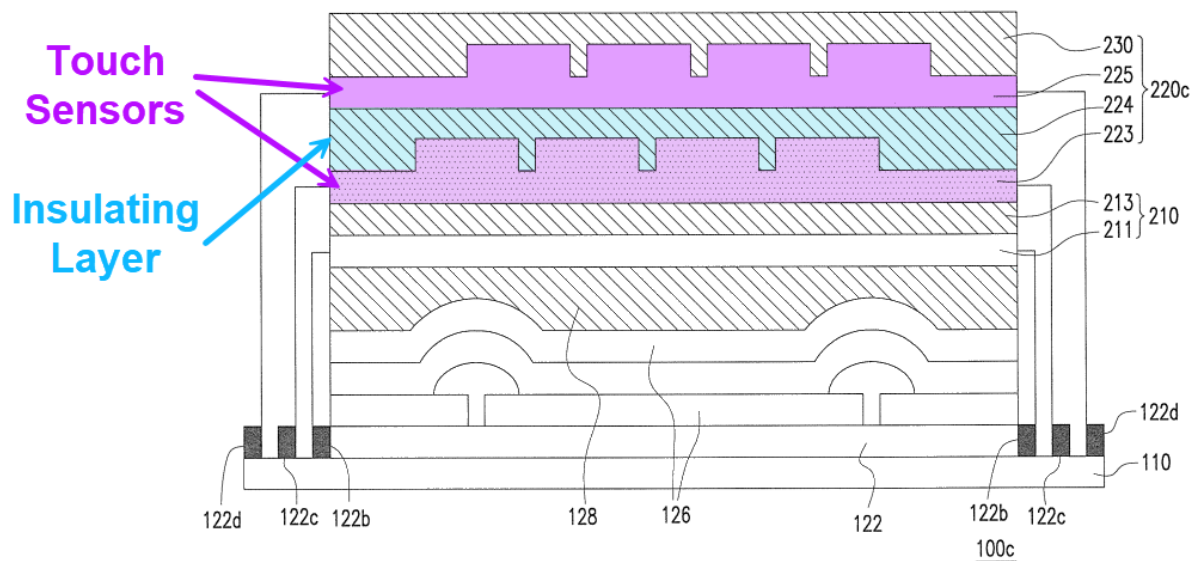


FIG. 3A

Id., Fig. 3A (annotated), 7:13-55; *see also* Fig. 4A (water/oxygen barrier insulation layer 234).

- i. **1[h]:** wherein the inclined surface of the sealing thin film is formed to be inclined downwardly toward the driving circuit,

176. In my opinion, Chen in view of Sano and Jang teaches or suggests 1[h].

177. Chen combined with Sano teaches or suggests forming Chen's barrier layer (128) as a multi-layered sealing layer consistent with Sano, which would produce a sealing layer with an inclined surface, as I explained in 1[c]. §X.A.2.d (1[c]). And Chen combined with Jang teaches or suggests connecting Chen's

conductive lines downwardly from the touch sensing layers at higher elevations to a driving circuit either directly on the lower-elevation substrate, or connected to the substrate through a flexible PCB, as I explained in 1[f]. §X.A.2.g (1[f]).

178. A POSITA would have understood, consistent with Sano, that when forming Chen's barrier layer (128) as a multi-layered sealing layer that has an inclined surface, the series of buffer and barrier layers cover the OLED-display elements to prevent degradants from reaching the display, and the edges of the sealing layer then taper or incline outwardly but would not have extended as far as a driving circuit, as Sano shows.

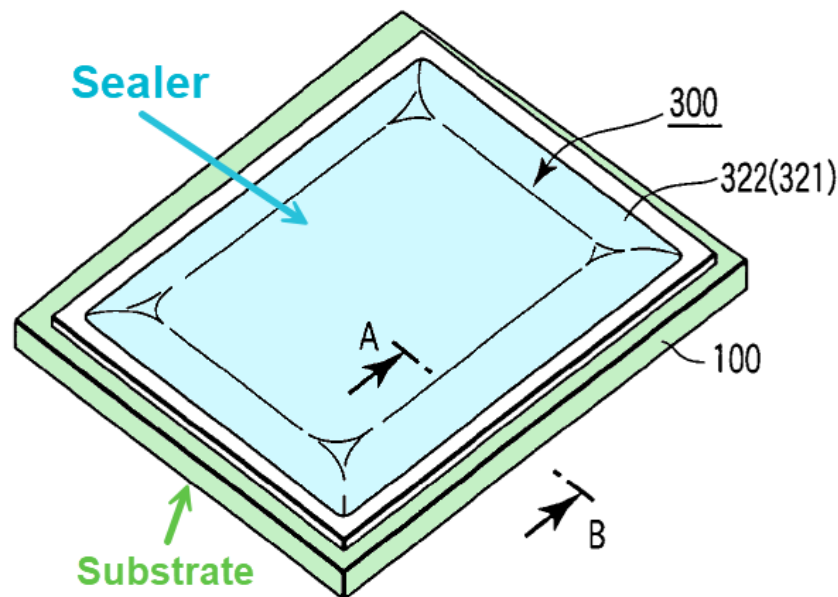
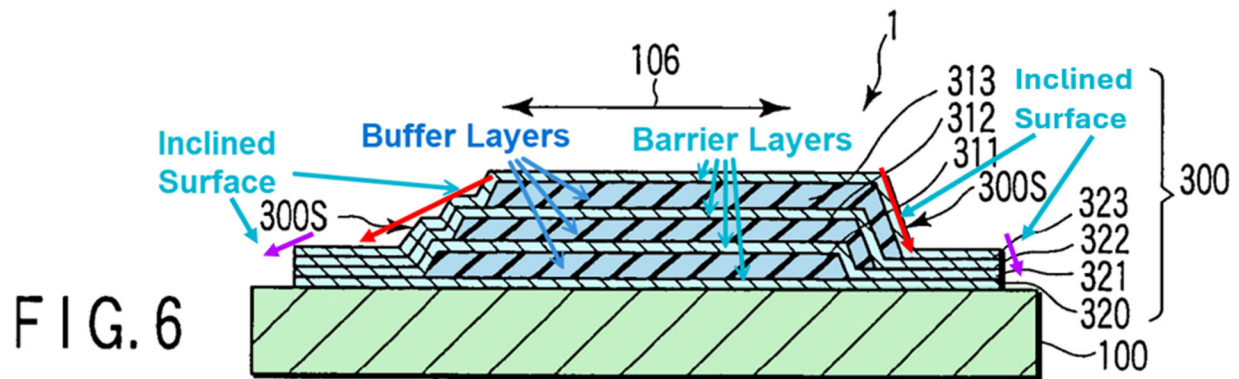
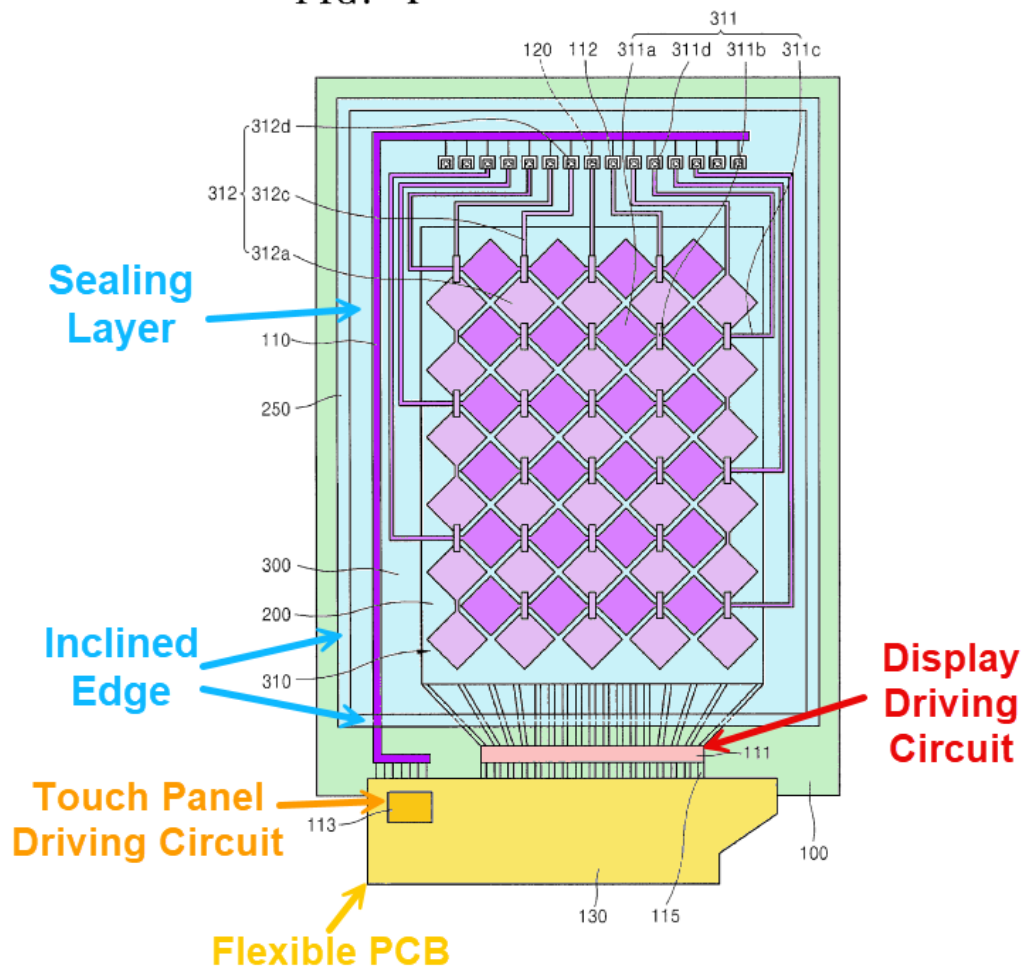


FIG. 3



Id., Figs. 3, 6 (annotated), ¶¶107-08, 133, 158, 171, 173, 215. Moreover, because Jang shows a driver circuit (TDI or a TDI integrated with a DDI) sitting **outside** of the display area, a POSITA would have appreciated that a sealing layer (128) formed consistent with Chen and Sano would be inclined downwardly towards the driving circuit that sits outside of the display area. Using Jang's Figure 4 to depict this arrangement (because, unlike Chen, Jang provides a top-down view), a POSITA would have understood that the peripheral edge of the Chen and Sano's sealing layer (128) would have a downward incline towards the substrate, and thus towards the driving circuit.

FIG. 4

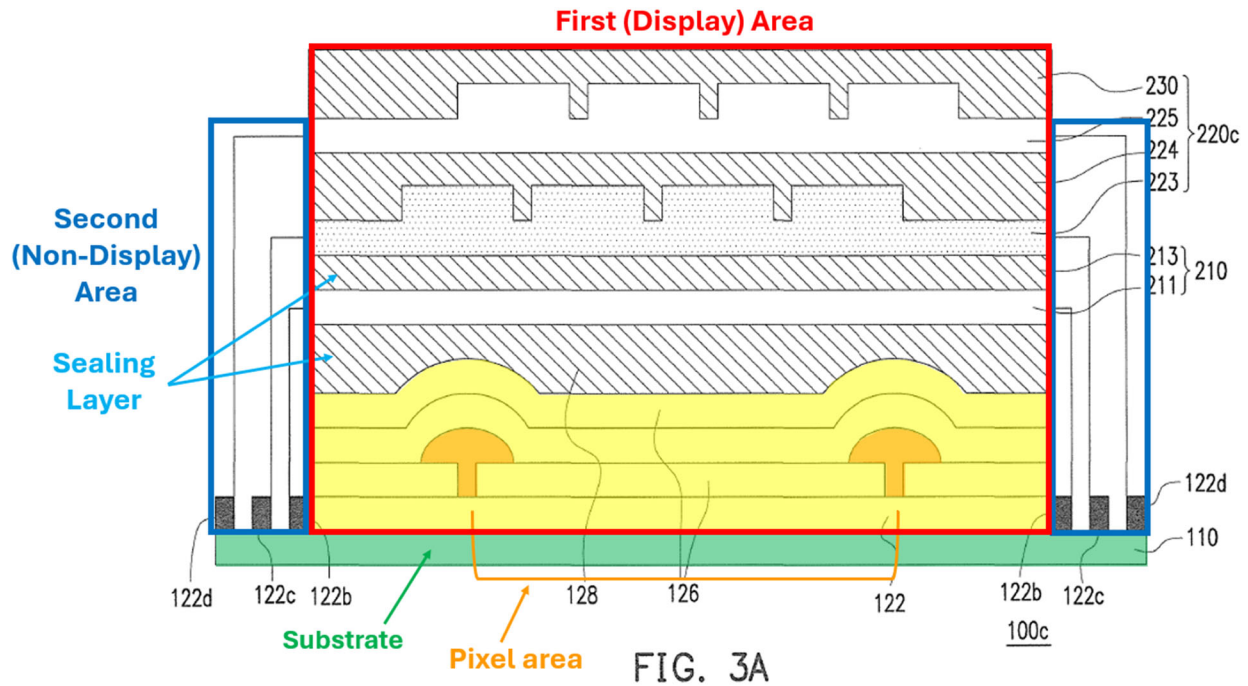


179. Although Jang discloses and depicts an encapsulation substrate (300) intended to cover both the display elements *and* touch-sensor elements, a POSITA would have appreciated that a sealing layer intended to protect only the OLED display elements—such as Chen’s barrier layer (128)—would be made smaller to cover only the OLED region (e.g. the region that Jang depicts as box 200).

j. 1[i]: wherein the sensing lines include inclined portion along the inclined surface of the sealing thin film,

180. In my opinion, Chen in view of Jang, Sano, and Sakamoto teaches or suggests 1[i].

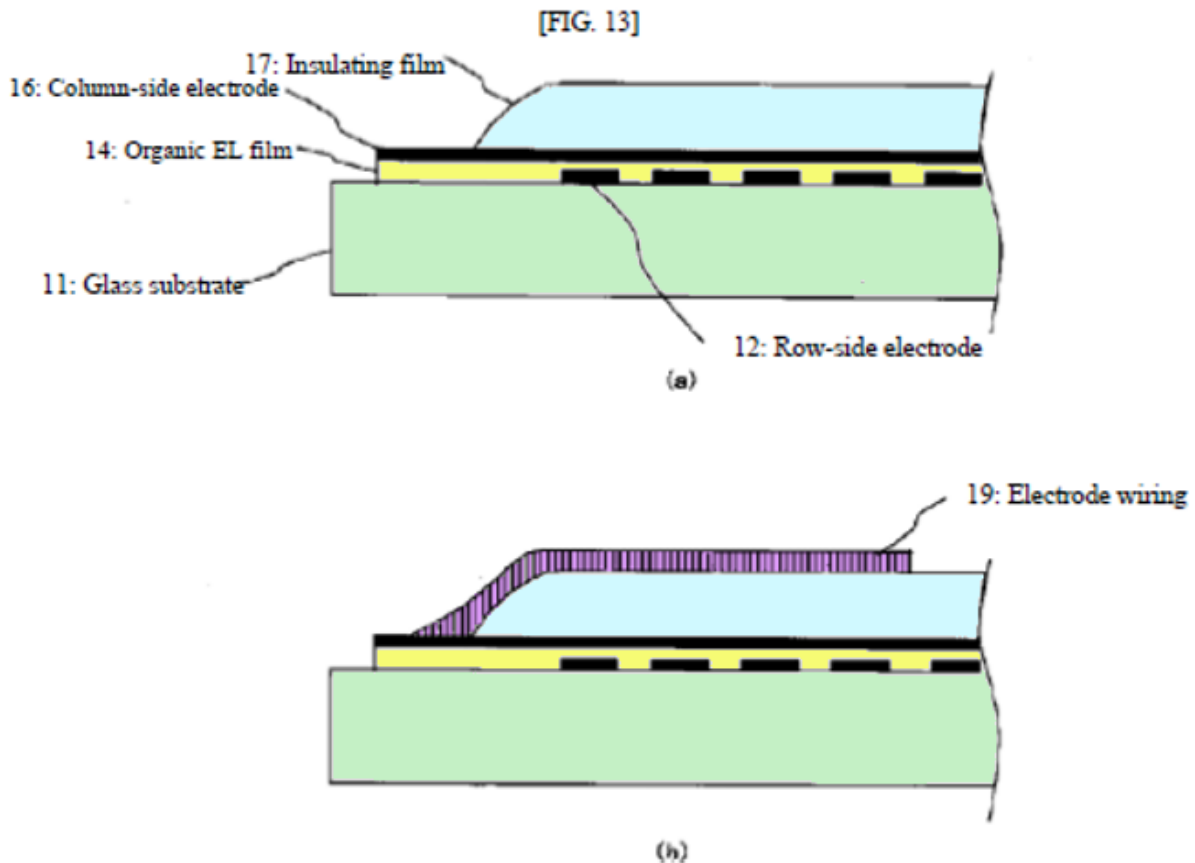
181. Chen discloses that the conductive lines are connected to conductive wires (122c, d) formed on the substrate (110), and depicts regions of the conductive wires as being outside of the sealing layer (128) and extending the length of a layer-mandated height differential or a step difference. A POSITA would be guided by the teachings in Chen on the first portion and second portion of the sensing lines in 1[e] to have understood that there will be another portion in the sensing lines between the first portion of the sensing lines on the top of the thin sealing film and the second portion of the sensing lines over the substrate to pass through an edge of the thin sealing film in light of the common elevation difference in routing the sensing lines in both Chen and Sano.



Chen, 7:13-55, Fig. 3A.

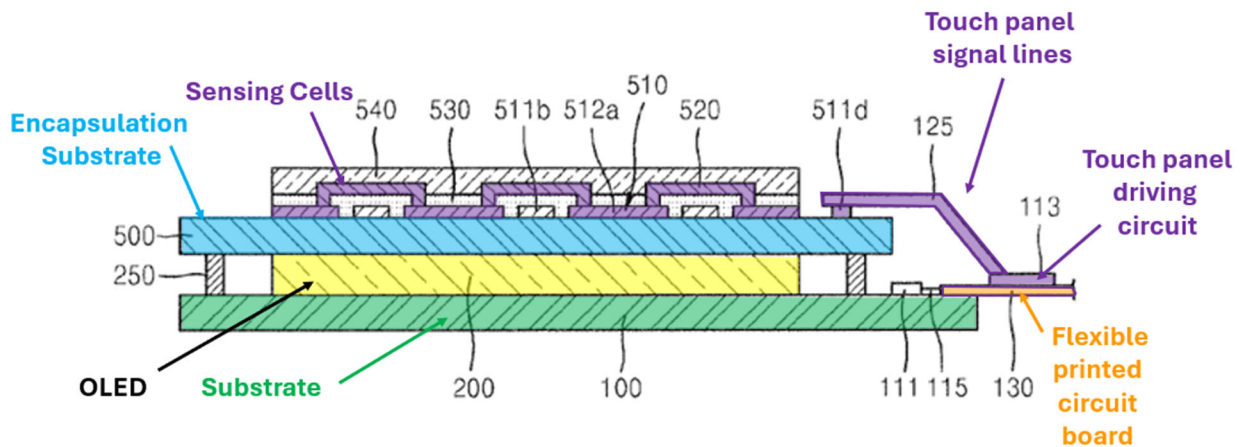
182. Upon modifying *Chen*'s barrier layer (128) to have a multi-layered sealing layer with an inclined edge, consistent with *Sano* (§X.A.2.d (1[c])), a POSITA would have appreciated that *Chen*'s conductive lines connect to conductive wires previously fabricated upon substrate 110, and would therefore traverse a layer-mandated height differential including passing over the inclined surface of the sealing thin film, as taught by *Sano* both at overall inclined surface 300S in the barrier layer for fully covering and sealing each underlying buffer layer and the inclined side at the end of each barrier layer as I previously explained, to connect the touch conductive layers (223, 225) on top of the sealing layer (128) to the conductive

wires (122c-d) on the substrate (110). Although a few ways were known to make that connection, a POSITA would have understood that one obvious (and, indeed, the most straightforward) option would be to form part of Chen's conductive lines to include an inclined portion to run along the inclined surface of the sealing layer (128), as taught by Sakamoto and others in the art to connect the first-formed conductive element such as conductive wires on the substrate (i.e., Chen's conductive wires 122c-d) to the touch panel sensors (i.e., electrodes 225) formed after and above this layer. §X.A.1.f (motivation).



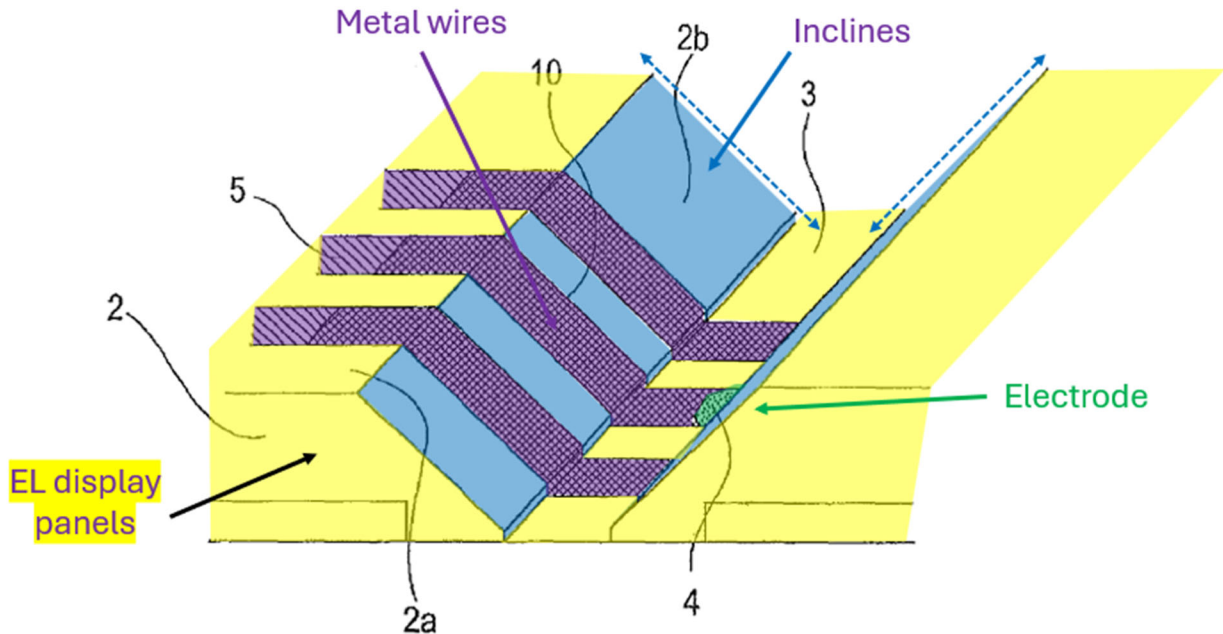
Sakamoto, Fig. 13a-b (annotated), ¶23.

183. A POSITA would have further found this to be an obvious design variant of common incline-shaped interconnection methods traversing a common OLED display and touch panel layer-mandated height differential using a known design and materials because this inclined shaped was a well-known, established design for connecting a touch panel formed over top of an encapsulating layer to a separate, lower substrate and was therefore ripe for use in deposition-based fabrication. *See Jang '041*, ¶¶ 122-26, Fig. 10 (annotated):



184. A POSITA would have further considered Hara. *Hara*, Figs. 1, 6:14-35, 6:52-7:3, 8:9-54, Fig. 5 (annotated):

FIG. 5



- k. 1[j]: wherein the sensing lines are formed over the top surface of the sealing thin film in the first portion and formed over the substrate in the second portion, and the sensing lines extend from the sensing cells along the inclined surface of the sealing thin film to the second area of the substrate, wherein the sensing lines are electrically connected to the driving circuit,

185. In my opinion, Chen in view of Jang, Sano, and Sakamoto teaches 1[j].

186. Chen discloses conductive lines as sensing lines have a first portion connected to the touch sensors formed on top of the barrier layer (128), and a second portion formed over the substrate that provides connection from the first portion to the conductive wires on the substrate as I explained in §§X.A.2.e-X.A.2.f (1[d]-[e]).

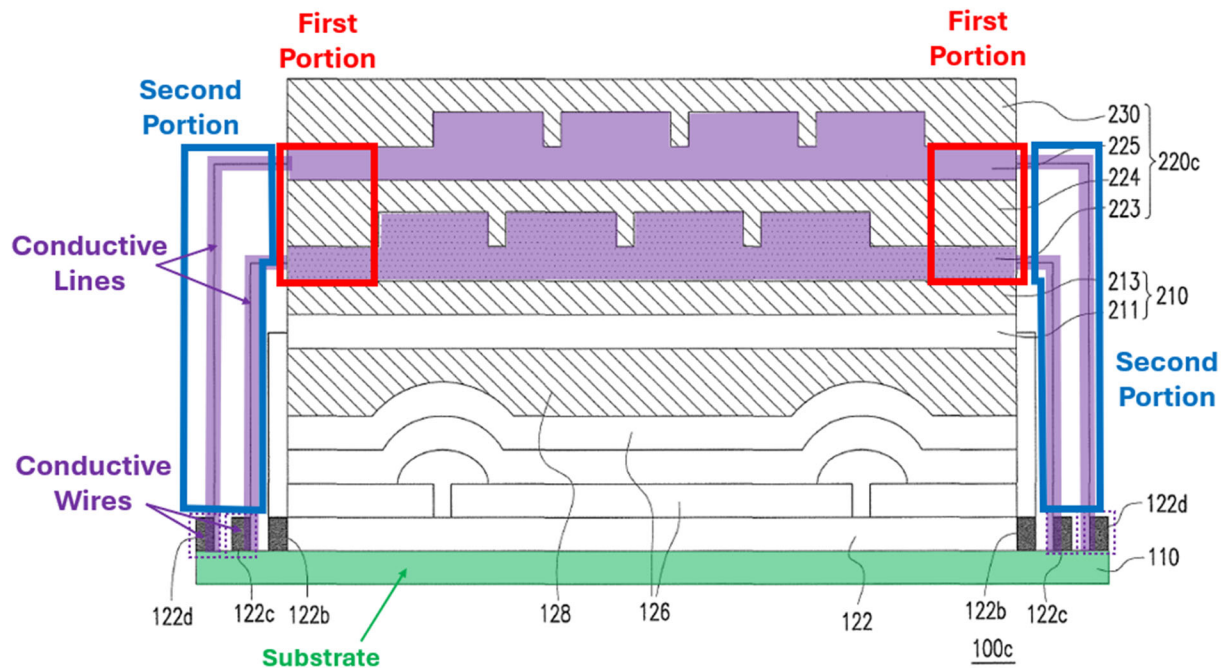
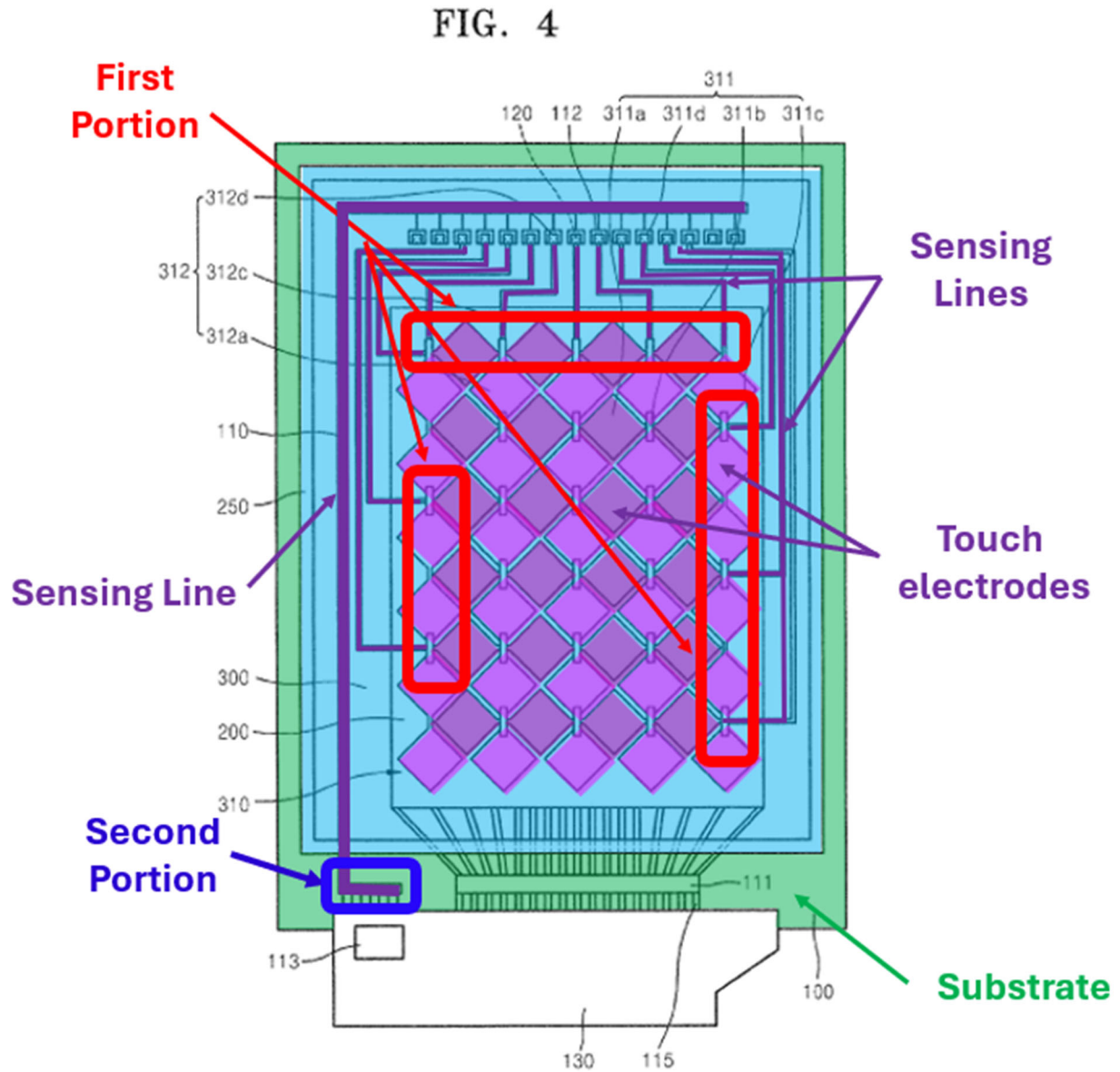


FIG. 3A

Chen, Fig. 3A (annotated), 7:13-55. And Jang provides an exemplary top-down view of a similar arrangement, showing a first portion connected to the touch sensors, and a second portion that runs along the substrate and connects to a driving circuit as I explained in §X.A.2.f (1[e]).



Jang, Fig. 4 (annotated).

187. Upon modifying Chen's barrier layer (128) to have a multi-layered sealing layer with an inclined edge, consistent with Sano (§X.A.2.d (1[c])), a POSITA would have appreciated that Chen's conductive lines as sensing lines would

have a first portion formed over the top surface of the barrier layer (128) and downwardly connect to another second portion connected to conductive wires 122c-d already formed on substrate (110)—similar to Jang’s top-down depiction—and the conductive lines extend from the touch sensors along the inclined edge of the barrier layer (128) (*i.e.*, Sano’s moderately inclined surface 300S and inorganic barrier layer taper at its end) to the second area of the substrate as taught by Sakamoto for connecting to the conductive wires and driving circuit as I explained in §§X.A.2.g (1[f]), X.A.2.j (1[i]).

- I. **1[k]: wherein the sensing cells include a plurality of first sensing cells connected along a first direction by first connection patterns and a plurality of second sensing cells connected along a second direction by second connection patterns, and**

188. In my opinion, Chen discloses 1[k].

189. Chen discloses that the touch sensor has two conductive layers (223, 225), each of which has a plurality of touch sensor pads (223b, 225b) (that constitute “sensing cells” for touch sensing as claimed) with connection patterns (223a, 225a) to create arrays of touch sensor pads oriented in two directions (223a, b in direction D1; 225a, b in direction D2):

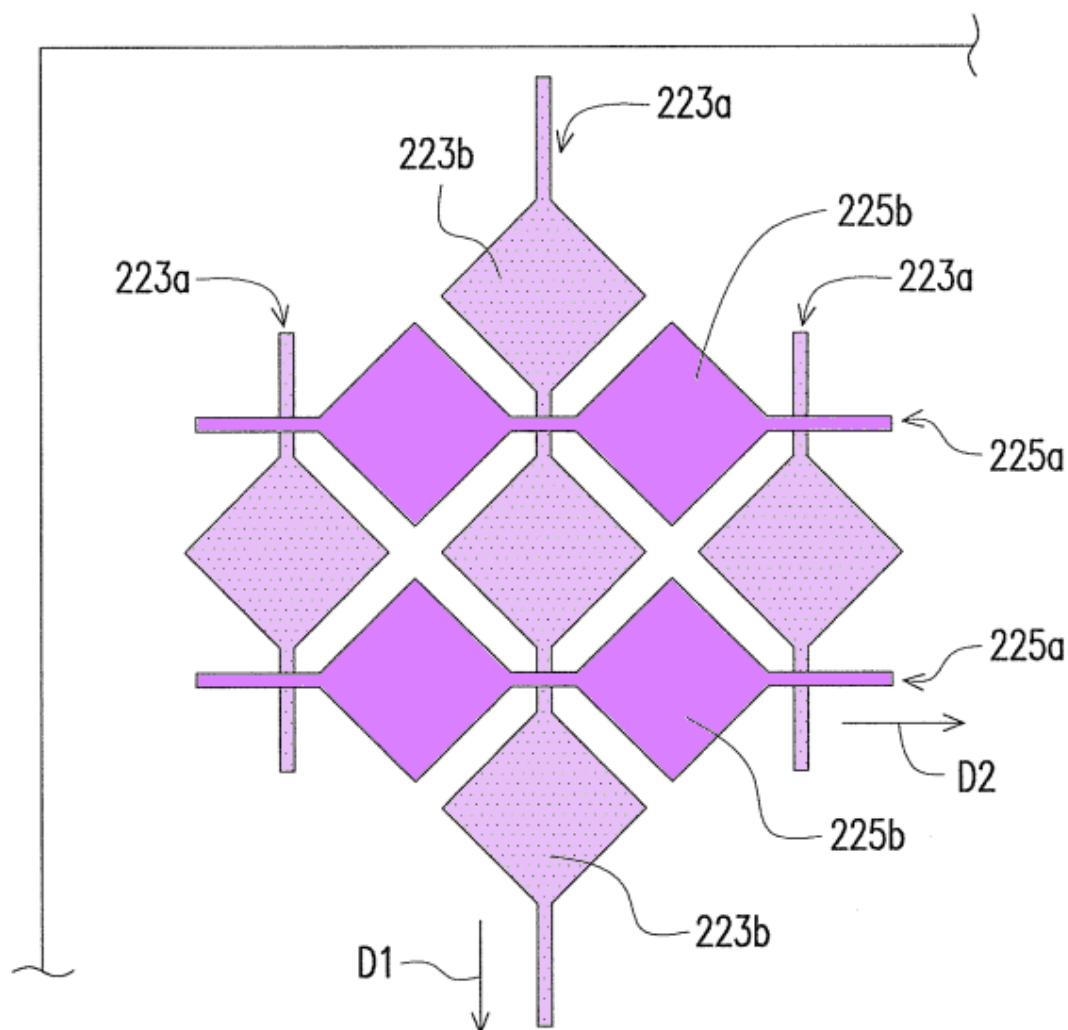


FIG. 3B

Chen, Fig. 3B, 7:13-55; *see also* my analyses in 1[d]-1[e] above, *Chen*, Fig. 4B, 7:56-8:39.

- m. **1[l]: wherein the insulating layer is interposed between the first connection patterns and the second connection patterns.**

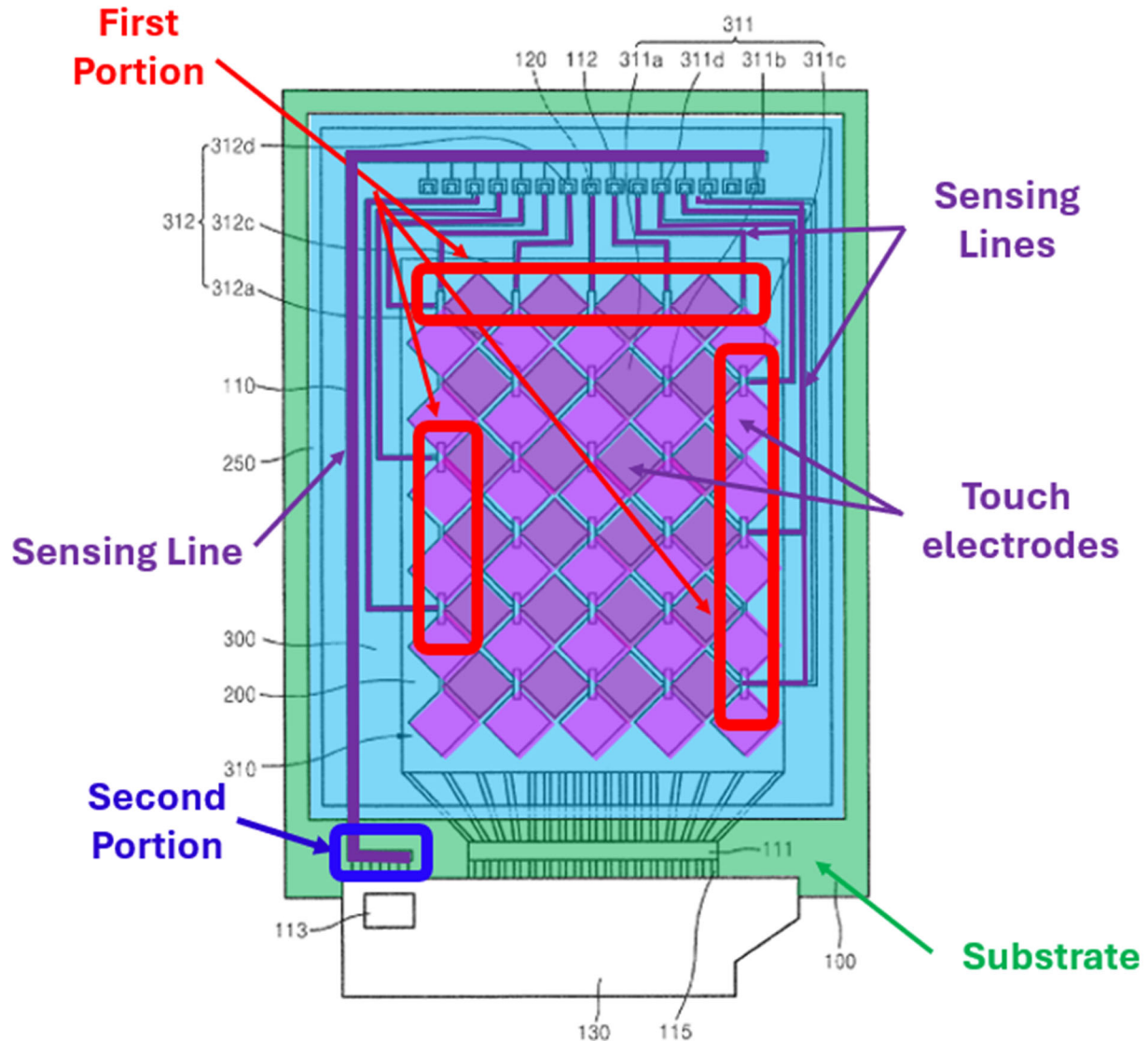
190. In my opinion, Chen discloses 1[l] for the reasons I explained above in §X.A.2.h (1[g]).

3. **Claim 2: The display according to claim 1, wherein the first portion is located on the sealing thin film and the second portion is located on the second area of the substrate, and wherein first portions of the sensing lines are located on a same layer.**

191. In my opinion, Chen in view of Jang teaches Claim 2.

192. Chen, alone or in combination with Jang, teaches conductive lines with a first portion provided on or near barrier layer (128) to connect to the touch sensors, and a second portion on substrate (110) as I explained in §§X.A.2.e (1[d]), X.A.2.f (1[e]), X.A.2.k (1[j]). And Jang further provides a top-down view that shows sensing lines (311c, 312c, 110) like Chen's conductive lines that extend from a first (display) area to a second (non-display) area of the substrate to connect on-display touch sensors to off-display processors, which would have guided a POSITA when implementing Chen's invention. *See, e.g., Jang*, Fig. 4; §X.A.2.b (1[a]).

FIG. 4



193. Chen also depicts a configuration in the sensing lines including conductive lines (“second portions”) located outside of and extending from, both ends of the touch electrode series (223a, 225a) (“first portions” of the sensing lines) within Chen’s patterned conductive layers (223, 225) downwardly to connect conductive

wires 122c-d formed on a substrate (110), meaning Chen discloses that at least some first portions of the conductive lines are located on a same layer.

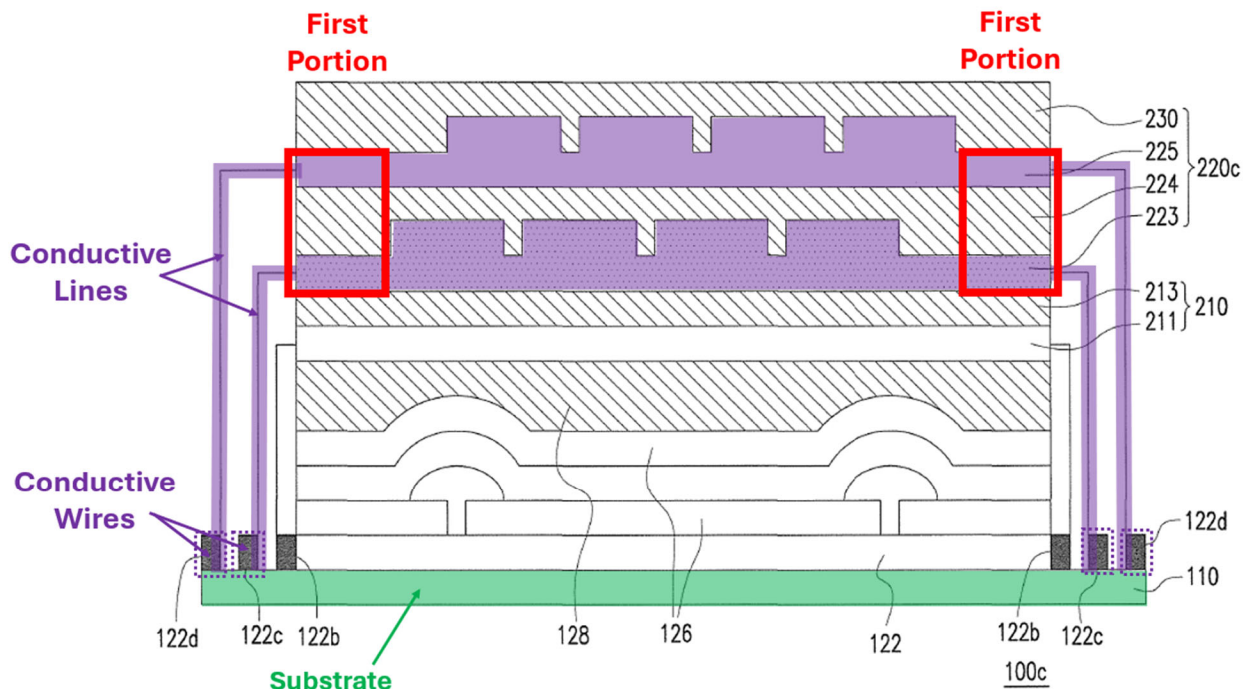


FIG. 3A

Chen, Fig. 3A (annotated), 7:13-55.

194. To the extent that Claim 2 may be construed to mean *all* first portions to be on the same layer, however, such an arrangement would have been obvious. Specifically, it was extremely old and well-known in the art that capacitive touch-sensor panels conventionally use two sets of touch-pad arrays—one for each (x, y) direction—that are electrically insulated from one another. *See, e.g.*, U.S.

Publication 2010/0214247 (Ex-1040) to Tang, et al. (“*Tang*”), ¶3 (“This invention relates to a capacitive touch panel, more particularly to a capacitive touch panel including a patterned conductive layer having two dimensionally arranged first and second electrodes and first and second conductive lines which are formed directly on the **same surface of a substrate**”) (emphasis added).

195. Chen’s Figure 3 embodiment depicts one way to form the two touch-sensor arrays: one set of touch sensor pads (223b) and their connections (223a) in one direction (D1) are formed on one layer (first patterned conductive layer 223), and another set of touch sensor pads (225b) and their connections (225a) to create an array in a different direction (D2) are formed on another layer (second patterned conductive layer 225), with the two layers (223, 225) separated by insulation. *Chen*, Figs. 3A, 3B. But the text and drawings in *Chen* also discloses an alternative embodiment in Figs. 4A-B, in which all touch sensor pads or touch sensing cells are formed on the same layer, with “bridge” connections where the arrays would otherwise intersect, with insulation covering at least where the bridge is formed. *Chen*, Figs. 4A, 4B, 7:56-8:38.

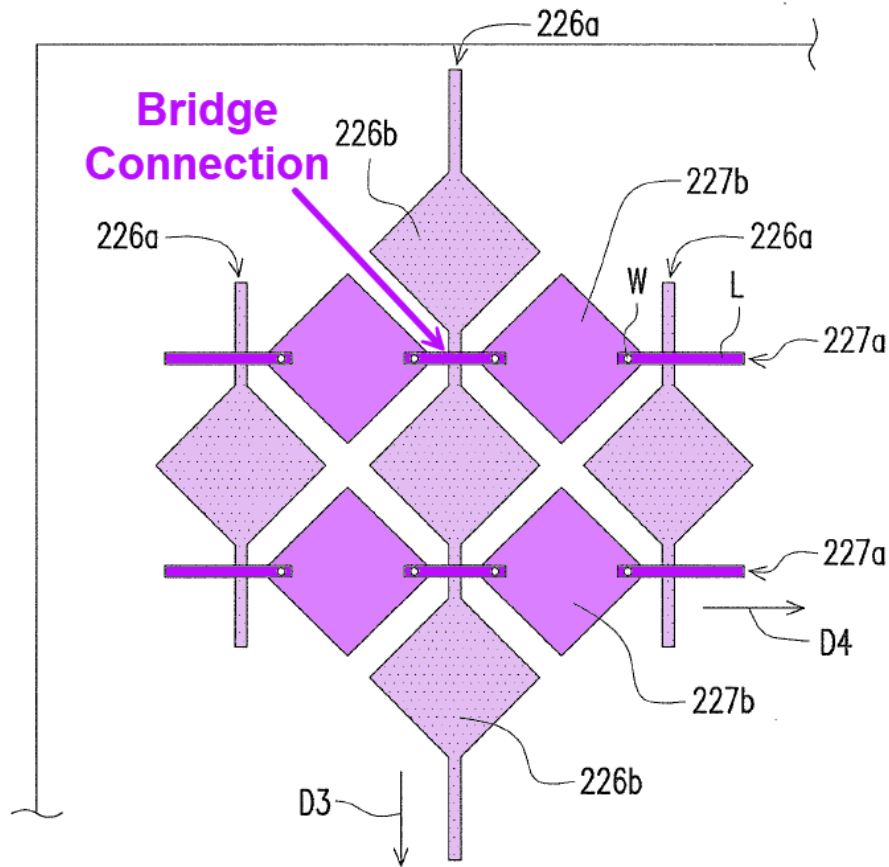
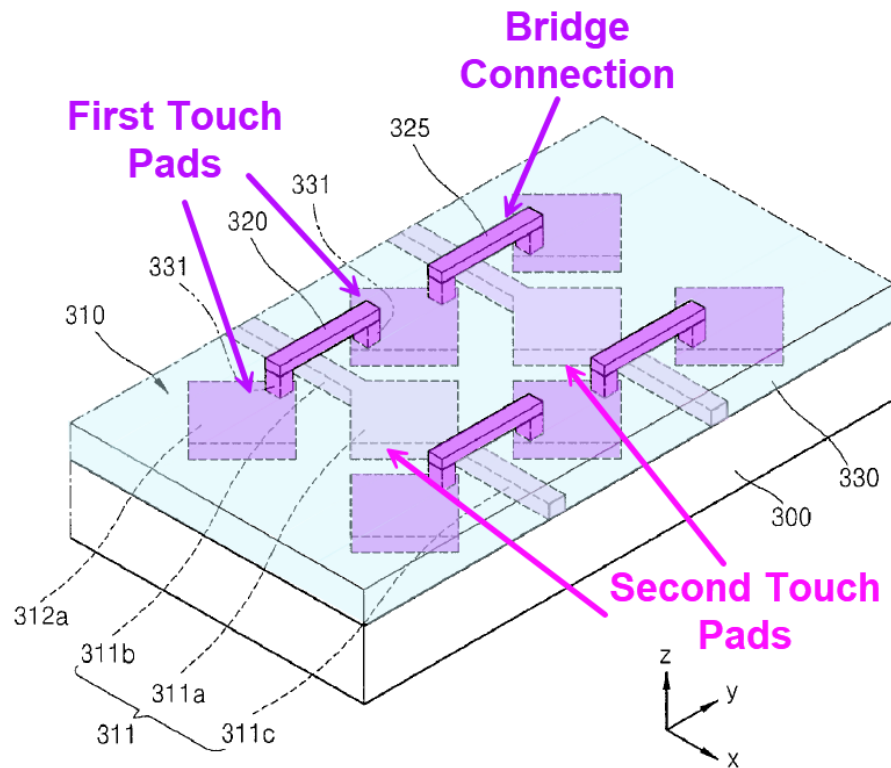


FIG. 4B

Jang similarly depicts this configuration in three dimensions, showing how the certain touch sensor pads and bridges are properly separated by insulation:

FIG. 3E



Jang, Fig. 3E (annotated). Because Chen discloses two possible configurations of the touch sensor pads, a POSITA would have considered either as an obvious design choice. But when forming all touch sensor pads on a single layer, with one set of touch sensor pads connected using a bridge, a POSITA would have appreciated that ***all*** “first portions” of Chen’s conductive lines would be on the same layer to connect to each set of touch sensor pads.

4. Claim 3: The display according to claim 2, wherein second portions of the sensing lines are located on a different layer from the first portions of the sensing lines.

196. In my opinion, Chen, alone or in combination with Jang, discloses or suggests Claim 3 for the same reasons as I explained above in §§X.A.2.f (1[e]), X.A.2.k (1[j]) (explaining first portion provided on or near barrier layer (128) and second portion on substrate (110)).

5. Claim 4: The display according to claim 1, wherein a first distance between first portions of the sensing lines and the substrate is greater than a second distance between second portions of the sensing lines and the substrate.

197. In my opinion, Chen, alone or combined with Jang, teaches or suggests Claim 4.

198. Because Chen discloses “first portions” of the conductive lines are located over the top of the sealing layer (e.g., water/oxygen barrier layer 128) to connect to the touch sensors formed on or above that layer, but “second portions” are provided over the top or on the substrate (§X.A.2.f (1[e])), a POSITA would have understood that Chen discloses that the first portions of the conductive lines have a first distance from the substrate that is greater than the distance between the second portions of the conductive lines and the substrate.

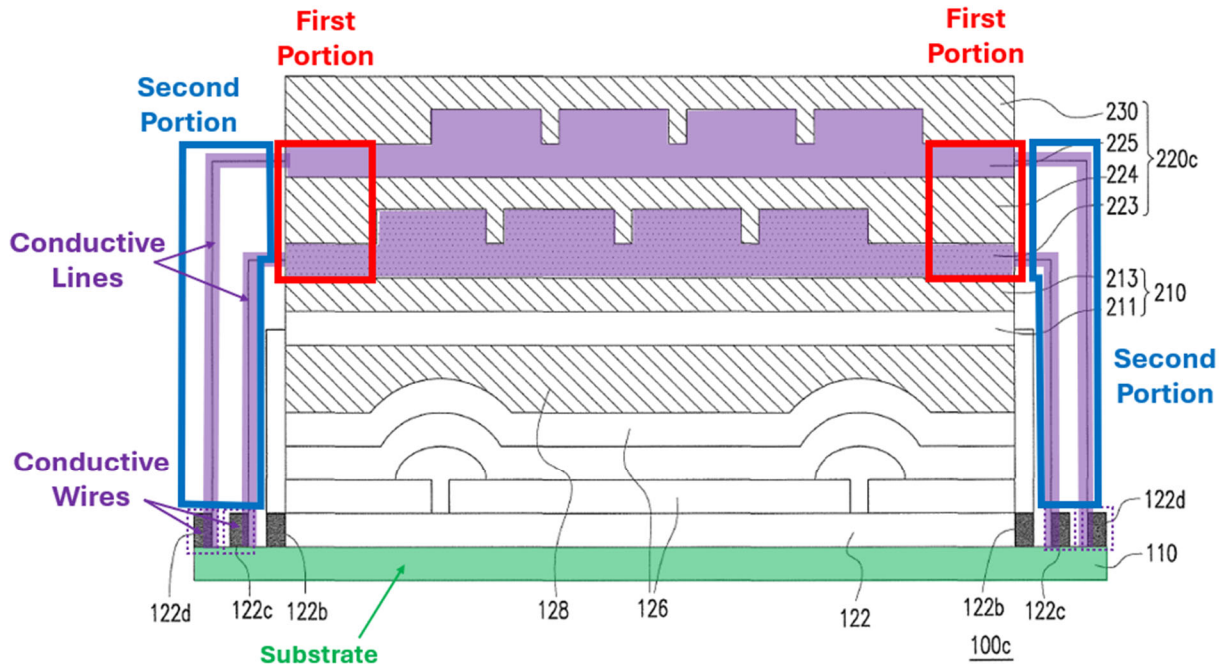


FIG. 3A

Chen, Fig. 3A (annotated), 7:13-55.

199. And for the reasons I explained above, Jang would have further confirmed this arrangement. §X.A.2.f (1[e]).

6. Claim 5: The display according to claim 1, wherein the sensing lines are electrically connected to the driving circuit through wiring lines.

200. In my opinion, Chen in view of Jang teaches claim 5.

201. A POSITA would have understood Chen discloses wiring lines connecting sensing lines to a driving circuit.

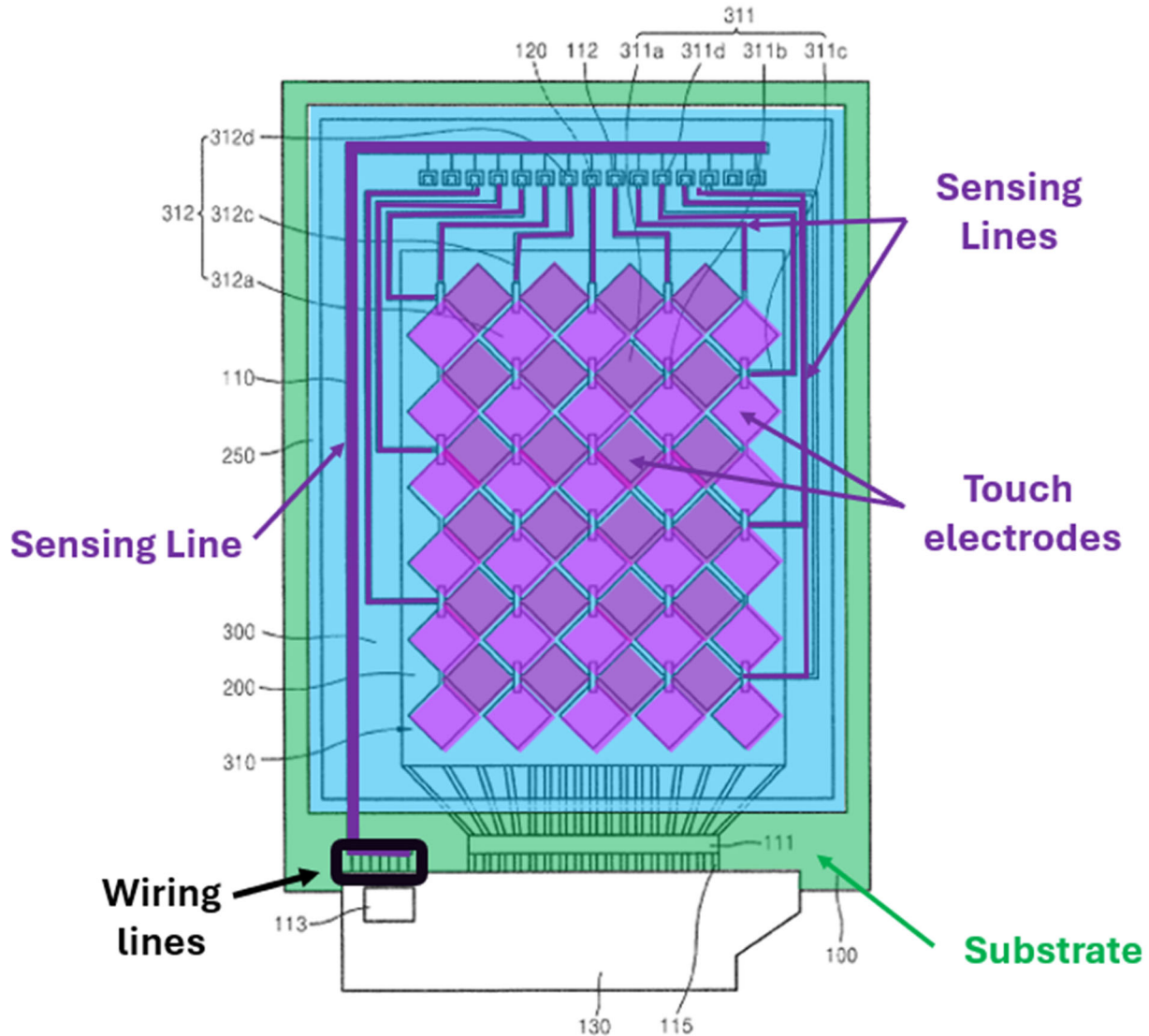
The fabricating method of the touch-sensing display apparatus 100c is substantially the same as the fabricating method of the touch-sensing display apparatus 100a of the previous embodiment, while the difference there between lies in the method of forming the first patterned conductive layer 223 and the second patterned conductive layer 225. The method of forming the first patterned conductive layer 223 includes forming the first touch electrode series 223a, and the method of forming the second patterned conductive layer 225 includes foaming [sic] the second touch electrode series 225a. Additionally, it should be mentioned that the first conductive wire 122b, the second conductive wire 122c, and the third conductive wire 122d can all be circuit pattern layers which are formed on the active array device 122 in advance. That is to say, **during formation of the active array device 122 on the substrate 110, the first conductive wire 122b, the second conductive wire 122c, and the third conductive wire 122d can be formed as well.**

Chen, 7:38-55 (emphasis added). A POSITA would have understood that *Chen*'s conductive *wires* 122c-d must connect—at an intermediate position—to both the touch electrode series through conductive lines (“sensing lines”) that are above

and/or over the substrate 110, and to driving and/or processing components to form an operative electrical connection that both delivers electricity *to* the touch sensors and evaluate electrical signals in response to a user's touch *from* the touch sensors. Accordingly, a POSITA would have understood that Chen's conductive wires 122c-d on the substrate 110 disclose the claimed "wiring lines" as claimed.

202. In similar touch display designs, Jang teaches conductive wires connected to two driving circuits: (1) a display-drive integrated circuit (111, "DDI") connected to a flexible PCB (130) to "drive the display unit 200" by input/output lines (115); and (2) a touch-panel-drive integrated circuit (113, "TDI") that is "configured to receive the electrical signals to drive and control the touch panel" disposed on flexible PCB (130):

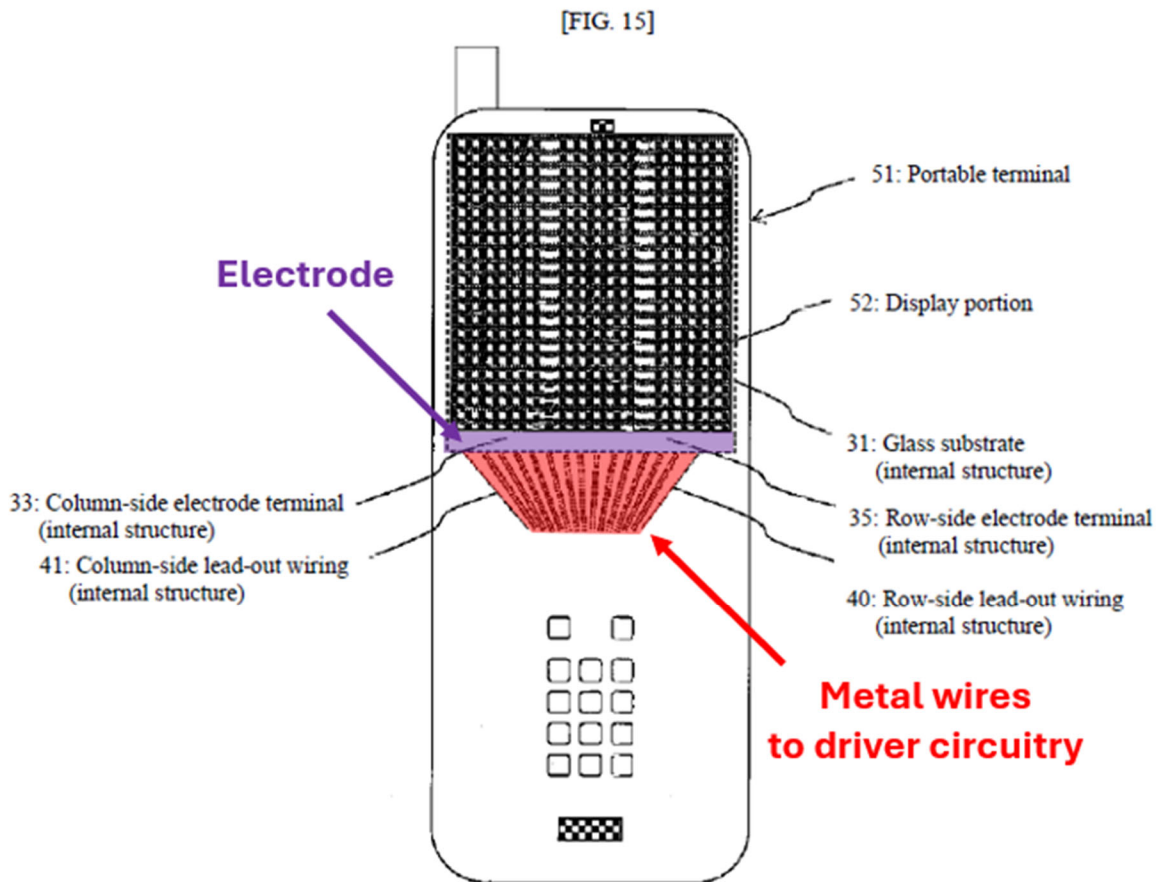
FIG. 4



Jang, Fig. 4 (annotated), ¶¶83-88. *Jang* also discloses that the touch sensors are connected by data line (110) to either a separate TDI (113), or the TDI may be integrated with the DDI (111) to consolidate and receive all touch sensing and display signals in a single driver circuit. *Id.*, ¶88.

203. A POSITA would have been motivated to connect Chen's conductive lines to driver circuitry for the same reasons I explained above in §X.A.2.g (1[f]).

204. A POSITA would have further understood that Chen's sensing lines connect to drive circuitry like Sakamoto's "lead-out wiring" in mobile phones as an application ripe for Chen's miniaturized device:



Sakamoto, Fig. 15 (annotated), ¶¶4-5 (describing purpose of consolidating and arranging lead-out wiring in one direction to "increase the proportion of the display portion relative to the housing of an information display terminal" otherwise

increased in size to cover more lead-out wiring in other directions) 26-27 (describing Fig. 15 lead-out wiring solution that consolidating the wiring to allow a display portion size increase), *see also* Figs. 14, 19-20; *Chen*, 1:16-57 (a “touch-sensing display apparatus” with “OLED is frequently applied to a number of electronic products” requiring “convenience, miniaturization, and being user-friendly”).

7. Claim 6: The display according to claim 1, wherein the sensing lines include a different material from the sensing cells.

205. In my opinion, *Chen* in view of *Jang* teaches Claim 6.

206. Although *Chen* does not expressly explain the materials used for the conductive lines and touch sensor pads (223b, 225b), a POSITA would have understood that they are different materials. For instance, *Jang* describes a capacitive touch panel in which “first pattern layer 310 and the second pattern layer 320 may be formed of suitable transparent materials such as ITO, IZO, ZnO, and/or In₂O₃.” *Jang*, ¶¶71-72, 77. Transparent conductive materials were extremely old and well-known for touch panels, and *Chen* even refers to the use of a transparent conductive material (like ITO and IZO) for the EMI layer. *Chen*, 6:15-40; *see also Barbier*, ¶3; *Bouten*, 3:30-41. *Chen* also discloses “conductive wires” 122c-d first formed on a substrate and connected to touch electrode by lines. *Chen*, 7:38-55, Figs. 3A, 4A. A POSITA would have understood that *Chen*’s conductive lines would have been

made of a metal wire material because metal wires were often used for connections because they provided far less electrical resistance than transparent conductive materials (like ITO and IZO), and thus could be made to have a smaller cross-sectional area when, e.g., forty or more connections are required in the border area surrounding a touch panel display. *See Projected-Capacitive Touch Screens* (Ex-1034) by Barrett, et al. (“*Barrett*”), pp. 3-5. Mobile device applications like smartphones with small screens require narrow borders to maximize the size of the screen in smaller implementations, and is therefore ripe for fine line silver printing at only 50-100 microns wide. *Id.*

207. Moreover, the selection of particular materials was an obvious design choice because most touch panels used similar materials: a cover glass, optical bonding adhesive, indium tin oxide (ITO), and glass subject to variations provided unique applications and user needs. *Id.*, 4-6 (describing iPhone materials). *See Kang*, Figs. 2-3, ¶¶16, 18, 75.

8. Claim 7: The display according to claim 1, wherein the driving circuit is located on the second area of the substrate.

208. In my opinion, Chen in view of Jang teaches Claim 7.

209. Jang teaches that the two driver circuits are both located in a second (non-display) area of the substrate as I explained in §X.A.2.g (1[f]). A POSITA

implementing Chen's invention consistent with Jang's arrangement would have similarly placed the driving circuit(s) in a second (non-display) area to process touch-sensor and display signals in an area outside that of the display to maintain a minimal thickness for the display as I explained in §§X.A.2.g (1[f]), X.A.1.f (motivation).

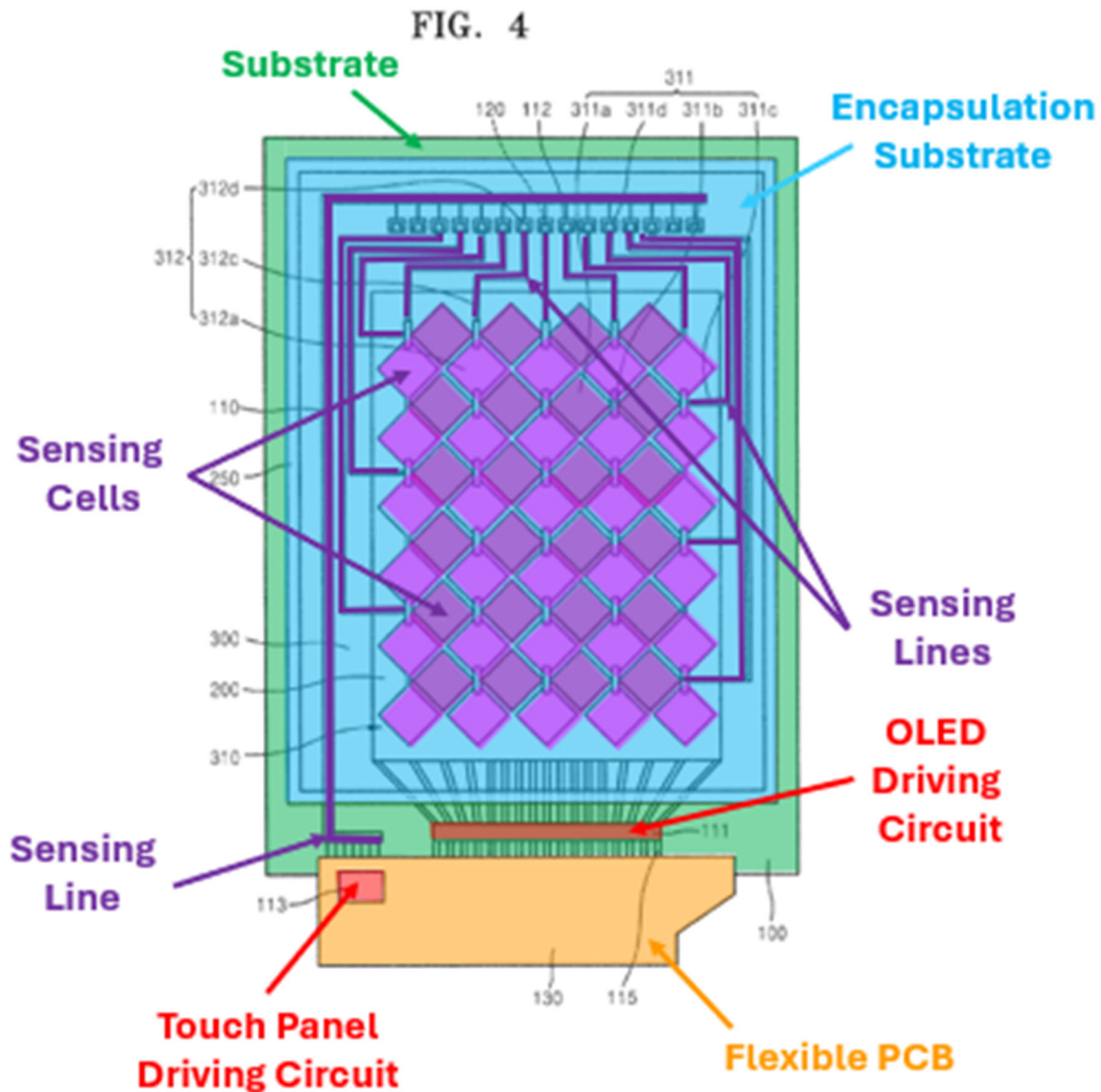
9. Claim 8: The display according to claim 7, further comprising a flexible printed circuit board (FPCB) attached to the second area of the substrate.

210. In my opinion, Chen in view of Jang discloses Claim 8 for the reasons I explained in §§X.A.2.g (1[f]), X.A.1.f (motivation).

10. Claim 9: The display according to claim 8, wherein the sensing lines are electrically connected to the driving circuit through the FPCB.

211. In my opinion, Chen in view of Jang discloses Claim 9 for the reasons I explained in §§X.A.2.g (1[f]), X.A.9 (cl. 8), X.A.1.f (motivation).

212. Specifically, Jang's touch panel driving circuit 113 is formed on the FPCB and connects to sensing line 110:



Jang, Fig. 4 (annotated).

11. Claim 10: The display according to claim 1, wherein the sensing lines are arranged outside the pixel area.

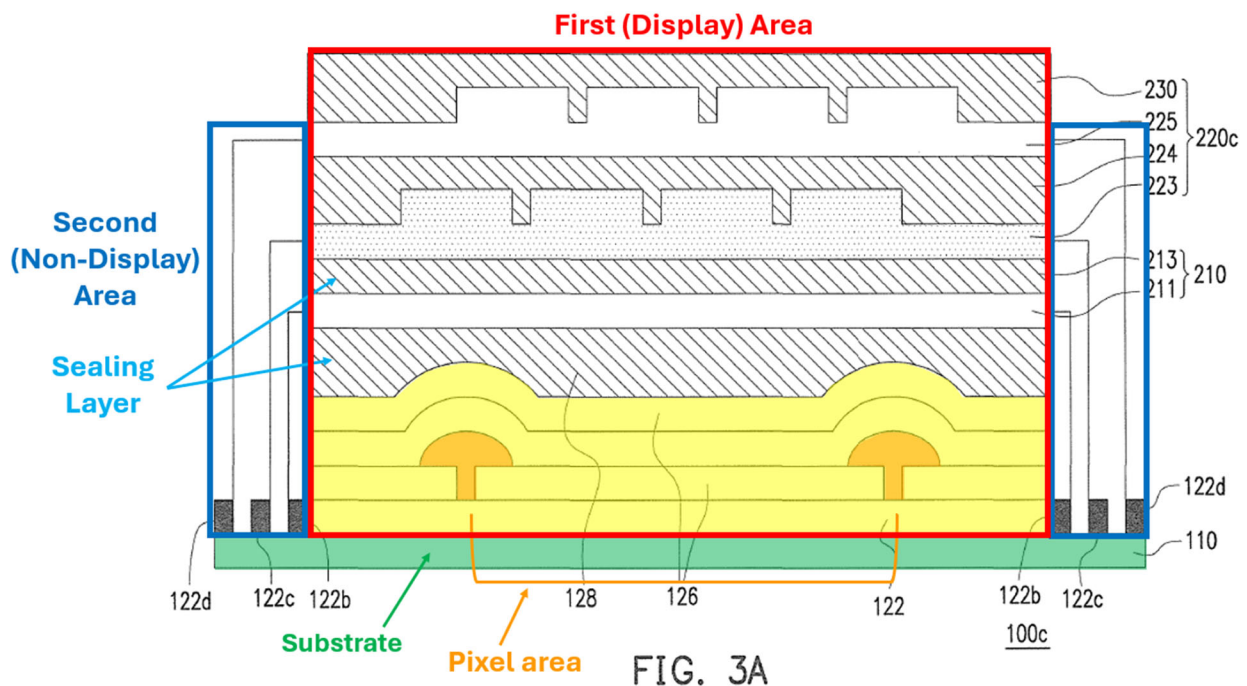
213. In my opinion, Chen in view of Jang teaches Claim 10 for the reasons I explained in §§X.A.2.a (1[pre]), X.A.2.b (1[a], teaching a display pixel area),

X.A.2.f (1[e]), X.A.2.j (1[i], teaching first, inclined, second sensing lines portions outside the display pixel area), X.A.1.f (motivation).

12. Claim 11: The display according to claim 1, wherein the first area has a greater area than the second area.

214. In my opinion, Chen teaches or suggests Claim 11.

215. Chen depicts a first (display) areas of greater area size than the second (non-display) areas:



Chen, Figs. 1A, 3A (annotated), 2:66-3:8, 3:10-13, 3:24-25, 5:50-52. Although a POSITA would have understood that *Chen* is not drawn to scale, a POSITA would have understood that display areas are typically much larger than the non-display

areas in an OLED display. *See, e.g., Lee '560* (Ex-1026), Figs. 1, 7. That is because a display area must be big enough to be viewable by a user, but non-display areas must only be big enough to house the wiring and processors needed to operate the display, which were known to be far smaller than the display itself. *See Sakamoto, ¶¶2-5*, which provides a wiring arrangement design to minimize frame width to “to increase the proportion of the display portion relative to the housing of an information display terminal.”

216. For these reasons, a POSITA would have understood that Chen’s first (display) area is greater than the second (non-display) area.

13. Claim 12: The display according to claim 1, wherein the sealing thin film includes at least one organic layer and at least one inorganic layer.

217. In my opinion, Chen in view Sano teaches or suggests Claim 12, for the reasons I explained in §§X.A.2.d (1[c]), X.A.1.f (motivation).

218. Specifically, Chen envisions its water/oxygen barrier layers as the sealing layer (128) “can be an inorganic thin film, an organic thin film, *or a combination thereof.*” *Chen*, 3:66-67 (emphasis added). Consistent with the teaching in *Chen*, Sano similarly teaches the buffer layers may be an organic material (*Sano*, ¶72) and the barrier layers may be an inorganic material (*id.*, ¶73).

- 14. Claim 13: The display according to claim 1, wherein the first connection patterns are respectively patterned to have independent patterns in upper or lower layers of the first sensing cells so that the first connection patterns are electrically connected to the first sensing cells at upper or lower portions of the first sensing cells.**

219. In my opinion, Chen, alone or in combination with Jang, teaches Claim 13 for the same reasons I explained in §X.A.3 (cl. 2).

220. Specifically, it would have been obvious to form all of Chen’s touch sensor pads (226b, 227b) on a single layer, with one set of touch sensor pads (227b) connected using a bridge provided on a different material layer (conductive lines connected to patterned conductive layers) as I explained in §X.A.3 (cl. 2). In doing so, a POSITA would have appreciated that the bridges (227a, the “first connection patterns,” as claimed) would be patterned independently from the touch sensor pads in an upper layer of the first touch sensor pads (227b) because the bridges (227a) would be formed on a separate material layer above an interstitial insulation layer (234). *Chen*, 7:56-8:38, Figs. 4A, B. Once again, Jang depicts this arrangement in three dimensions I explained in §X.A.3 (cl. 2).

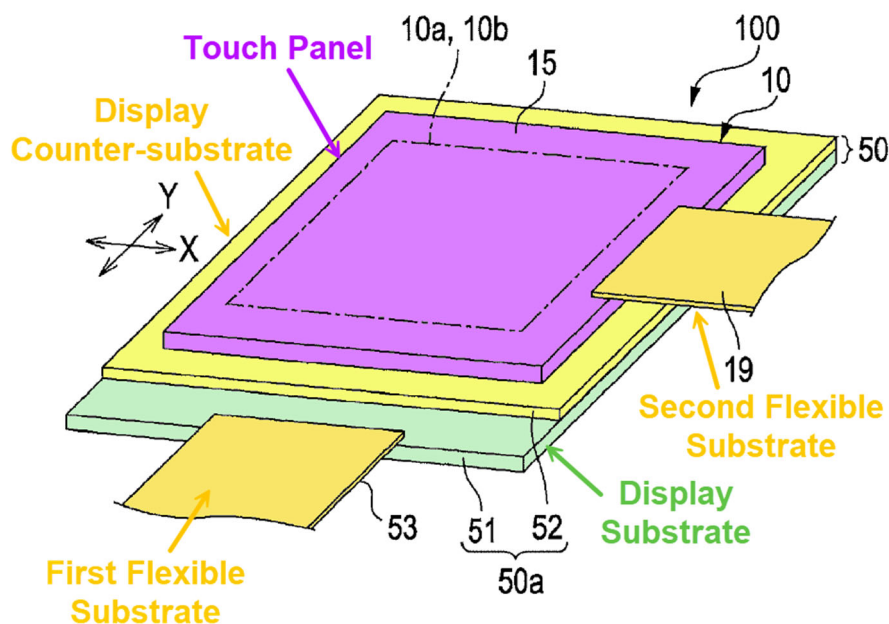
B. Ground 1B: Obviousness in view of Chen, Matsuo, Sano, and Sakamoto (Claims 1-13)

1. Prior Art

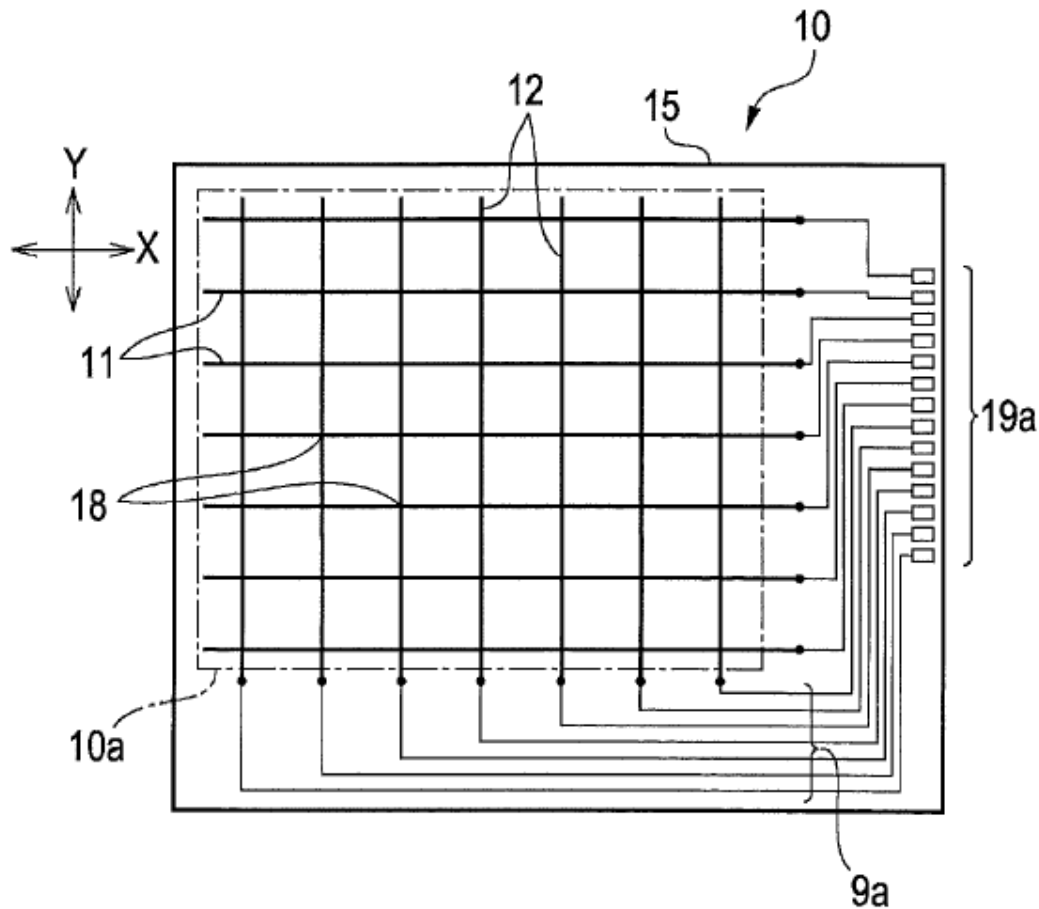
a. Matsuo (Ex-1010)

221. Matsuo discloses the layout of a touchscreen display—which may be an “organic electroluminescent display.” *Matsuo*, Abstract, ¶¶38, 39, 79, Fig. 1A. Matsuo discloses that the display includes display substrates (51, 52) that together form a display area, and a touch-sensor panel (15) formed above the display. *Id.*, ¶¶38, 39.

FIG. 1A



Matsuo also explains that the touch panel (15) includes electrode lines (11, 12) arranged in two different directions (x, y) that are electrically coupled to metal wires (9a) extending outside the touch panel area for connection to a flexible substrate:



Id., Fig. 1B, ¶¶42, 47, 55.

b. Chen, Sano, Matsuo, and Sakamoto are Analogous Art

222. Chen, Sano, and Sakamoto are analogous to the '088 patent for the reasons I explained above. §X.A.1.e (analogous art). In my opinion, Matsuo is also analogous art to the '088 patent because it also relates to an organic light emission display device (a common field of endeavor) and is directed toward improving otherwise inefficient and unreliable OLED designs (and are therefore reasonably pertinent to solving the same problem). '088 patent, 3:24-28. For example, Matsuo

discloses a need to simplify the process for manufacturing a touchscreen display—which may be an “organic electroluminescent display.” *Matsuo*, Abstract, ¶¶9, 11, 38, 39, 79, Fig. 1A.

223. Because my review of *Matsuo* confirms it is reasonably pertinent to facing the same problem in a common field of endeavor as the ’088 patent, it is my opinion that it qualifies as analogous art.

224. Because the *Matsuo* reference is reasonably pertinent to facing the same problem in a common field of endeavor as the ’088 patent, it is my opinion that it qualifies as analogous art.

c. Motivation to Combine

225. Grounds 1A and 1B differ only insofar as Jang is replaced by *Matsuo*. But just as a POSITA would have looked to Jang for further guidance to implement Chen’s conductive lines, a POSITA would have alternatively been motivated to turn to a reference such as *Matsuo*, which expressly describes how touch sensing lines for a touch-sensor panel are arranged outside of a display area to connect to a driving circuit. *Matsuo*, ¶¶38, 39. *Matsuo* simply provides a top-down view showing the arrangement of conductive lines that Chen does not expressly provide to guide a POSITA when implementing Chen’s invention.

226. A POSITA would have had a reasonable expectation of success in modifying Chen in view of Matsuo because Matsuo describes the arrangements of touch-sensor lines that Chen already provides. The only difference between Chen and Matsuo's implementation is that Chen provides its conductive lines ("sensing lines") on the display substrate, whereas Matsuo provides them on a touch-panel substrate, but Matsuo would have still informed a POSITA how to arrange Chen's lines with respect to a substrate, generally, outside of the display area. In other words, Matsuo merely provides additional, express guidance as to how to implement Chen's invention on a physical display panel I explained in §X.A.1.f (Ground 1A, motivation).

227. Because Matsuo is simply a replacement for Jang, in Ground 1B I address only those limitations that had relied upon Jang's teachings in Ground 1A and explain how Matsuo provides those teachings in Ground 1B. I incorporate all other claim elements by reference herein.

2. Independent Claim 1

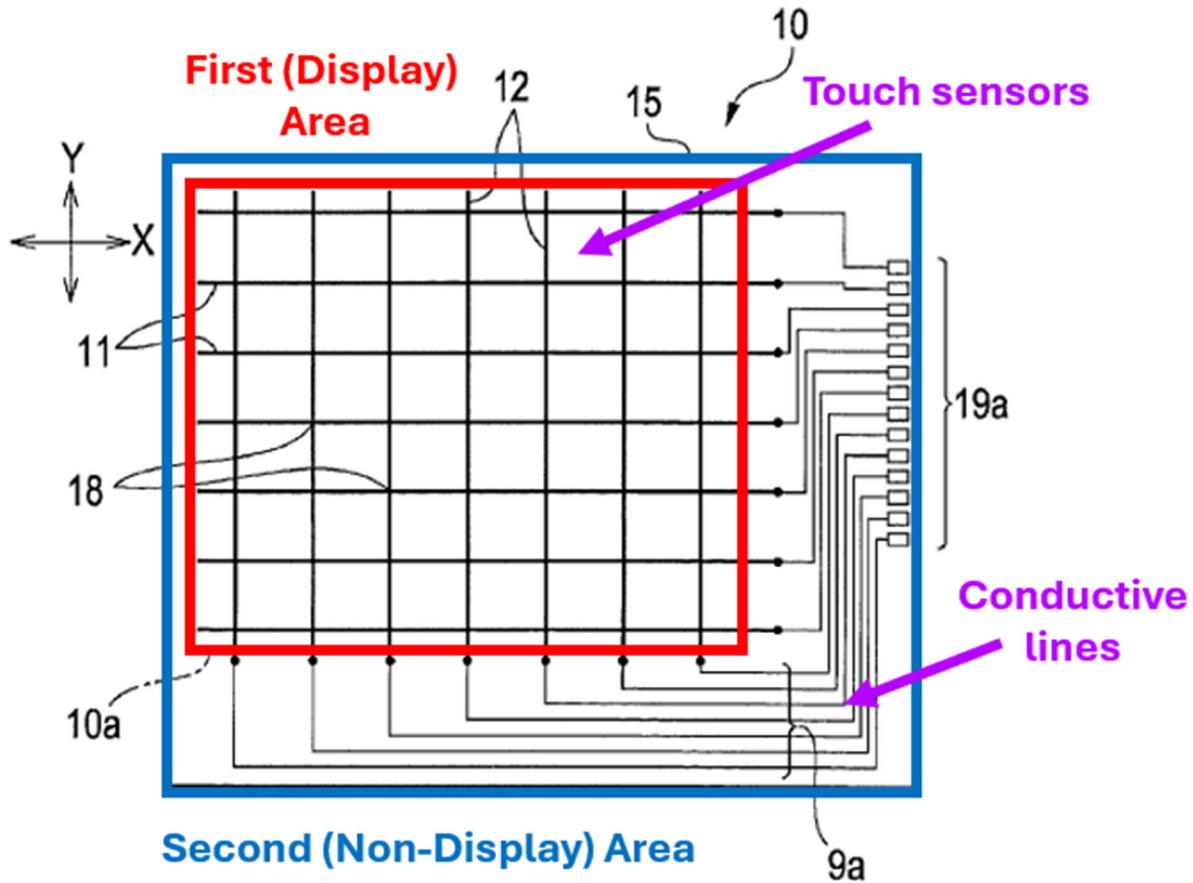
a. 1[pre]: A display comprising:

228. See my analysis of 1[pre] in Ground 1A. §X.A.2.a.

b. 1[a]: a substrate including a first area having a pixel area and a second area adjacent to the first area;

229. In my opinion, Chen, alone or combined with Matsuo, discloses or suggests 1[a] I explained in §X.A.2.b (Ground 1A, 1[a], providing Chen’s teachings). Matsuo further confirms how a POSITA would have understood the arrangement Chen discloses I explained in §X.B.1.c (motivation). Specifically, unlike Chen’s cross-sectional views, Matsuo provides a top-down view that shows conductive metal wires (9a) (“sensing lines”) like Chen’s conductive lines that connect on-display touch sensors to off-display processors (at 19). *See, e.g., Matsuo*, Fig. 1B; *see also id.*, ¶47 (“the metal wires 9a extend ***outside the input region*** 10a.”) (emphasis added).

FIG. 1B



230. A POSITA would have understood that, when implementing Chen's invention, Chen's display would have a first display area with the display and touch-sensor components, and a second non-display area adjacent the first display area with the processing elements and conductive lines connecting the on-display and off-display components, consistent with Matsuo I explained in §X.B.1.c (motivation).

c. 1[b]: a plurality of pixels in the pixel area of the substrate;

231. In my opinion, Chen in view of Matsuo teaches 1[b] for the reasons I explained in §§X.A.2.b (Ground 1A, 1[a]), X.B.2.b (1[a]).

d. 1[c]: a sealing thin film covering the first area of the substrate and including an inclined surface at an end of the sealing thin film to inhibit infiltration of oxygen or moisture into the pixels; 1[c]: a sealing thin film covering the first area of the substrate and including an inclined surface at an end of the sealing thin film to inhibit infiltration of oxygen or moisture into the pixels;

232. See my analysis of 1[c] in Ground 1A. §X.A.2.d.

e. 1[d]: a plurality of sensing cells formed over a top surface of the sealing thin film to sense a touch;

233. See my analysis of 1[d] in Ground 1A. §X.A.2.e.

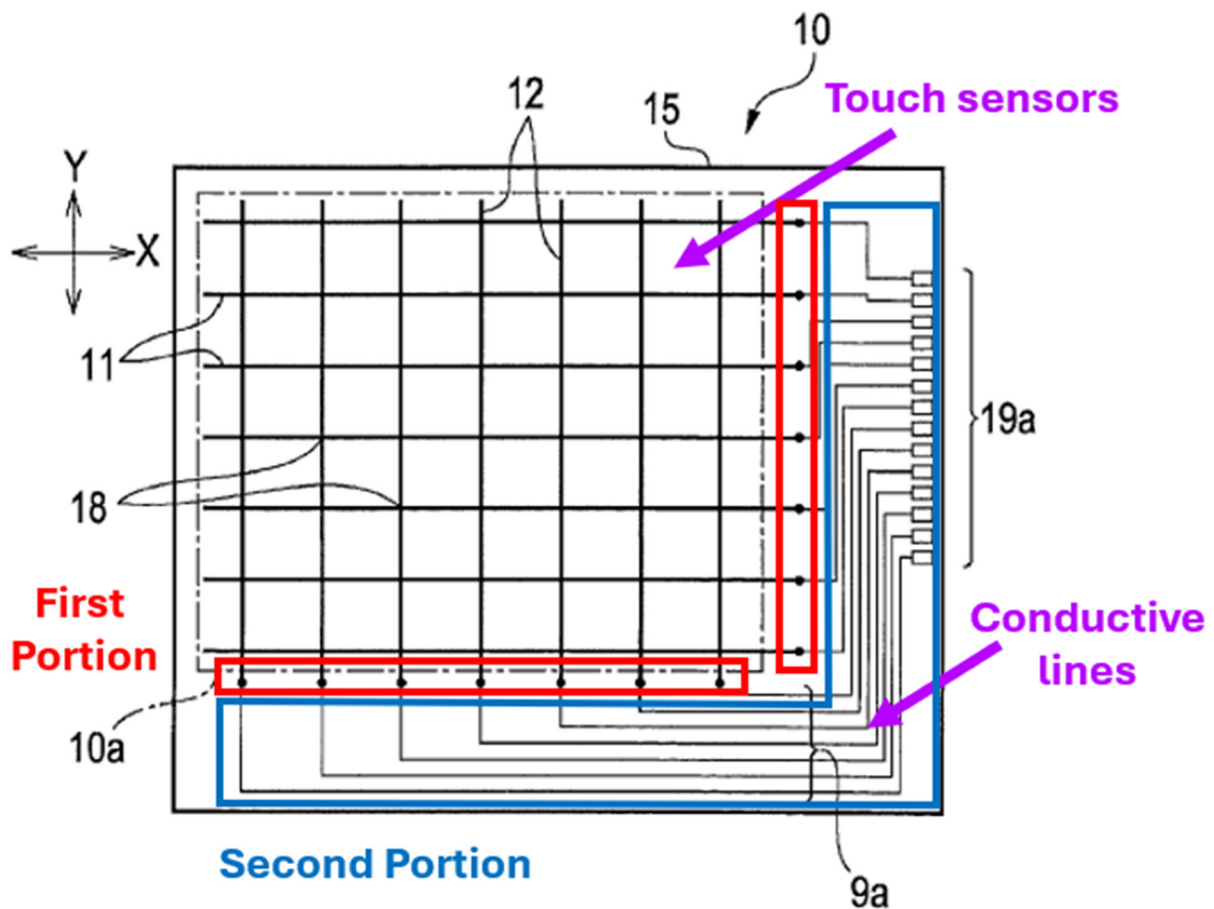
f. 1[e]: a plurality of sensing lines coupled to the sensing cells, the sensing lines comprising a first portion and a second portion;

234. In my opinion, Chen, alone or in combination with Matsuo, discloses or suggests 1[e] as I explained in §X.A.2.f (Ground 1A, 1[e], providing Chen's teachings).

235. Matsuo confirms how a POSITA would have understood the arrangement Chen discloses as I explained in §X.B.1.c (motivation). Specifically, unlike Chen's cross-sectional views, Matsuo provides a top-down view that shows

conductive lines (9a) like Chen's conducting lines that have a first portion connecting to the touch sensors, and another portion that runs along the substrate to connect to a PCB.

FIG. 1B



See, e.g., Matsuo, Fig. 1B (annotated), ¶¶47, 61, 77.

236. A POSITA would have therefore understood Chen in Fig. 3A provides conductive lines as sensing lines which include one portion as the “first portion”

connecting to the conductive layers 223, 225 that includes a part that bridges over a step difference downwardly to the substrate 110 to connect to another portion as the “second portion” formed over the substrate to reach the conductive wires 122c-d on the substrate 110, to off-display processing components, consistent with Matsuo as I explained in §X.B.1.c (motivation).

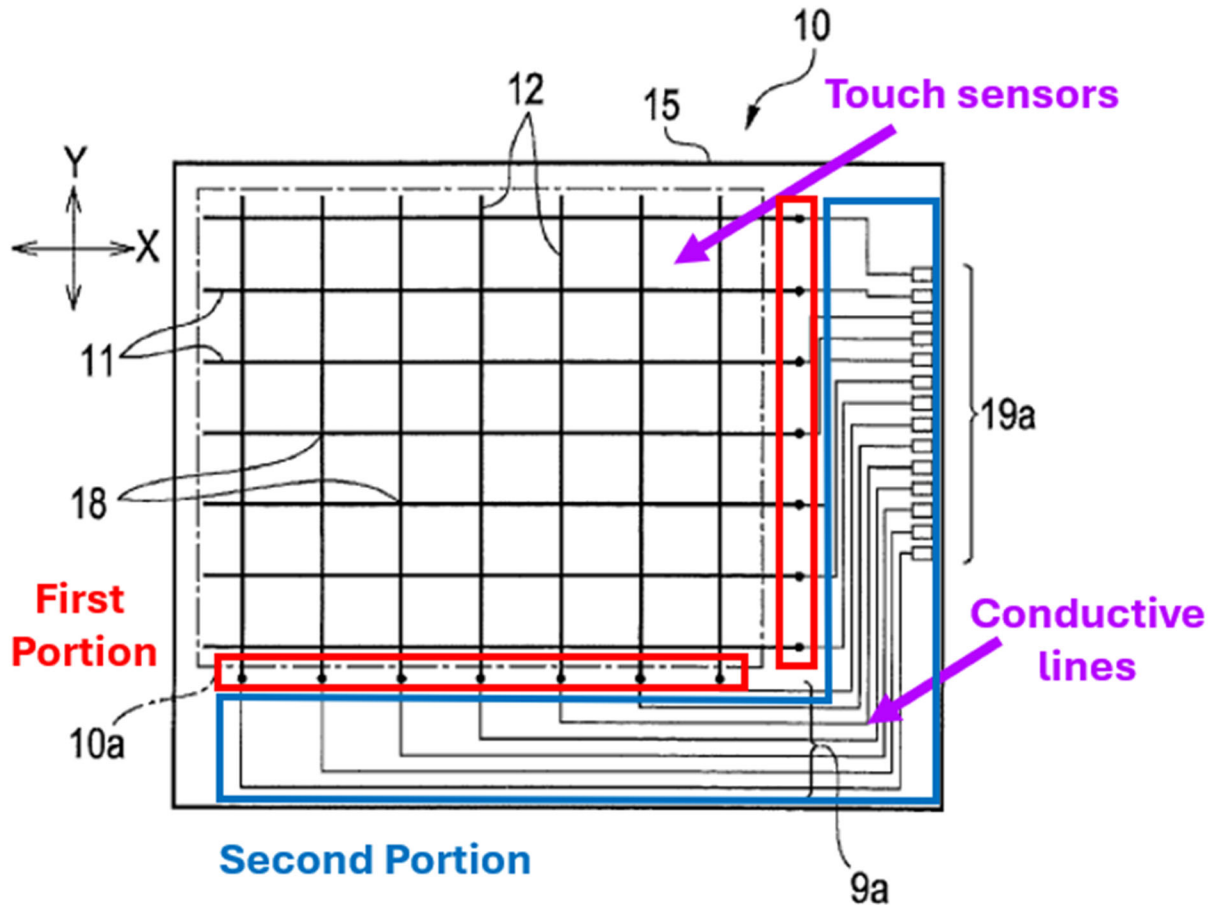
g. 1[f]: a driving circuit electrically connected to the sensing cells via the sensing lines; and

237. In my opinion, Chen in view of Matsuo teaches 1[f].

238. Although Chen does not expressly explain what the conductive wires (122c, d) and conductive lines are connected to, a POSITA would have understood that they are necessarily connected to driving and/or processing circuitry to deliver electricity to the touch sensors and evaluate electrical signals in response to a user’s touch.

239. Matsuo, for instance, teaches that “[t]he second flexible substrate 19 is also connected to a driving circuit (not shown) for allowing the capacitive input device 10 to detect an input position,” and shows metal wires (9a) connecting to terminals (19a) to form the connection to the flexible substrate (19) with the driving circuit).

FIG. 1B



Matsuo, Fig. 1B (annotated), ¶¶39, 47.

240. When implementing Chen's invention, a POSITA would have been motivated to connect Chen's conductive wires (122c, d) to a driving circuit on a separate substrate to drive the touch sensors and respond to a user's touch I explained in §X.B.1.c (motivation).

h. 1[g]: an insulating layer,

241. See my analysis of 1[g] in Ground 1A. §X.A.2.h.

i. 1[h]: wherein the inclined surface of the sealing thin film is formed to be inclined downwardly toward the driving circuit,

242. In my opinion, Chen in view of Sano and Matsuo teaches or suggests 1[h].

243. Chen combined with Sano teaches or suggests forming Chen's barrier layer (128) as a multi-layered sealing layer consistent with Sano, which would produce a sealing layer with an inclined surface, as I explained in 1[c]. §X.A.2.d (1[c]). And Chen combined with Matsuo teaches or suggests connecting Chen's conductive wires (122c, d) to a driving circuit either directly on the substrate, or connected to the substrate through a flexible PCB, as I explained in 1[f]. §X.B.2.g (1[f]).

244. A POSITA would have understood, consistent with Sano, that when forming Chen's barrier layer (128) as a sealing layer that has an inclined surface, the series of buffer and barrier layers cover the OLED-display elements to prevent degradants from reaching the display, and the edges of the sealing layer then taper outwardly, as Sano shows (only without the underlying OLED-display elements).

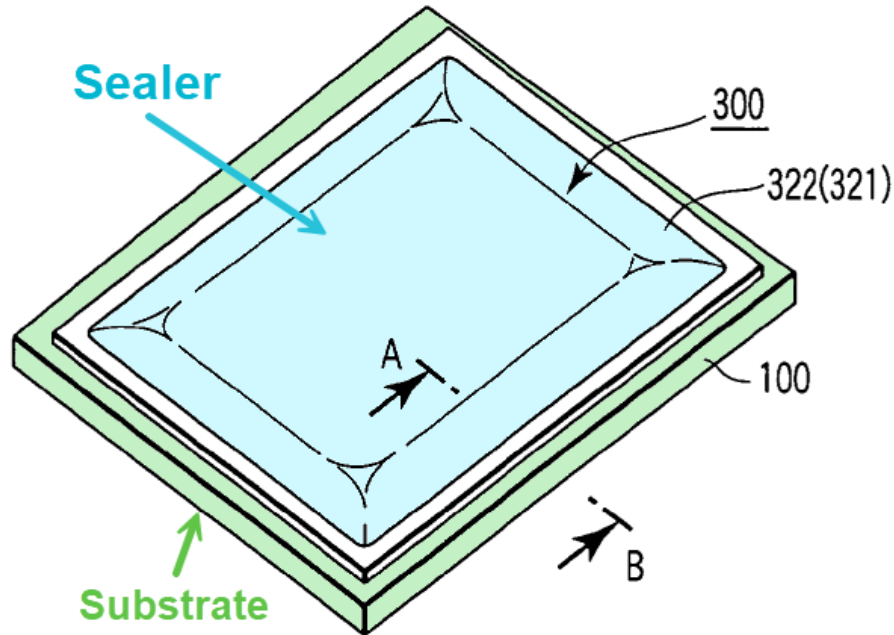


FIG. 3

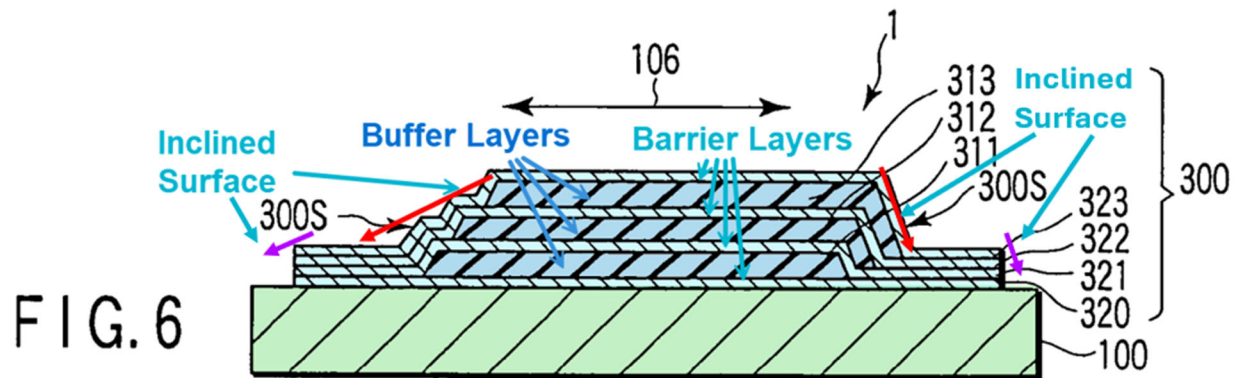


FIG. 6

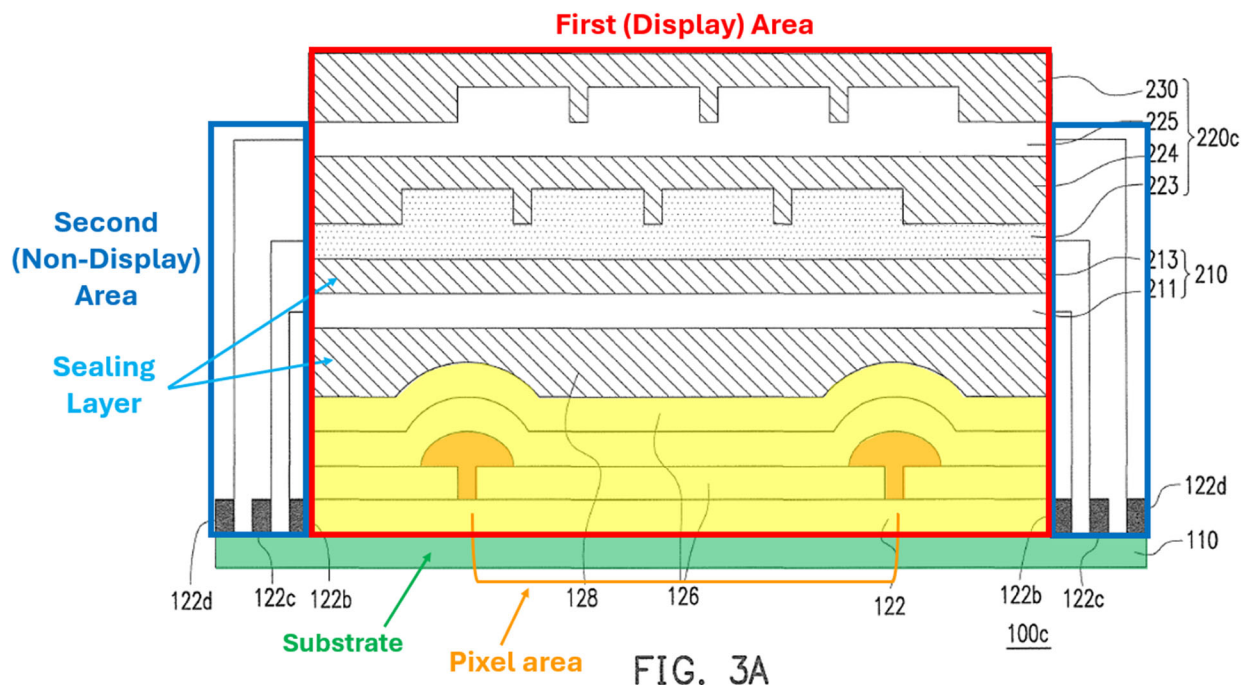
Sano, ¶¶107-08, 133, 158, 171, 173, 215. Moreover, because Matsuo teaches using a driving circuit (not shown) sitting *outside* of the display area (on flexible substrate 19), a POSITA would have appreciated that a sealing layer formed consistent with

Chen and Sano would be inclined downwardly towards the driving circuit that sits outside of the display area.

j. 1[i]: wherein the sensing lines include inclined portion along the inclined surface of the sealing thin film,

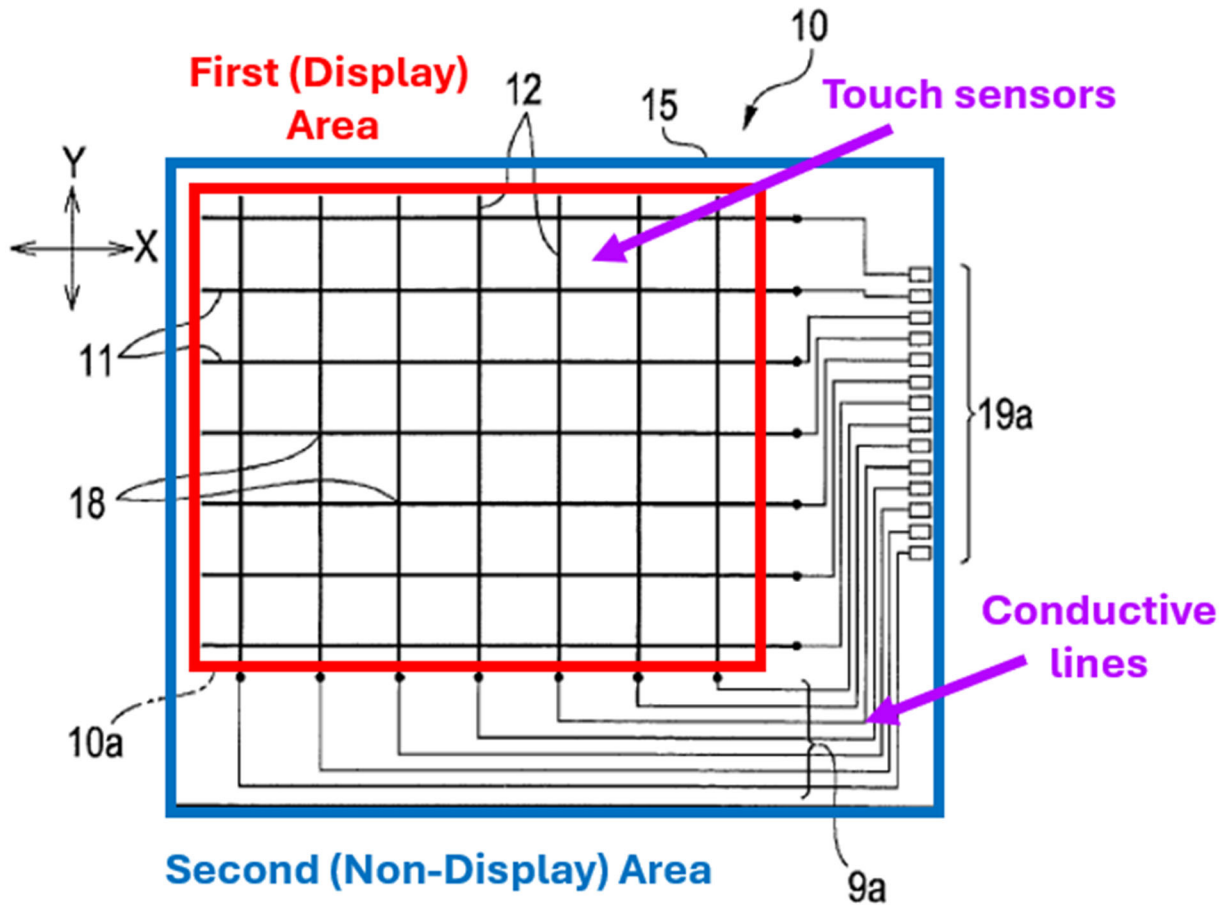
245. In my opinion, Chen in view of Matsuo, Sano, and Sakamoto teaches or suggests 1[i].

246. Chen discloses that the conductive lines connect to conductive wires (122c, d) formed on the substrate (110), and depicts regions of the conductive lines as being outside of the sealing layer (128).



Chen, 7:13-55, Fig. 3A. Similarly, Matsuo shows at least a portion of its own conductive lines as being outside of the display area.

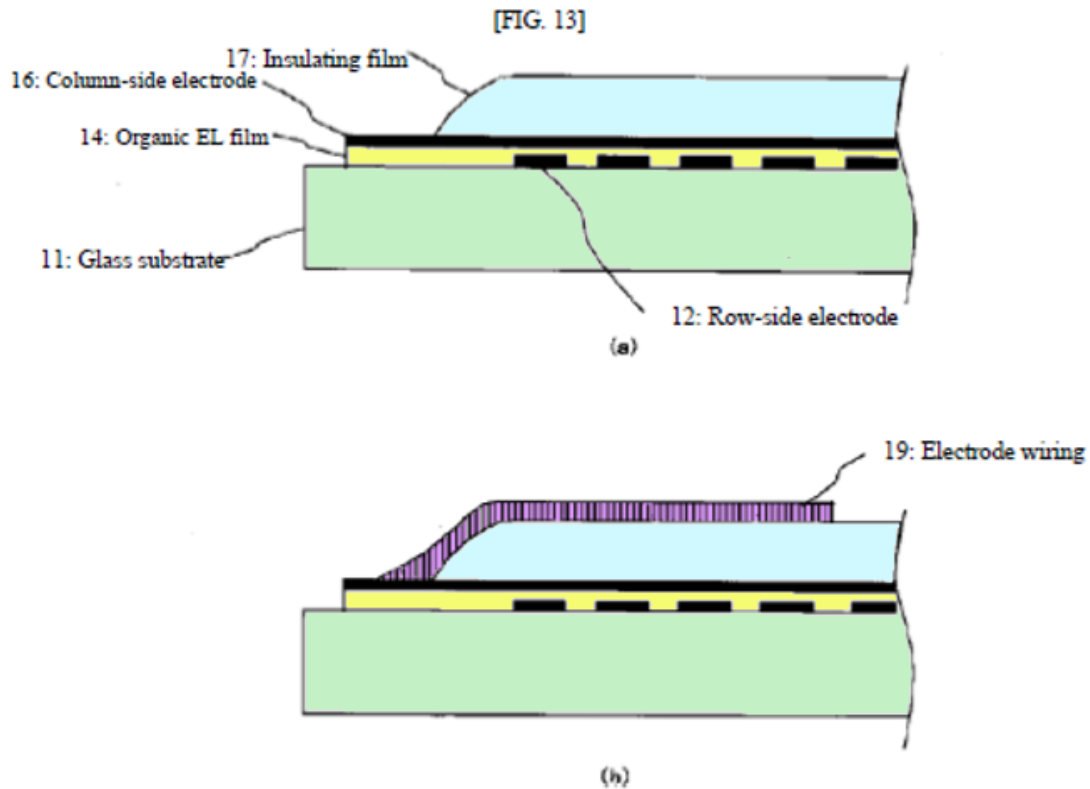
FIG. 1B



Matsuo, Fig. 1B.

247. Upon modifying Chen's barrier layer (128) to have a multi-layered sealing layer with an inclined edge, consistent with Sano (§X.A.2.d (Ground 1A, 1[c])), a POSITA would have appreciated that some parts of Chen's conductive wires lines be connected to conductive wires 122c-d on the substrate 110 and would need to connect to first and second patterned conductive layers (223, 225) on top of

the sealing layer (128). Although a few ways were known to make that connection, a POSITA would have understood that one obvious (and, indeed, the most straightforward) option would be to form part of Chen's conductive lines as sensing lines between the first portion on the top of the sealing layer (128) and the second portion over the substrate (110) to connect Chen's conductive wires (122c, d) on the substrate (110) so that this portion of the sensing lines is along the inclined surface of the sealing layer (128) to connect the first portion and second portion to each other, as taught by Sakamoto and others in the art I explained in §X.A.1.e (Ground 1A, motivation).



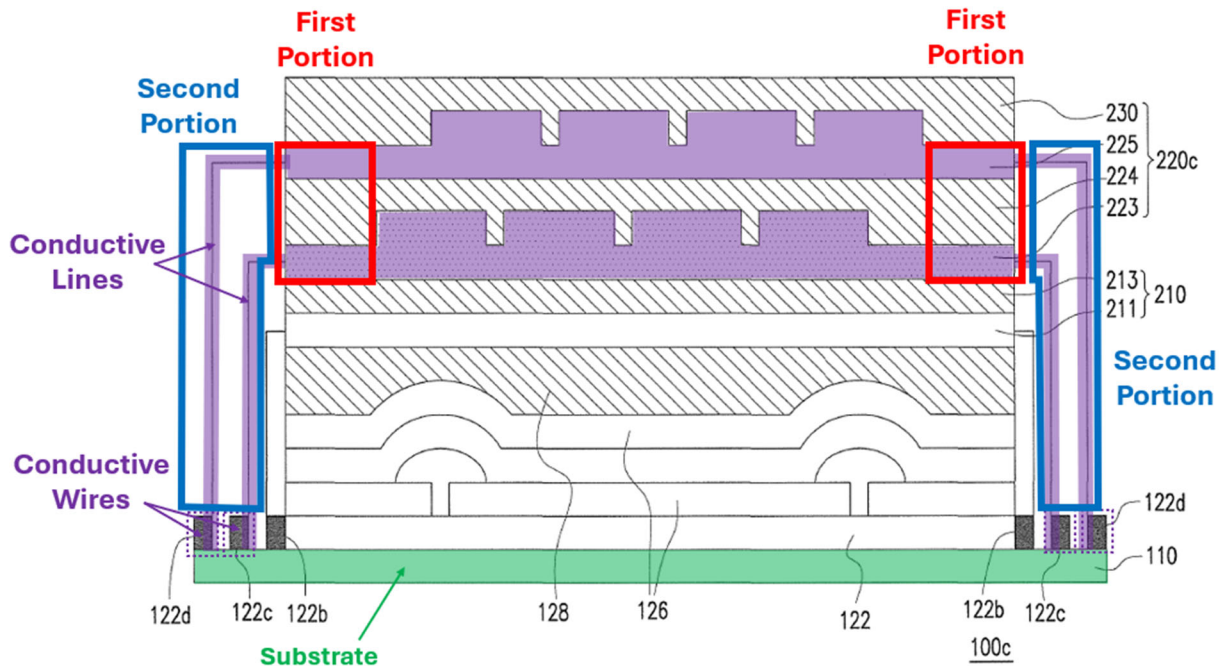
Sakamoto, Figs. 13(a)-(b) (annotated).

- k. **1[j]: wherein the sensing lines are formed over the top surface of the sealing thin film in the first portion and formed over the substrate in the second portion, and the sensing lines extend from the sensing cells along the inclined surface of the sealing thin film to the second area of the substrate, wherein the sensing lines are electrically connected to the driving circuit,**

248. In my opinion, Chen in view of Matsuo, Sano, and Sakamoto teaches 1[j].

249. Chen's conductive lines as the sensing lines have a first portion over the top of the sealing layer (128) to connect to the touch sensors (223, 225) formed

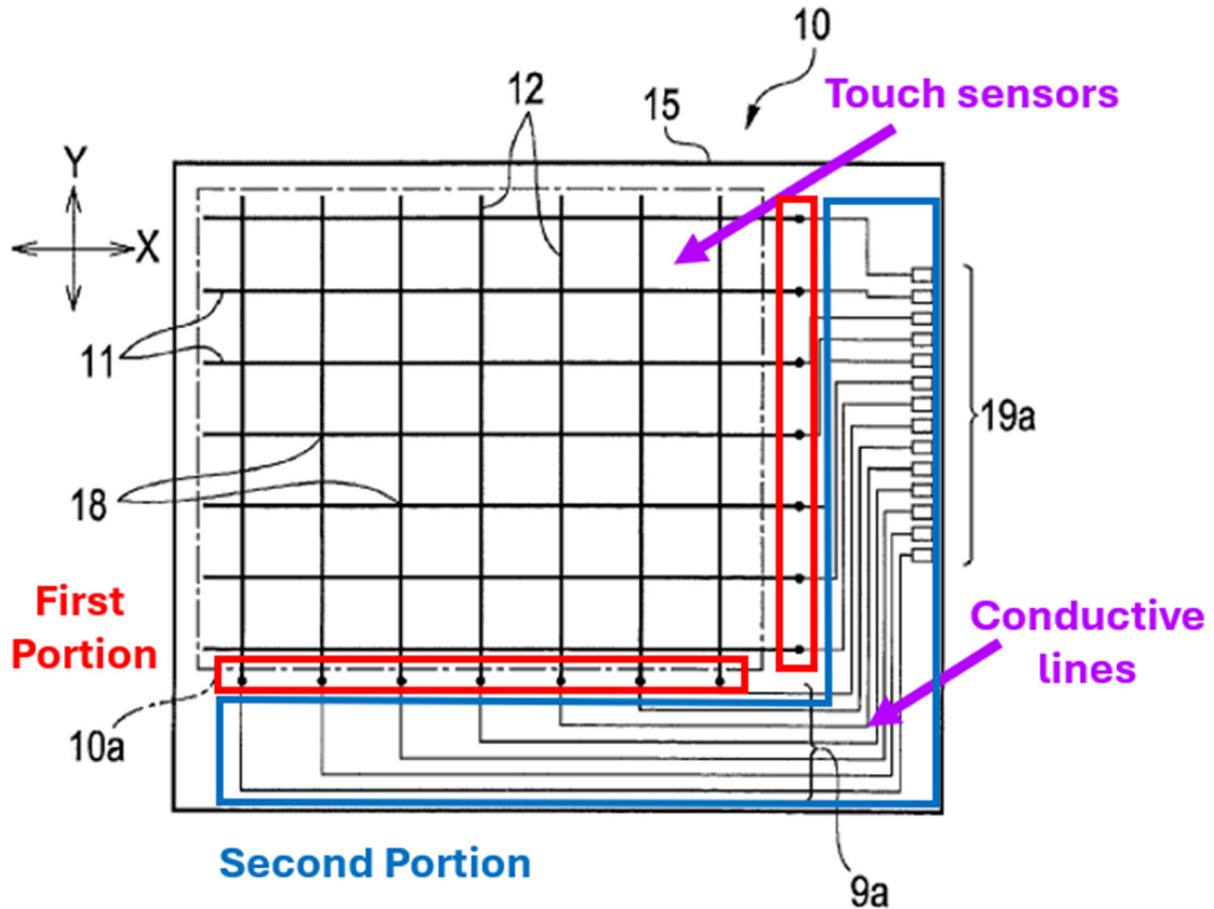
on top of the sealing layer (128), and a second portion over the substrate (110) connected to conductive wires 122c-d formed on the substrate (110) as I explained in §§X.A.2.e-X.A.2.f (Ground 1A, 1[d]-[e]).



Chen, Fig. 3A (annotated), 7:13-55.

250. And Matsuo provides an exemplary top-down view of a similar arrangement, showing a first portion connected to the touch sensors, and a second portion that runs along the substrate and connects to a driving circuit as I explained in §X.B.2.f (1[e]).

FIG. 1B



Upon modifying Chen's barrier layer (128) to have a multi-layered sealing layer with an inclined edge, consistent with Sano (§X.A.2.d (Ground 1A, 1[c])), a POSITA would have appreciated that Chen's conductive lines would have a first portion formed over the top surface of the barrier layer (128) and downwardly connect to another second portion connected to conductive wires 122c-d already formed on the substrate (110)—similar to Matsuo's top-down depiction—and the

conductive lines extend from the touch sensors along the inclined edge of the sealing layer (128) (*i.e.*, Sano's moderately inclined surface 300S and inorganic barrier layer taper at its end) to the second area of the substrate as taught by Sakamoto for connecting to the conductive wire and driving circuit as I explained in §§X.B.2.g (1[f]), X.B.2.j (1[i]).

- l. 1[k]: wherein the sensing cells include a plurality of first sensing cells connected along a first direction by first connection patterns and a plurality of second sensing cells connected along a second direction by second connection patterns, and**

251. See my analysis of 1[k] in Ground 1A. §X.A.2.1.

- m. 1[l]: wherein the insulating layer is interposed between the first connection patterns and the second connection patterns. 1[c]: a sealing thin film covering the first area of the substrate and including an inclined surface at an end of the sealing thin film to inhibit infiltration of oxygen or moisture into the pixels;**

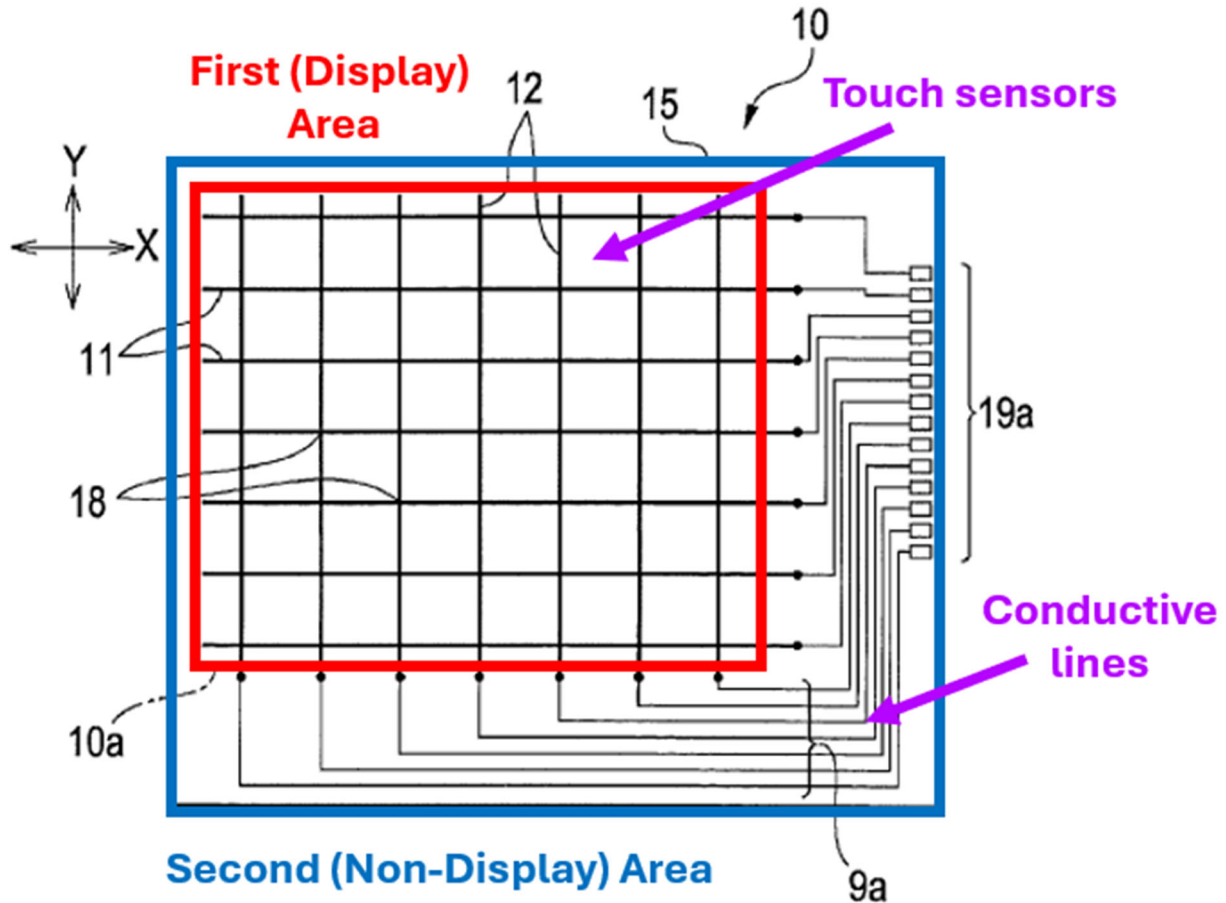
252. See my analysis of 1[l] in Ground 1A. §X.A.2.m.

- 3. Claim 2: The display according to claim 1, wherein the first portion is located on the sealing thin film and the second portion is located on the second area of the substrate, and wherein first portions of the sensing lines are located on a same layer.**

253. In my opinion, Chen in view of Matsuo discloses or suggests this additional limitation.

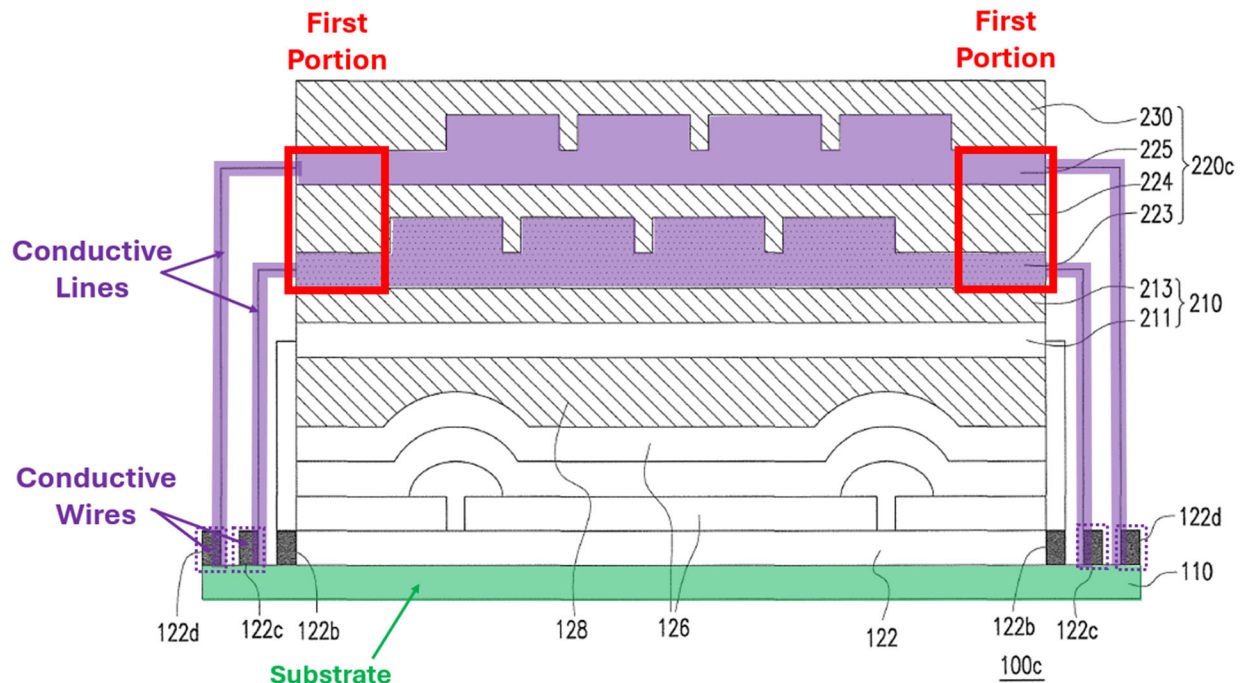
254. Chen, alone or in combination with Matsuo, teaches conductive lines with a first portion provided in the layers for the touch sensors over the top of the barrier layer (128) to connect to the touch sensors, and second portion of the sensing lines over the substrate (110) to connect to conductive wires 122c-d on substrate (110) as I explained in §§X.A.2.e (Ground 1A, 1[d]), X.B.2.f (1[e]), X.B.2.k (1[j]). And Matsuo further provides a top-down view that shows conductive lines (9a) as sensing lines like Chen's conductive lines that extend from a first (display) area to a second (non-display) area of the substrate to connect on-display touch sensors to off-display processors, which would have guided a POSITA when implementing Chen's invention. *See, e.g., Matsuo*, Fig. 1B; §X.B.2.b (1[a]).

FIG. 1B



255. Moreover, Chen in Fig. 3A also depicts both ends of a touch-pad array (223, 225) of touch sensor pads (223b, 225b) as sensing cells include connecting electrodes as the first portion of the sensing lines that are connected between sensing cells in form of the touch sensor pads (223b, 225b) and second portion of the conductive lines as the sensing lines that downwardly connect to the conductive wires (122c-d) on the substrate (110). Referring to Fig. 3B in light of Fig. 3A, first

portions (223a on the edge of the touch-pad array formed by touch sensor pads 223b) of the different sensing lines are in the same conductive layer 223 and, similarly, first portions (225a on the edge of the touch-pad array formed by touch sensor pads 225b) of the different sensing lines are in the same conductive layer 225. Therefore, Chen discloses that at least some first portions of the conductive lines are located on a same layer.



Chen, Fig. 3A (annotated), 7:13-55.

256. To the extent this limitation requires *all* first portions to be on the same layer, however, such an arrangement would have been obvious in view of *Chen*, for

the reasons I explained above in §X.A.3 (Ground 1A, cl. 2, explaining how Chen discloses an embodiment in which all touch sensor pads are formed on the same layer, connected by bridges).

4. Claim 3: The display according to claim 2, wherein second portions of the sensing lines are located on a different layer from the first portions of the sensing lines.

257. In my opinion, Chen, alone or in combination with Matsuo, discloses or suggests this additional limitation for the same reasons as I explained in §§X.B.2.f (1[e]), X.A.2.k (1[j]) (explaining first portion provided on or near barrier layer (128) and second portion on substrate (110)).

5. Claim 4: The display according to claim 1, wherein a first distance between first portions of the sensing lines and the substrate is greater than a second distance between second portions of the sensing lines and the substrate.

258. In my opinion, Chen, alone or combined with Matsuo, teaches or suggests this additional limitation.

259. Because Chen's "first portions" of the conductive lines are located over the top of the sealing layer (e.g., 128) to connect to the touch sensors formed on or above that sealing layer, but "second portions" are provided over the substrate (110) to connect to conductive wires (122c-d) on the substrate (110) (§X.B.2.f (1[e])), a POSITA would have understood that Chen discloses that the first portions of the

conductive lines have a first distance from the substrate that is greater than the distance between the second portions of the conductive lines and the substrate.

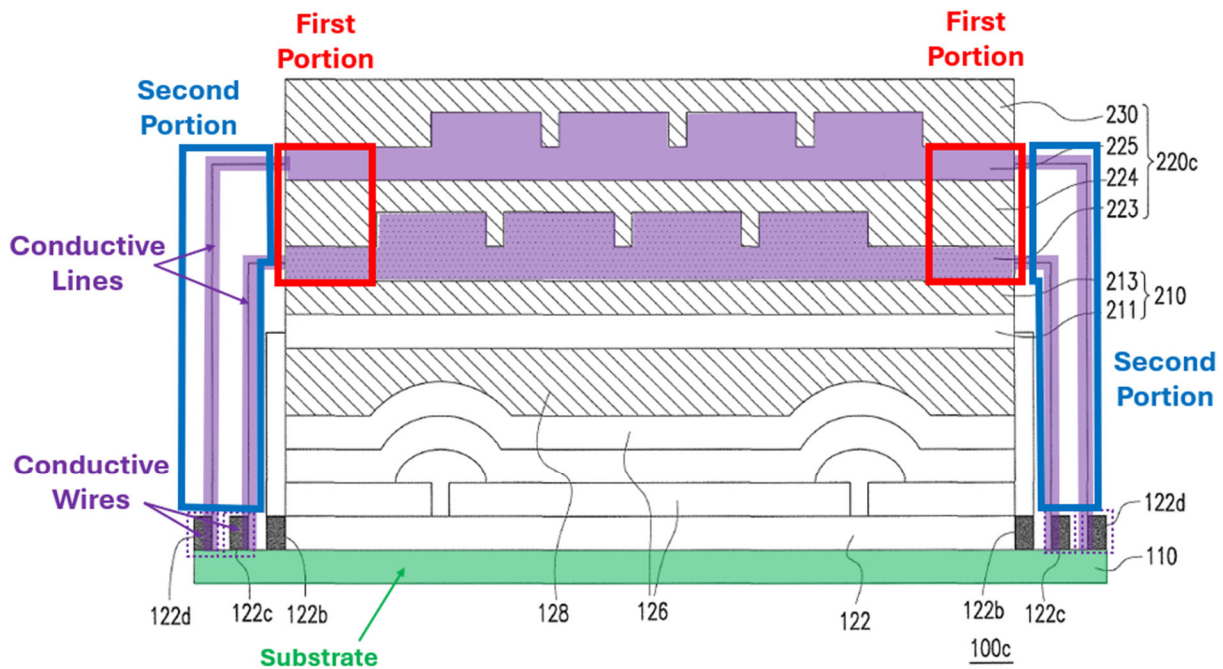


FIG. 3A

Chen, Fig. 3A (annotated), 7:13-55.

260. Matsuo would have further confirmed this arrangement as I explained in §X.B.2.f (1[e]).

6. Claim 5: The display according to claim 1, wherein the sensing lines are electrically connected to the driving circuit through wiring lines.

261. In my opinion, Chen in view of Matsuo teaches this additional limitation for the same reasons as I explained in §X.B.2.g (1[f]).

7. Claim 6: The display according to claim 1, wherein the sensing lines include a different material from the sensing cells.

262. In my opinion, Chen in view of Matsuo teaches this additional limitation.

263. Although Chen does not expressly explain implementation details for the materials used for the conductive lines and touch sensor pads (223b, 225b), a POSITA would have understood they can be different materials. *See* §X.A.7 (Ground 1A, Claim 6). Similarly, transparent conductive materials were extremely old and well-known for touch panels, and Matsuo even refers to the use of a transparent conductive material (like ITO and IZO). Specifically, Matsuo describes a capacitive touch panel where “[t]he translucent conductive metal oxide layer is made of, for example, indium tin oxide [(ITO)] or indium zinc oxide [(IZO)].” *Matsuo*, ¶17. Matsuo further describes “a plurality of metal wires which are connected to the first and second translucent electrode lines.” *Matsuo*, ¶20; *see also*, *e.g., id.* ¶¶42, 47 (noting elements 9a as “metal wires”), 51 (“The metal wires 9a are connected to the second ITO layers 3a of the first and second translucent electrode lines”).

264. A POSITA would have understood that metal wires were often used for connections because they provided far less electrical resistance than transparent

conductive materials (like ITO and IZO), and thus could be made to have a smaller cross-sectional area when, e.g., forty or more connections are required in the border area surrounding a touch panel display. *Barrett*, pp. 3-5. Mobile device applications like smartphones with small screens require narrow borders to maximize the size of the screen in smaller implementations, and is therefore ripe for fine line silver printing at only 50-100 microns wide. *Id.*

265. Moreover, the selection of particular materials was an obvious design choice because most touch panels used similar materials: a cover glass, optical bonding adhesive, indium tin oxide (ITO), and glass subject to variations provided unique applications and user needs. *Id.*, 4-6 (describing iPhone materials); *see also* U.S. Publication 2010/0182250A1 to Kang, et al. (Ex-1039), Figs. 2-3, ¶¶ 16, 18, 75 (describing touch panel materials including indium tin oxide, silicon oxide, and zirconium oxide; “detecting lines” made of “low resistance material” including a “triple-layer of molybdenum/aluminum/molybdenum or a chrome film”).

8. Claim 7: The display according to claim 1, wherein the driving circuit is located on the second area of the substrate.

266. In my opinion, Chen in view of Matsuo teaches this additional limitation.

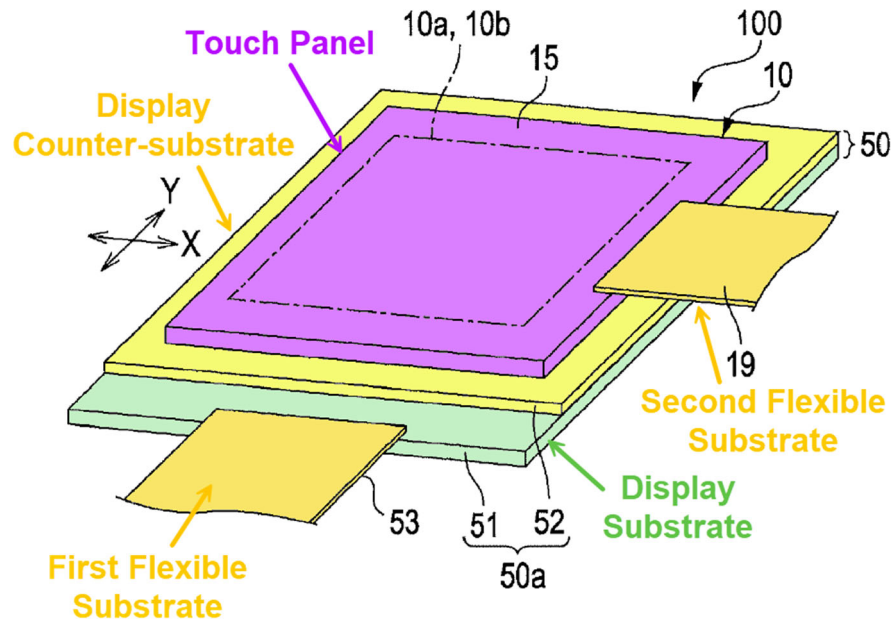
267. Matsuo teaches that the metal wires (9a) are connected to a driving circuit located on a flexible substrate (19a) as I explained in §X.B.2.g (1[f]). Although Matsuo does not teach providing a driving circuit on the *display* substrate, a POSITA implementing Chen’s invention would have understood that the driving circuit would be placed in or on a second (off-display) area of the *display* substrate—either placing the driving circuit directly on the substrate, or connected to the substrate by a separate flexible substrate, consistent with Matsuo—because Chen discloses its conductive line connect to conductive wires (122c, d) are provided on the *display* substrate as I explained in §§X.B.2.g (1[f]), X.B.1.c (motivation). Moreover, Matsuo discloses *also* providing driving integrated circuits on the display substrate as well. *See, e.g., Matsuo*, ¶38.

9. Claim 8: The display according to claim 7, further comprising a flexible printed circuit board (FPCB) attached to the second area of the substrate.

268. In my opinion, Chen in view of Matsuo discloses this additional limitation.

269. Matsuo discloses that a “flexible substrate” (53) is attached to the second area of the *display* substrate. *Matsuo*, Fig. 1A, ¶38.

FIG. 1A



270. Although Matsuo does not expressly state that the flexible substrates (53, 19) are flexible PCBs, a POSITA would have known that because the flexible substrates were intended to contain driving circuits (*see* §X.B.2.g (1[f])), they would be formed as printed circuit boards so that the connecting lines are embedded on the flexible substrate.

10. Claim 9: The display according to claim 8, wherein the sensing lines are electrically connected to the driving circuit through the FPCB.

271. In my opinion, Chen in view of Matsuo discloses this additional limitation for the reasons I explained in §§X.B.2.g (1[f]), X.B.9 (cl. 8), X.B.1.c (motivation).

11. Claim 10: The display according to claim 1, wherein the sensing lines are arranged outside the pixel area.

272. In my opinion, Chen in view of Matsuo teaches this additional limitation for the same reasons I explained in §§X.A.2.a (Ground 1A, 1[pre]), X.B.2.b (1[a], teaching a display pixel area), X.B.2.f (1[e]), X.B.2.j (1[i], teaching first, inclined, second sensing lines portions outside the display pixel area).

12. Claims 11, 12 and 13

273. It is my opinion that claims 11, 12, and 13 are obvious over the teachings of Chen and Sano for the same reasons I explained in my analysis of Claims 11, 12 and 12 in Ground 1A, above. *See* §§X.A.12-X.A.14.

C. Grounds 2A/2B: Obviousness in view of Imamura, Yang, and Sakamoto or Imamura, Yang, Sakamoto, and Chen (Claims 1-13)

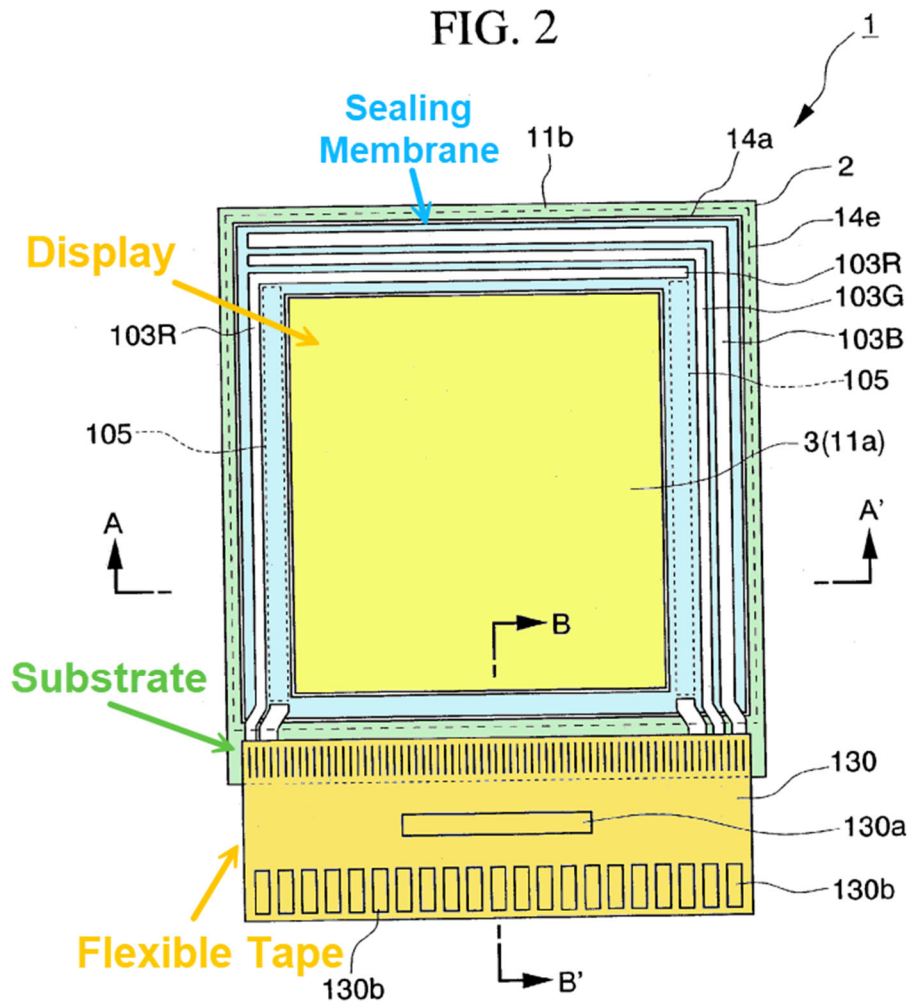
1. Prior Art

a. Imamura (Ex-1011)

274. Imamura discloses an organic electroluminescent (EL) display (OLED)¹ with a multilayered barrier-sealing structure. *Imamura*, Abstract, ¶4. Specifically, Imamura discloses the display device (401) includes a substrate (2), display element section (3), drive circuits (104, 105), and flexible tape (130) to host an integrated circuit (130a) and external terminals (130b). *Imamura*, Figs. 1-2, ¶¶90-102. Imamura then discloses forming a multilayered sealing structure “on the display element section” using alternating “flattening resin layers” and “barrier layers.” *Id.*, ¶112.

275. One object of Imamura’s design is to “provide a sealing structure with a barrier membrane for a display device, with which the thickness of the display device can be reduced while ensuring sufficient barrier properties against water and oxygen so as to prevent deterioration of luminous layers.” *Id.*, e.g., ¶¶10, 20, 22, 26, 39, 41, 43, 47, 114, 121, 125, 144.

¹ A POSITA would have recognized Imamura’s organic EL (electroluminescence) display as an organic light-emitting diode (OLED) display because Imamura’s device produces organic electroluminescence (how light is created) using active matrix circuits with thin film transistor and pixels common in OLEDs (what creates that light) as I explained above. *Imamura*, ¶¶4, 91-93; §VI.



Imamura, Fig. 2 (annotated). A cross-sectional view shows the alternating layers of the sealing membrane (14c1, 14d2, 14c2, 14d2) form an inclined surface toward the substrate 2:

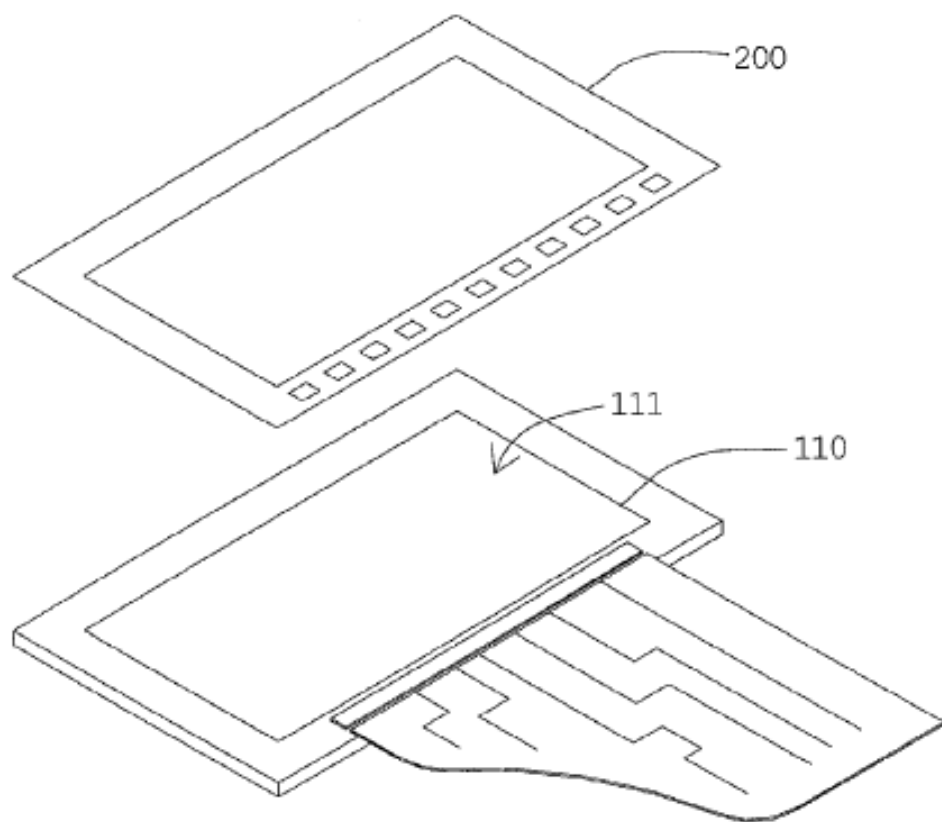


Id., Fig. 4 (annotated), ¶¶112-13.

b. Yang (Ex-1012)

276. Yang teaches a capacitive touch panel and display device including a touch panel 200 disposed on a display surface 111 of display panel 110:

100



Yang, Fig. 2, Abstract, ¶33. *Yang*'s touch panel 200 includes two series-connected electrode layers 300, 500 separated by a dielectric layer 250:

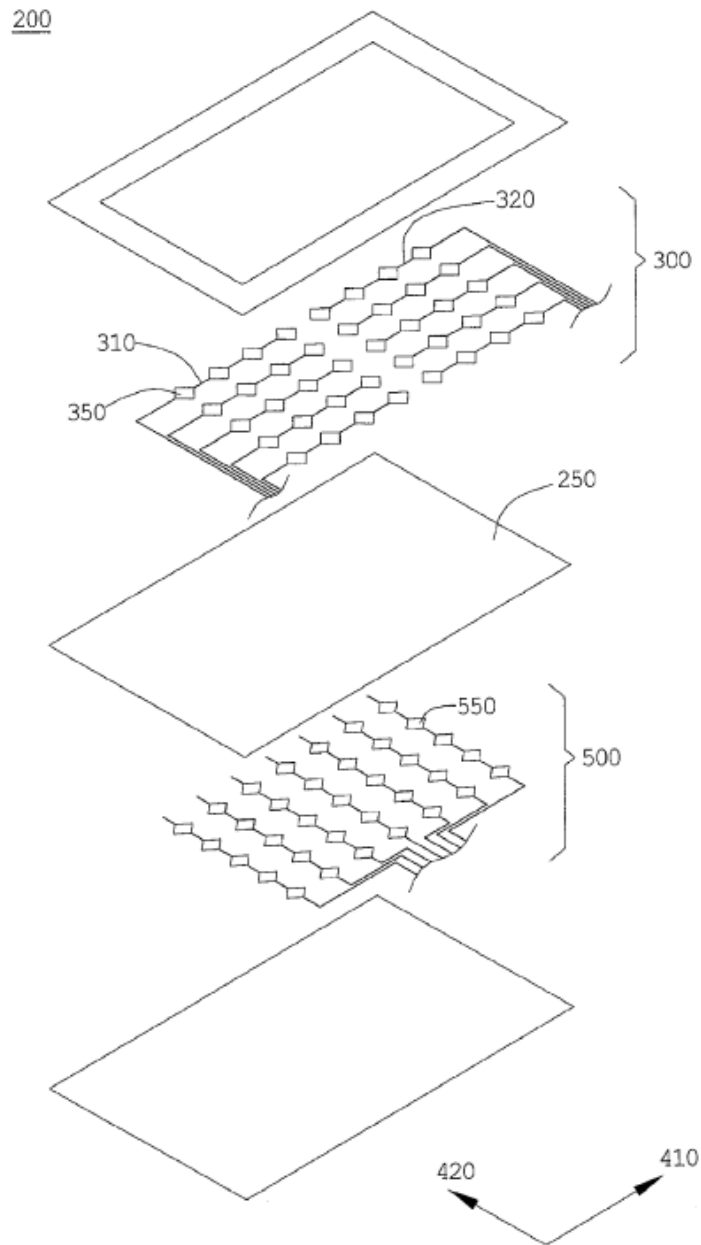


Fig.3

Id., Fig. 3, ¶34. In one application, the capacitive touch panel is further “integrated into...a flat panel display device” comprising an organic light emitting diode (OLED) display panel. *Id.*, ¶32.

c. Imamura, Yang, Sakamoto, and Chen are Analogous Art

277. In my opinion, Imamura, Yang, Sakamoto, and Chen are analogous to the '088 patent because they disclose organic light emission display devices (a common field of endeavor) and are directed toward improving otherwise inefficient and unreliable OLED designs (and are therefore reasonably pertinent to solving the same problem). *See '088 patent*, 3:24-28 (“Conventionally, in the organic light emitting display, a glass substrate having a cavity or plate pattern is joined with the substrate 100 under a vacuum atmosphere so as to prevent the organic light emitting elements from being exposed to moisture and oxygen.”) Sakamoto and Chen are analogous for the reasons I discussed above. §X.A.1.e (analogous art including Sakamoto and Chen).

278. Comparatively, Imamura discloses an organic electroluminescent (EL) display (OLED) containing a substrate, display element section, drive circuits, and flexible tape to host an integrated circuit and external terminals with a multilayered barrier-sealing structure “ensuring sufficient barrier properties against water and oxygen so as to prevent deterioration of luminous layers.” *Imamura*, Abstract, ¶4. Additionally, Yang discloses a capacitive touch panel and display device including a touch panel 200 disposed on a display surface 111 of display panel 110 that is, in one application, an organic light emitting diode (OLED) display panel to form a

“display device which incorporates [a] capacitive touch panel with less system loading.” *Yang*, Fig. 2, Abstract, ¶¶11, 32-33.

279. Because the Imamura and Yang references are reasonably pertinent to facing the same problem in a common field of endeavor as the '088 patent, it is my opinion that they qualify as analogous art.

d. Motivation to Combine

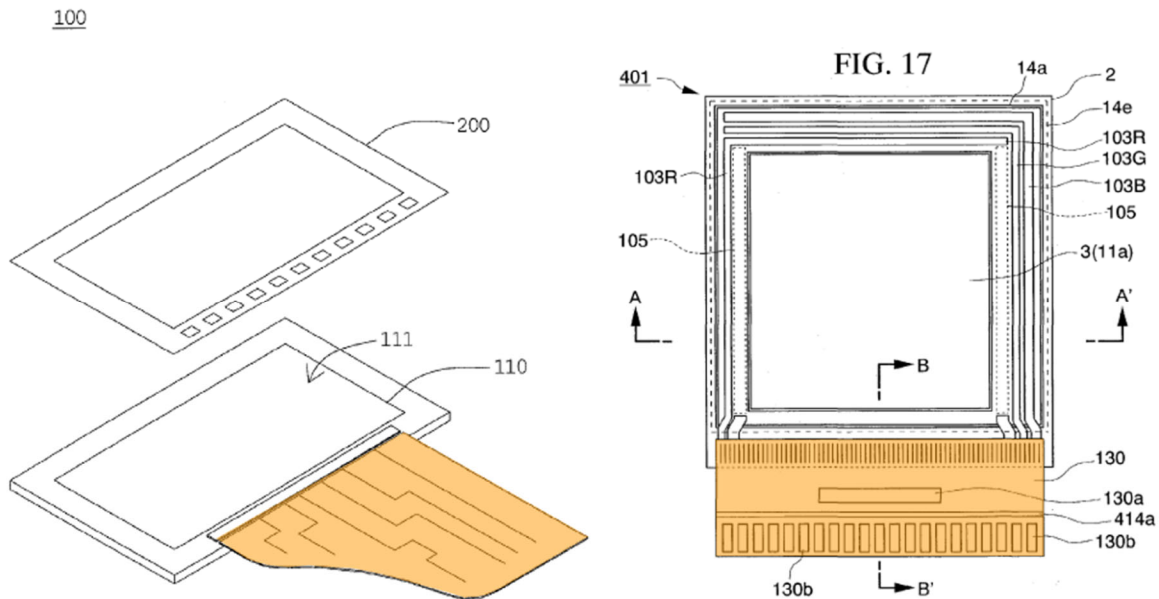
280. Although Imamura discloses an OLED display that is sealed from environmental degradants, Imamura does not explain the display with any form of user input; Imamura's display either has no user input, or relies upon external inputs (like a keyboard and mouse). However, touch-panel displays were growing in popularity as of 2010, and a POSITA would have been motivated to modify Imamura to incorporate a touch panel into Imamura's display to provide a direct form of user input.

281. A POSITA would have turned to other prior-art references, such as Yang and Chen, to identify the known structures of the touch panel and how they would have been integrated into the display. Regarding **claim 1[d]**, Yang expressly teaches that its capacitive touch panel may be “integrated into a panel of [a] display device” with an OLED display (*Yang*, ¶32), and describes how the touch-panel layers are formed on top of a display. *Yang*, ¶¶5, 11-12, 32-33. Chen further teaches

forming a touch sensing structure over top a water/oxygen barrier layer as I explained above. §X.A.2.e.

282. A POSITA would have had a reasonable expectation of success in making this modification because the modification merely involves forming additional touch-panel-related layers on Imamura's display; both Yang and Chen taught the layers required. Moreover, integrating a touch-sensor panel into a display was a routine and well-known process as of 2010. *See, e.g., Chen*, Figs. 3A-B (disclosing a sensor panel-OLED display).

283. Upon adding a touch-sensor panel to Imamura's display, however, a POSITA would have appreciated that the touch sensors would need to be connected to an off-display driving circuit to operate. Indeed, both Yang and Imamura couple a flexible printed circuit board (orange) to a substrate to provide control circuitry to their respective panels. *Compare Yang*, Fig. 2 (left) with *Imamura*, Fig. 17 (right):



284. Because the touch panel would be formed on top of Imamura's existing display, a POSITA would have appreciated that there would need to be some way to connect the touch sensors on top of Imamura's sealing membrane to a driving circuit placed in a non-display area on either Imamura's substrate or flexible tape. A POSITA would have appreciated that there are a few ways to make this connection, but would have been particularly motivated to deposit a connection along Imamura's sealing membrane for the reasons discussed above in Ground 1A based on Sakomoto. §X.A.1.f (Ground 1A, motivation).

285. A POSITA would have had a reasonable expectation of success in making this modification because the modification required only combining discrete elements—a display panel and a touch panel—into an integrated device, as others

had long done. Aside from forming the touch-sensor panel layers on Imamura's display, a POSITA would have needed to route electrical signals between each of the two panels—either by integrating their circuitry as well or providing separate circuitry for each—which would have been within the skills of a POSITA to accomplish.

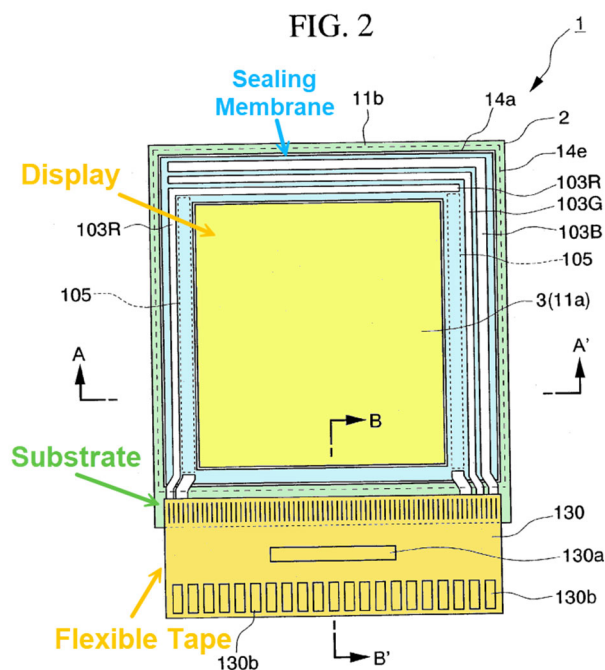
2. Independent Claim 1

a. 1[pre]: A display comprising:

286. In my opinion, Imamura teaches 1[pre].

287. Imamura discloses “an organic EL display device” with display section

3:

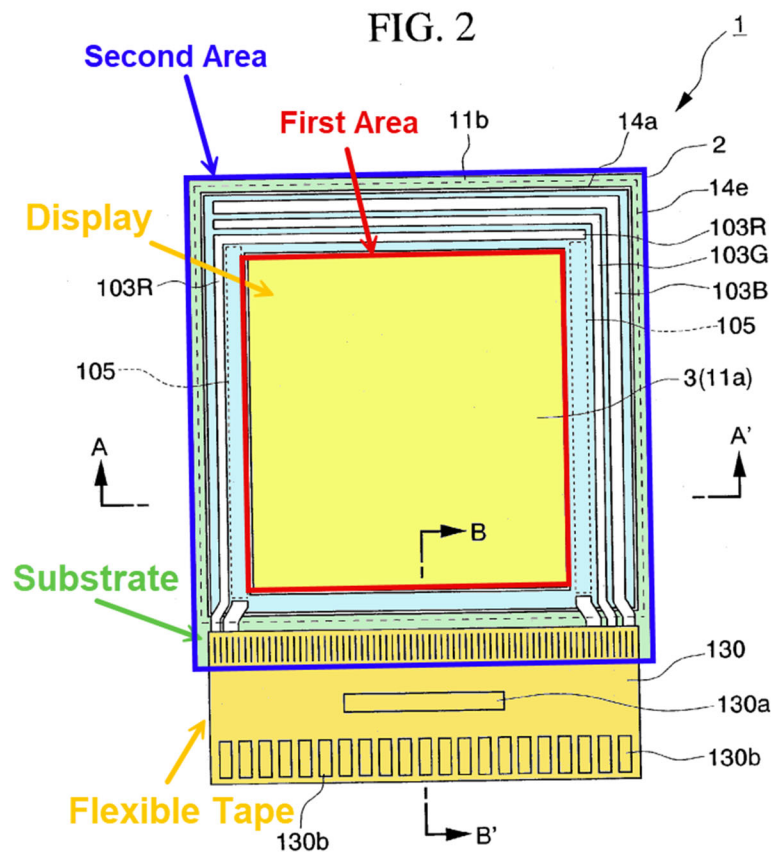


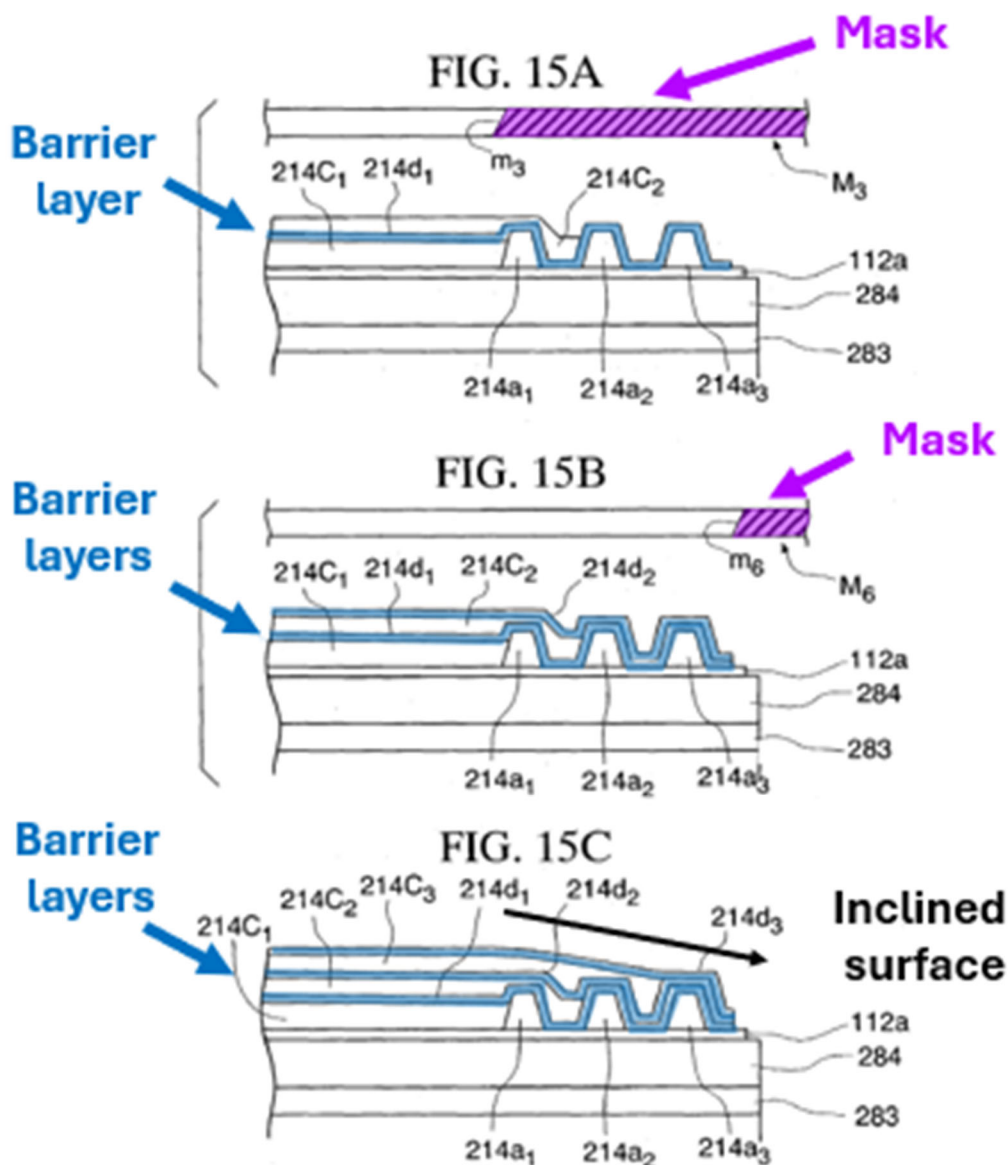
Imamura, Fig. 2 (annotated), ¶¶2, 90, 99.

- b. 1[a]: a substrate including a first area having a pixel area and a second area adjacent to the first area;

288. In my opinion, *Imamura* teaches 1[a].

289. *Imamura* discloses a first display area (3) provided on a substrate (2) on which a plurality of pixel electrodes (111) with thin-film transistors (“TFTs”) (123) are formed, and a second area adjacent to the first area (the non-display portions of the substrate):





Id., Figs. 15A-C, ¶¶163, 168-73.

293. Imamura also explains that the sealing membrane is “superior in blocking water and oxygen” and “functions to prevent degradation of the cathode electrode 12 and the active layer 110 by inhibiting permeation of water, oxygen, impurity ions, or the like into the display element section 3.” *Id.*, ¶114.

e. 1[d]: a plurality of sensing cells formed over a top surface of the sealing thin film to sense a touch;

(i) Ground 2A

294. In my opinion, Imamura in view of Yang teaches 1[d].

295. Imamura teaches a multilayer sealing membrane in OLED displays.
§X.C.2.d (1[c]).

296. Although Imamura does not explain touch sensing based on a plurality of sensing cells formed on top of the sealing film, a POSITA would have been motivated to add a touch-sensor panel to Imamura's display as discussed above. §X.C.1.c (motivation). To that end, Yang teaches a capacitive touch panel (200) that includes a first direction (410) electrode layer (300) that includes first direction electrodes 350 as part of the claimed "sensing cells," and second direction (420) electrode layer (500) that includes second direction electrodes 550 as part of the claimed "sensing cells" oriented in two different directions (410, 420) and separated by an electrical insulating dielectric layer (250):

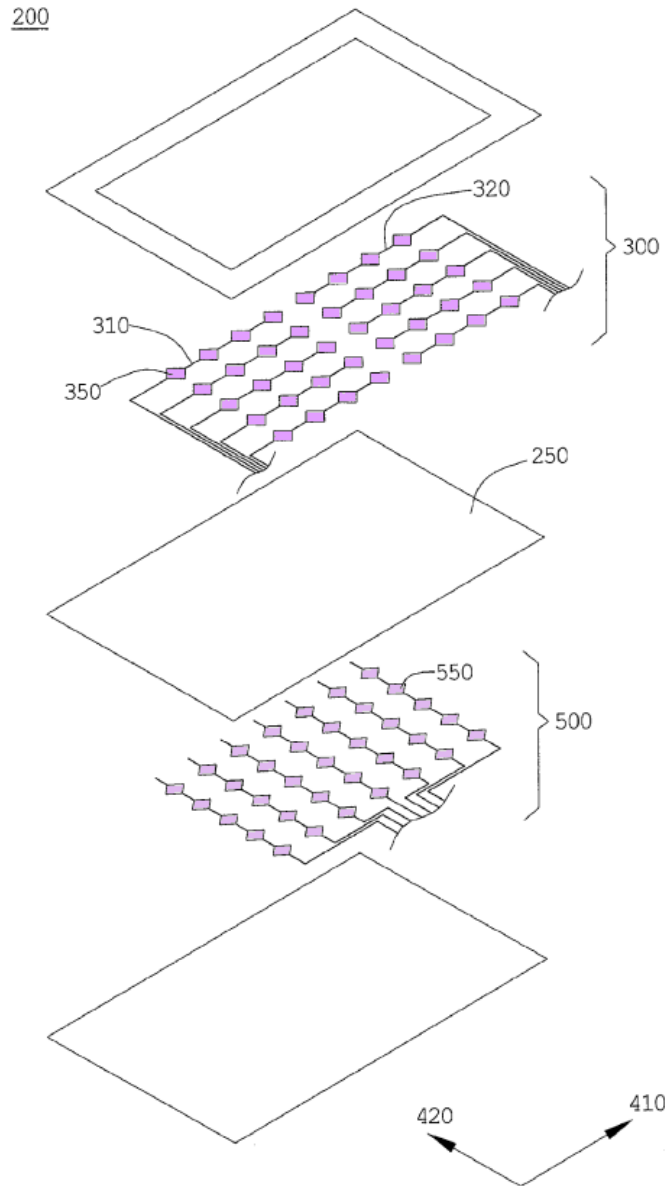


Fig.3

Yang, Fig. 3 (annotated), ¶34.

297. A POSITA would have understood that Yang's first and second electrode layers (300, 500) would have been formed over a top surface of Imamura's sealing membrane to sense a user's touch for a touch sensing OLED display as taught

by Chen. *Yang*, ¶33 (explaining that the “touch panel may...be integrated in the [display] panel” and “the capacitive touch panel 200 will detect the [user’s] contact point and transmit a signal”), ¶¶5, 11-12, 32; *Chen*, 7:13-55; §X.C.1.d (motivation).

(ii) Ground 2B

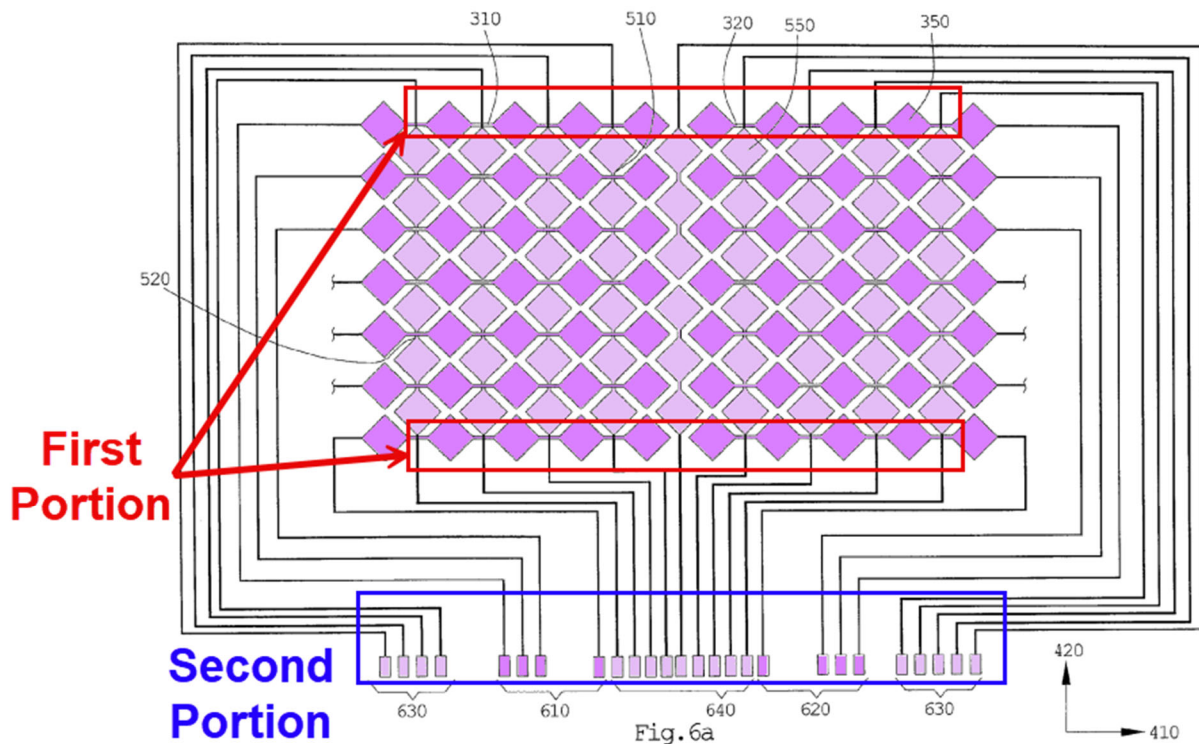
298. To the extent necessary, POSITAs would have combined Imamura and Yang as explained above and further looked to Chen’s known structure to understand how Yang’s first and second electrode layers would have been formed over a top surface of Imamura’s sealing membrane. *Yang*, ¶33; *Chen*, 7:13-55; §X.C.1.d; *Flasck*, ¶297.

f. 1[e]: a plurality of sensing lines coupled to the sensing cells, the sensing lines comprising a first portion and a second portion;

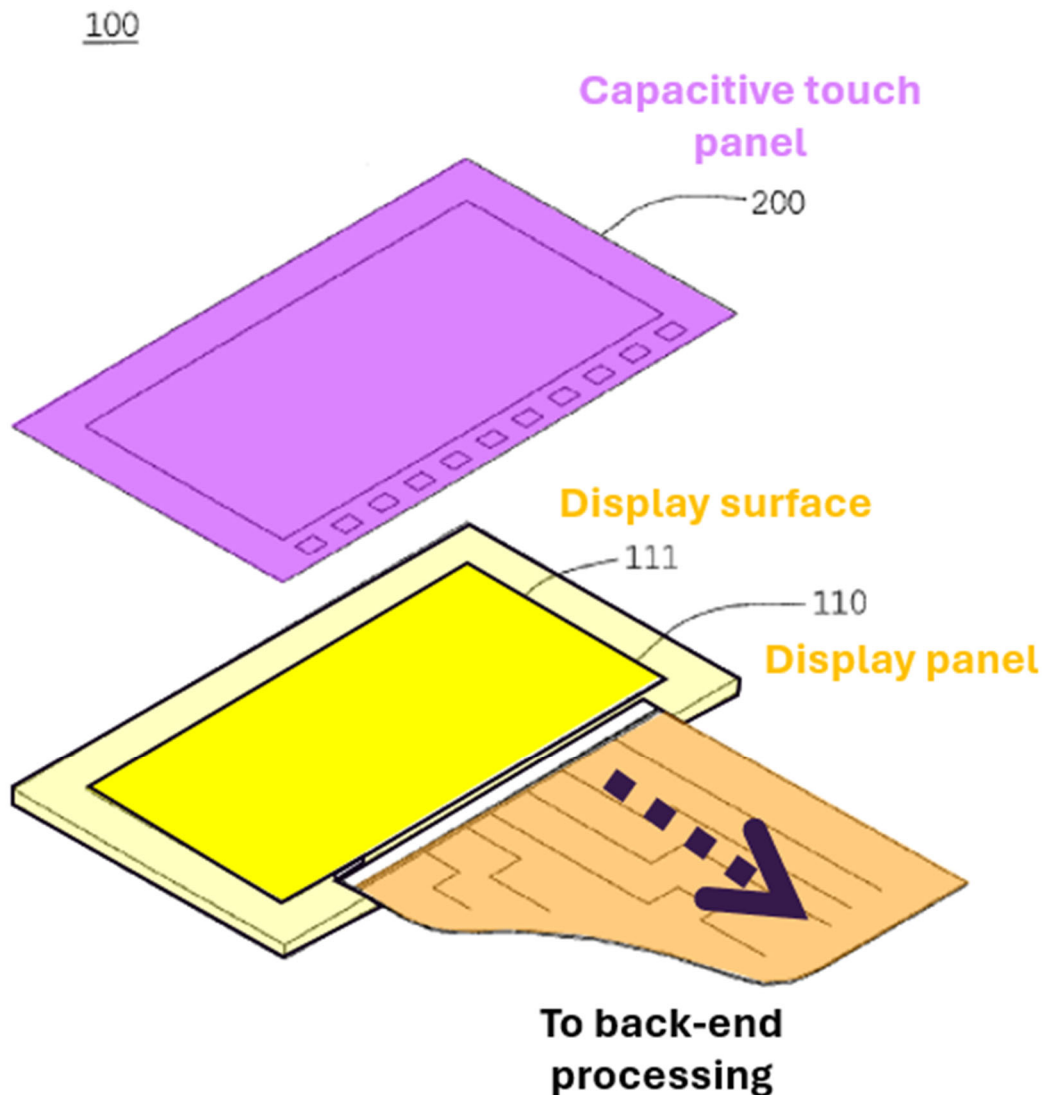
299. In my opinion, Imamura in view of Yang teaches 1[e].

300. Although Imamura does not explain whether there is a touch-sensor panel on its OLED display, a POSITA would have been motivated to add a touch-sensor panel to Imamura’s display as discussed above. §X.C.1.d (motivation). To that end, Yang teaches a capacitive touch panel that includes a plurality of touch electrodes (e.g., 350, 550) electrically coupled together in strings (510, 520) along two directions (410, 420), respectively, and further to a plurality of conductive lines (“sensing lines,” as claimed) at their ends that a POSITA would have understood

would have been formed above Imamura's sealing membrane layer ("first portion") and downwardly connected to linking pads (610-40) formed upon Imamura's substrate ("second portion") for further connection to processing elements described in 1[f], below



Yang, Fig. 6a (annotated), ¶¶35, 38, 40-42. Yang further discloses a "back-end processor" where "the capacitive touch panel will detect the contact point and send a signal to be processed by the backend processor" *Id.*, ¶¶12, 32-33, Fig. 2 (annotated).



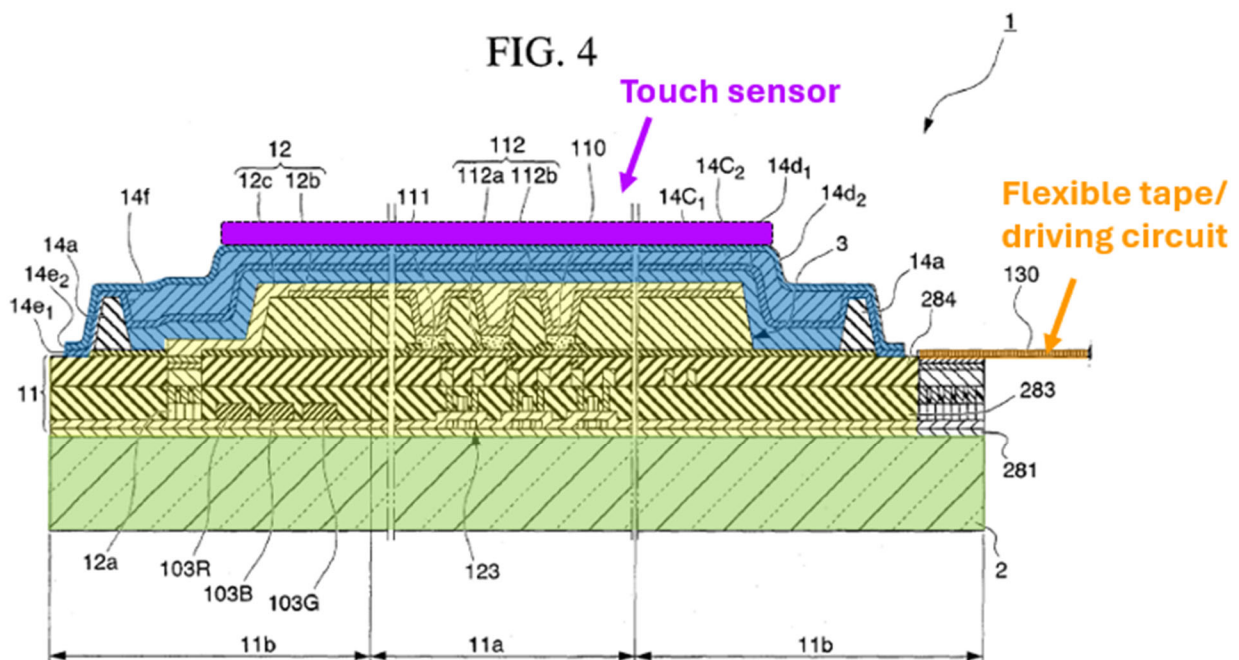
A POSITA would have recognized that Yang expressly teaches how its touch panel layers are formed on top of a display (*Yang*, ¶¶12, 32-33), and that a display would have included its own substrate and required fabricating some type of structure to route the electrical connections at the higher layers (“first portion”) as part of the sensing lines downwardly to electrical connections of the sensing lines

over the lower display substrate (“second portion”) to connect to drive circuitry (or “back-end processor”) coinciding with the lowest substrate on which the display panel is formed to control the entirety of the multilayer OLED/touch panel display.
§X.C.1.d (motivation).

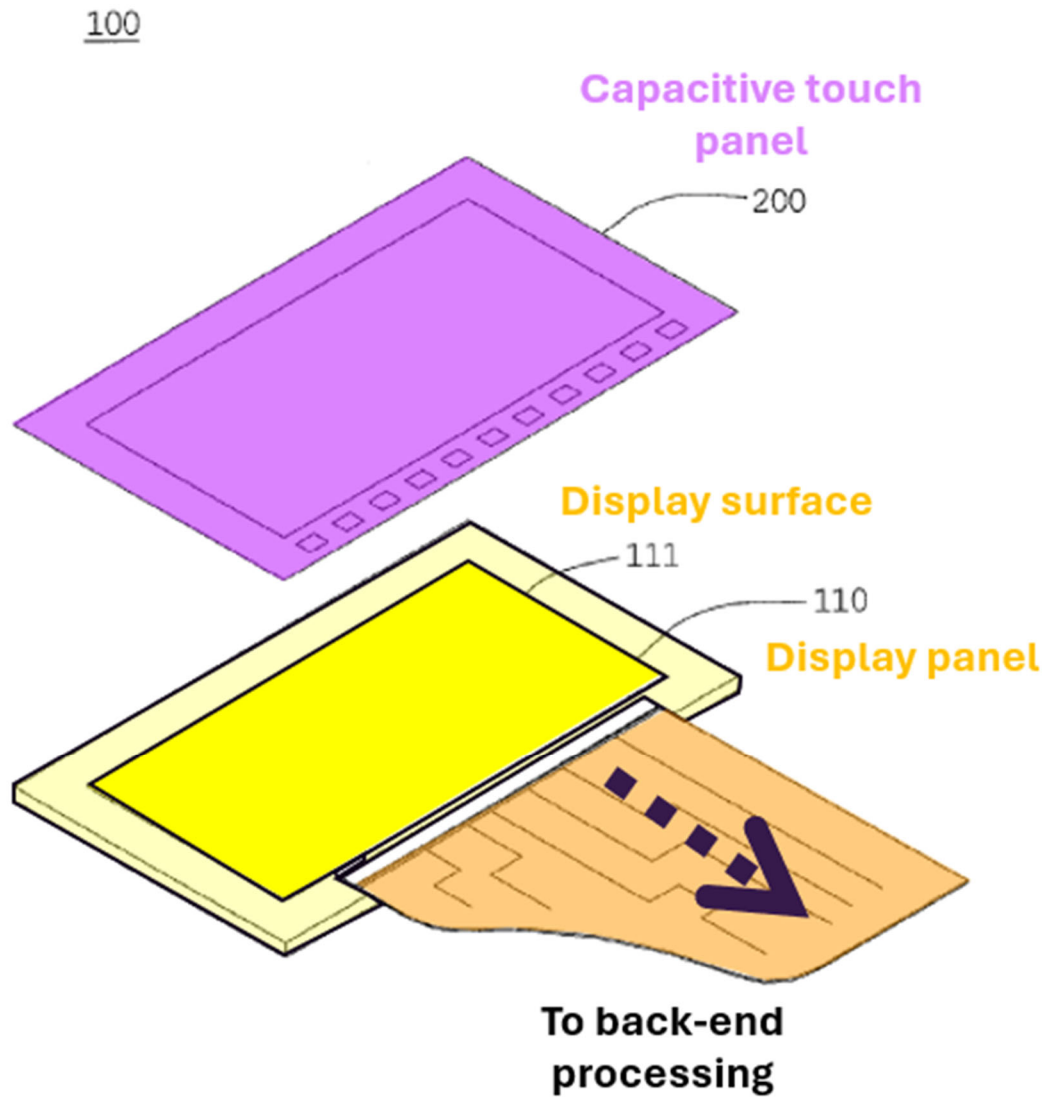
g. 1[f]: a driving circuit electrically connected to the sensing cells via the sensing lines; and

301. In my opinion, Imamura in view of Yang teaches 1[f].

302. Imamura teaches a “drive circuit” for the display located on flexible tape 130. *Imamura*, ¶¶196, 208. Although Imamura does not explain a driving circuit for a touch-sensor panel, a POSITA would have been motivated to add a touch-sensor panel to Imamura’s display.



Id., Fig. 4 (annotated); §X.C.1.c (motivation). To that end, Yang teaches that a capacitive touch panel (200) is coupled to a “back-end processor” to process a signal from a user’s touch.



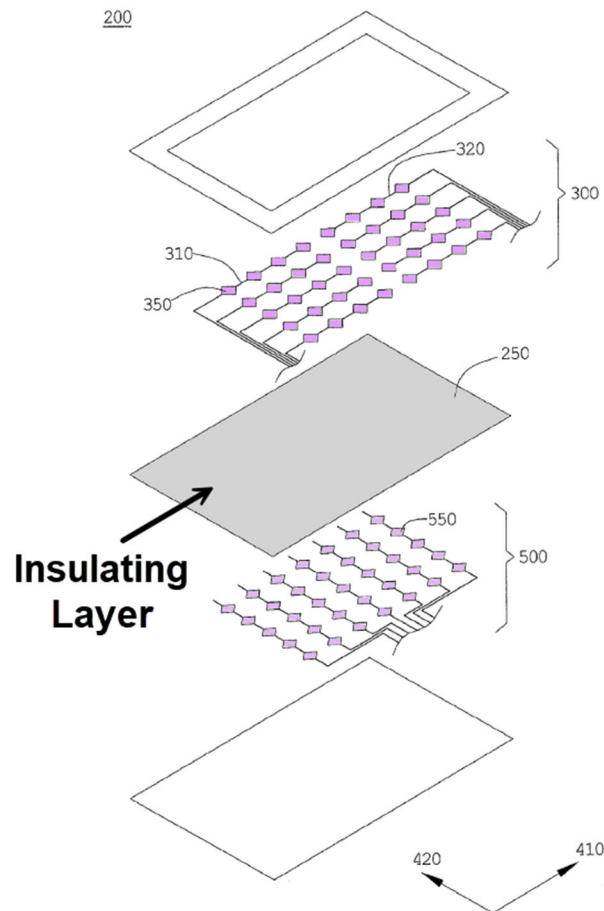
Yang, Fig. 2 (annotated), ¶¶12, 33, 38, 42, 46.

303. A POSITA would have understood that, upon integrating Yang's touch panel with Imamura's display, either two different "back-end" driving circuits would be provided (one for the display panel, and one for the touch panel), or alternatively Yang's "back-end" processor would be integrated into Imamura's display driving circuit to drive both the display and touch-sensor panels because these were two known options to choose from. *Jang*, ¶88; *Cok*, 2:47-51.

h. 1[g]: an insulating layer,

304. In my opinion, Imamura in view of Yang teaches 1[g].

305. Although Imamura does not explain a touch-sensor panel on the display, a POSITA would have been motivated to add a touch-sensor panel to Imamura's display as I explained above in §X.C.1.d (motivation). To that end, Yang teaches an intermediary dielectric layer 250 ("insulating layer," as claimed) positioned between the two electrode layers (300, 500):



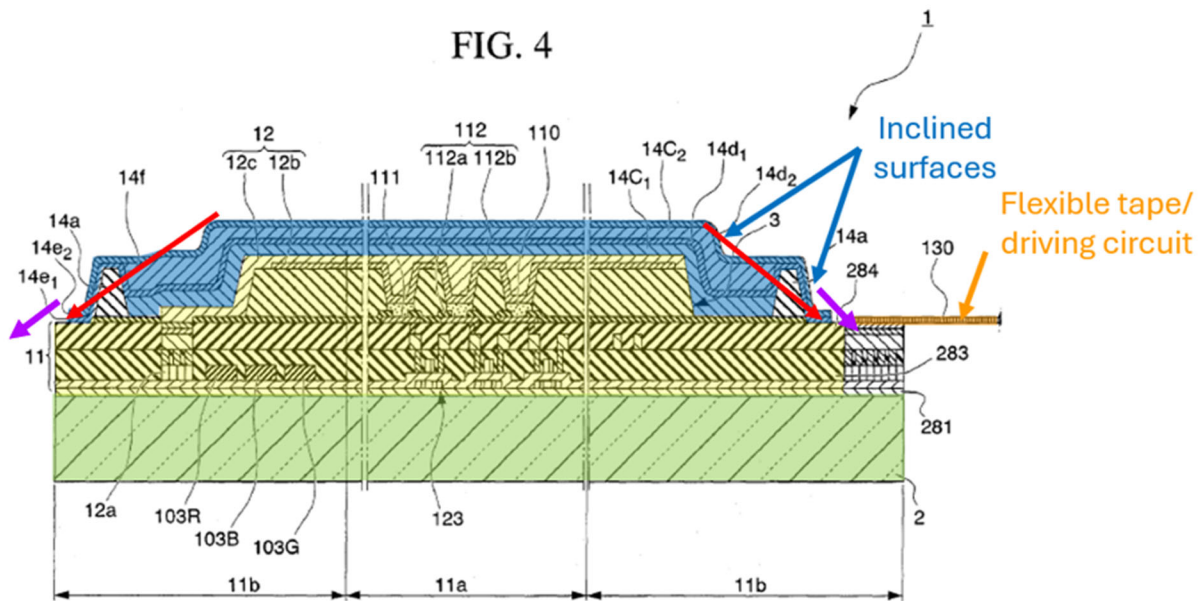
Yang, Fig. 3 (annotated), ¶34; *see also* §X.C.2.e (1[d]).

- i. **1[h]: wherein the inclined surface of the sealing thin film is formed to be inclined downwardly toward the driving circuit,**

306. In my opinion, *Imamura* in view of *Yang* teaches or suggests 1[h].

307. *Imamura* shows a multilayered sealing membrane that a POSITA would have recognized includes a two-part inclined surface sloping downward

toward (“inclines downwardly”) the flexible tape (130) containing drive circuit (130a):

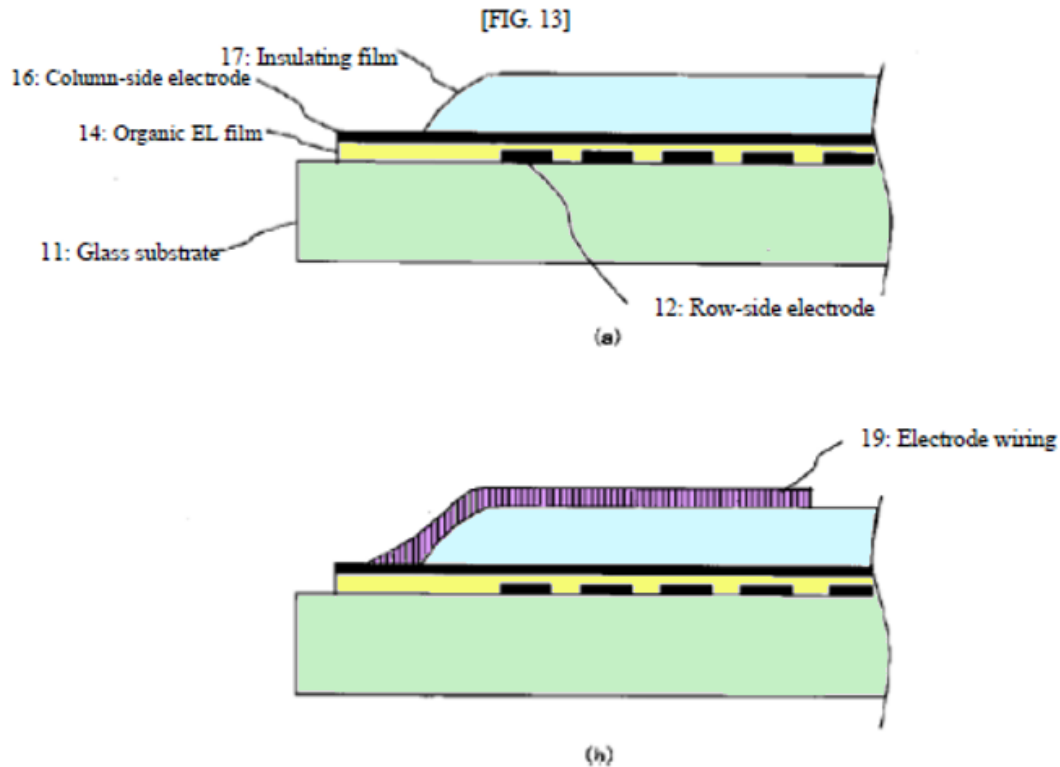


Imamura, Fig. 4 (annotated); ¶¶100, 112. A POSITA would have appreciated that because *Imamura*’s sealing membrane is intended to encapsulate the OLED display, upon integrating a touch-sensor panel such as the one taught by Yang (§X.C.1.d (motivation)), the sealing membrane would incline downwardly towards the driving circuit of the touch-sensor panel regardless of whether it is provided separate or integrated into *Imamura*’s existing driving circuit because the driving circuit is placed outside of the display area being encapsulated.

j. 1[i]: wherein the sensing lines include inclined portion along the inclined surface of the sealing thin film,

308. In my opinion, Imamura in view of Yang and Sakamoto teaches 1[i].

309. Upon integrating a touch-sensor panel such as Yang's on top of Imamura's display, a POSITA would have understood that because Imamura's sealing membrane encapsulates the OLED display, and the driving circuits are placed outside of the encapsulated OLED display area, the touch panel's conductive lines would need to traverse from the driving circuit to an area above Imamura's sealing membrane as I explained in §§X.C.2.e-X.C.2.g (1[d]-1[f]). Although a few ways were known to make that connection, a POSITA would have understood that one obvious (and, indeed, the most straightforward) option would be to form part of Yang's touch-panel conductive lines along the inclined surface of the sealing layer, as taught by Sakamoto and others in the art as I explained in §§X.C.1.d (motivation), X.A.1.f (Ground 1A, motivation).

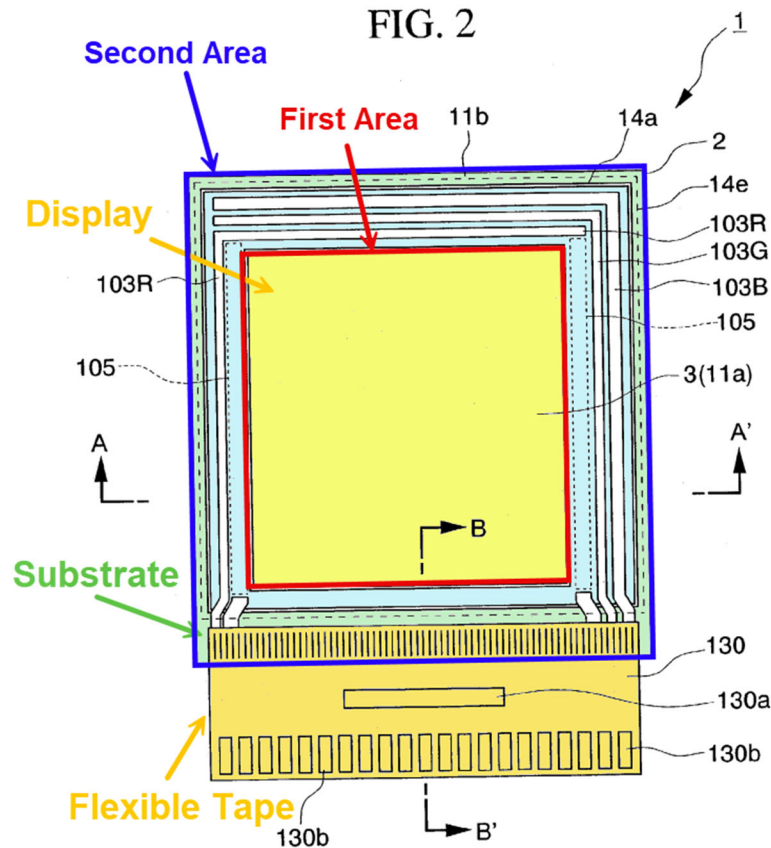


Sakamoto, Figs. 13(a)-(b) (annotated).

- k. 1[j]: wherein the sensing lines are formed over the top surface of the sealing thin film in the first portion and formed over the substrate in the second portion, and the sensing lines extend from the sensing cells along the inclined surface of the sealing thin film to the second area of the substrate, wherein the sensing lines are electrically connected to the driving circuit,

310. In my opinion, Imamura in view of Yang and Sakamoto teaches 1[j].

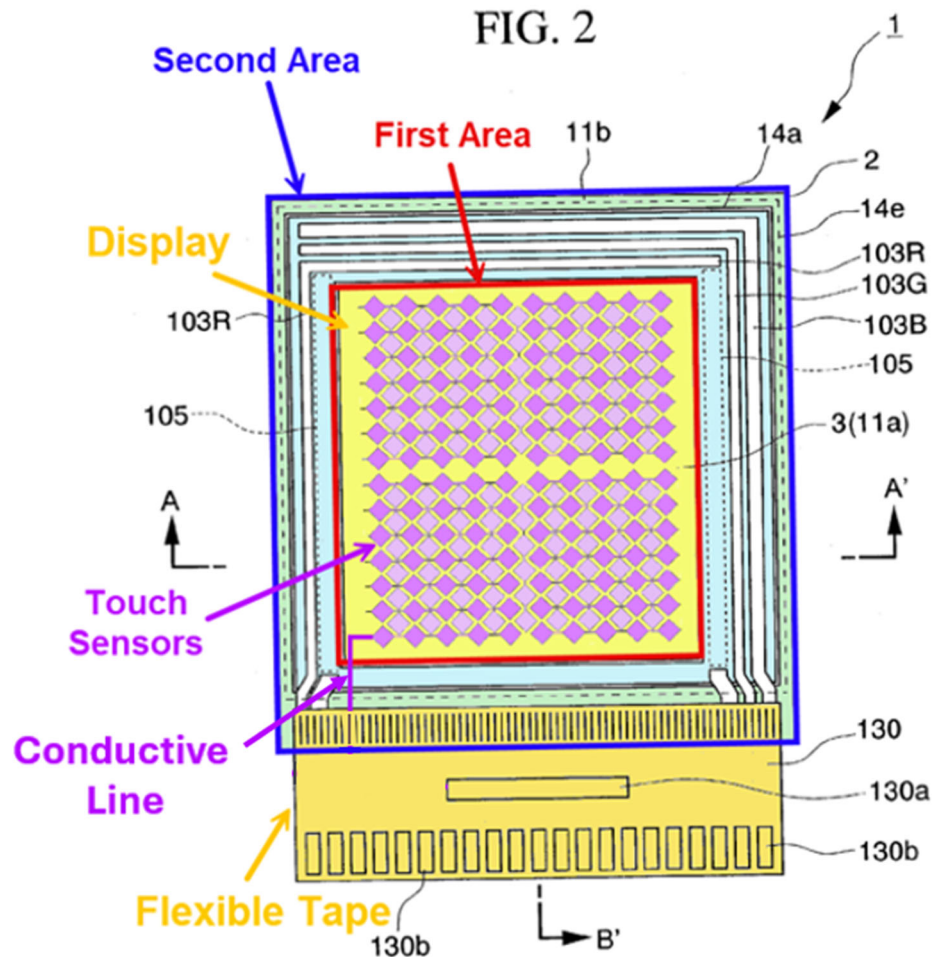
311. Imamura shows a display device with a first display area (3) and adjacent second areas containing non-display circuitry as I explained in §X.C.2.b (1[a]):



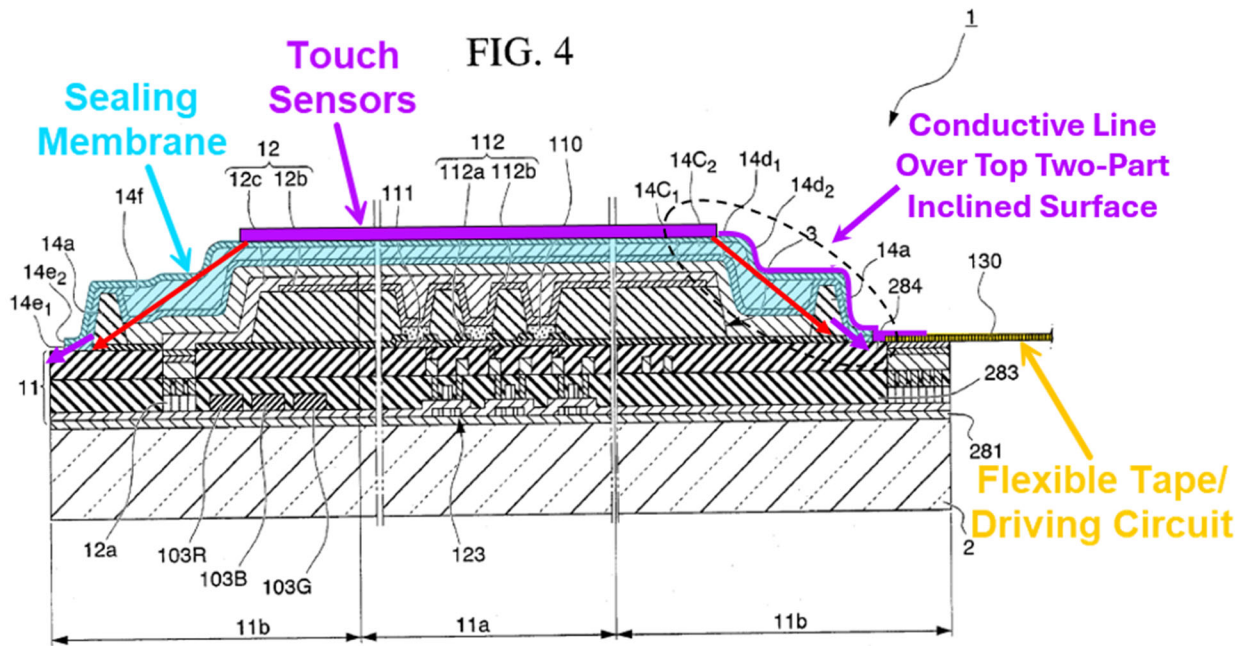
Imamura, Fig. 2 (annotated).

312. Upon integrating a touch-sensor panel such as Yang's on top of Imamura's display, a POSITA would have understood that because Imamura's sealing membrane encapsulates the OLED display, and the driving circuits are placed outside of the encapsulated OLED display area, the touch panel's conductive wires would need to traverse from the first (display) area to the second (off-display) area—including over the inclined surface of Imamura's sealing membrane—where the driving circuit is located in the second area as I explained in §§X.C.2.e-X.C.2.g

(1[d]-1[f]). A POSITA would have understood the following example of the Imamura-Yang combination showing Yang's touch-sensor electrodes placed in Imamura's display area with conductive lines leaving that area to connect to an off-display driving circuit:



Imamura, Fig. 2 (annotated).



Id., Fig. 4 (annotated).

313. Accordingly, a POSITA would have understood that the combination would produce conductive lines (“sensing lines”) that are formed over the top surface of Imamura’s sealing membrane in the first (display) portion and formed over the substrate in the second (non-display) portion, along Imamura’s two-part inclined sealing membrane surface to the second (non-display) area to connect the conductive lines to conductive wires that serve as a conductive interface to and from the driving circuit. *See* §VI.

- l. 1[k]: wherein the sensing cells include a plurality of first sensing cells connected along a first direction by first connection patterns and a plurality of second sensing cells connected along a second direction by second connection patterns, and**

314. In my opinion, Imamura in view of Yang teaches 1[k].

315. Although Imamura does not explain a touch-sensor panel on the display, a POSITA would have been motivated to add a touch-sensor panel to Imamura's display as discussed above. §X.C.1.d (motivation). To that end, Yang discloses each set of electrodes are connected by first and second connection patterns (e.g., 310) to connect sets of electrodes in two directions. *See, e.g., Yang*, ¶¶34, 35, Figs. 3-6c.

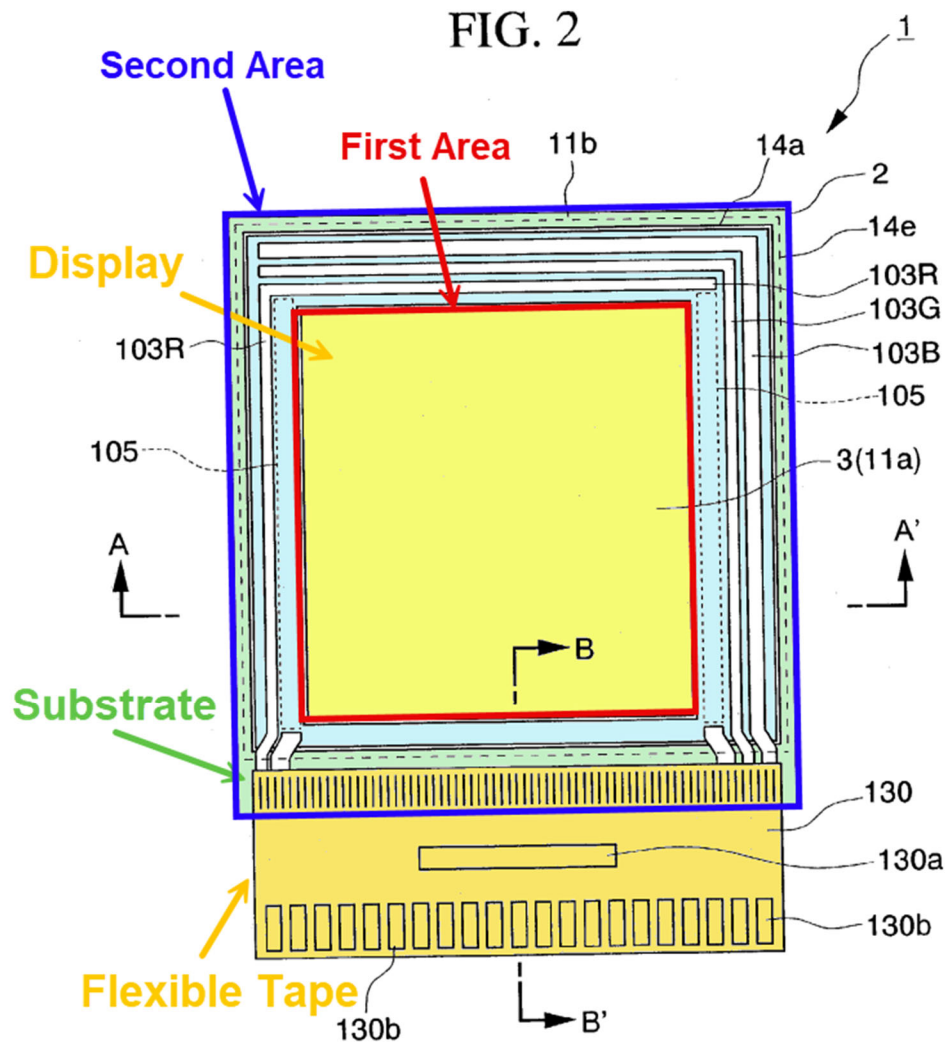
- m. 1[l]: wherein the insulating layer is interposed between the first connection patterns and the second connection patterns.**

316. In my opinion, Imamura in view of Yang teaches 1[l] for the same reasons I explained in 1[g]. §X.C.2.h (1[g]).

- 3. Claim 2: The display according to claim 1, wherein the first portion is located on the sealing thin film and the second portion is located on the second area of the substrate, and wherein first portions of the sensing lines are located on a same layer.**

317. In my opinion, Imamura in view of Yang and Sakamoto teaches this additional limitation.

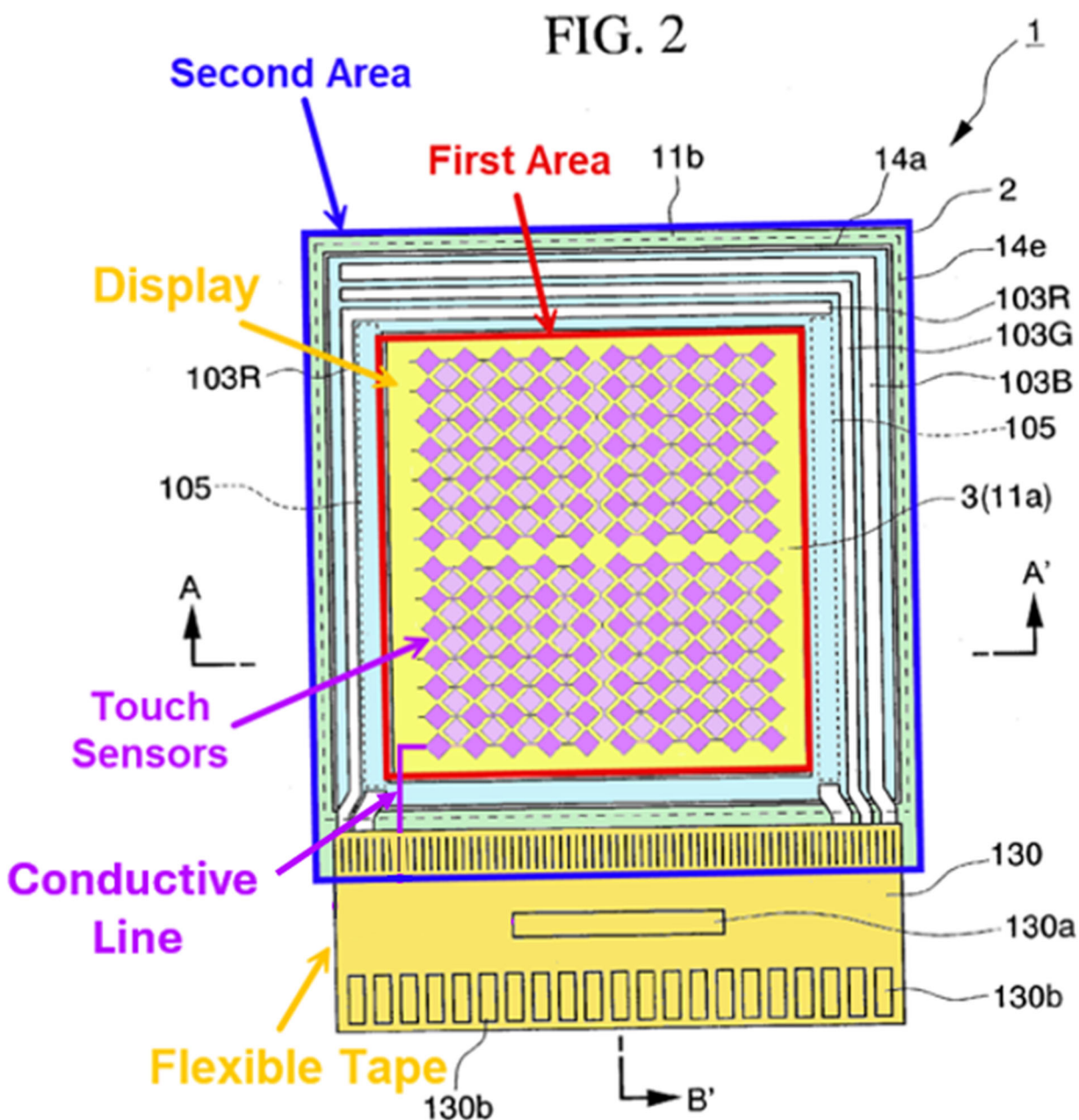
318. Imamura discloses a first (display) area and a second (non-display) area as I explained in §X.C.2.b (1[a]).



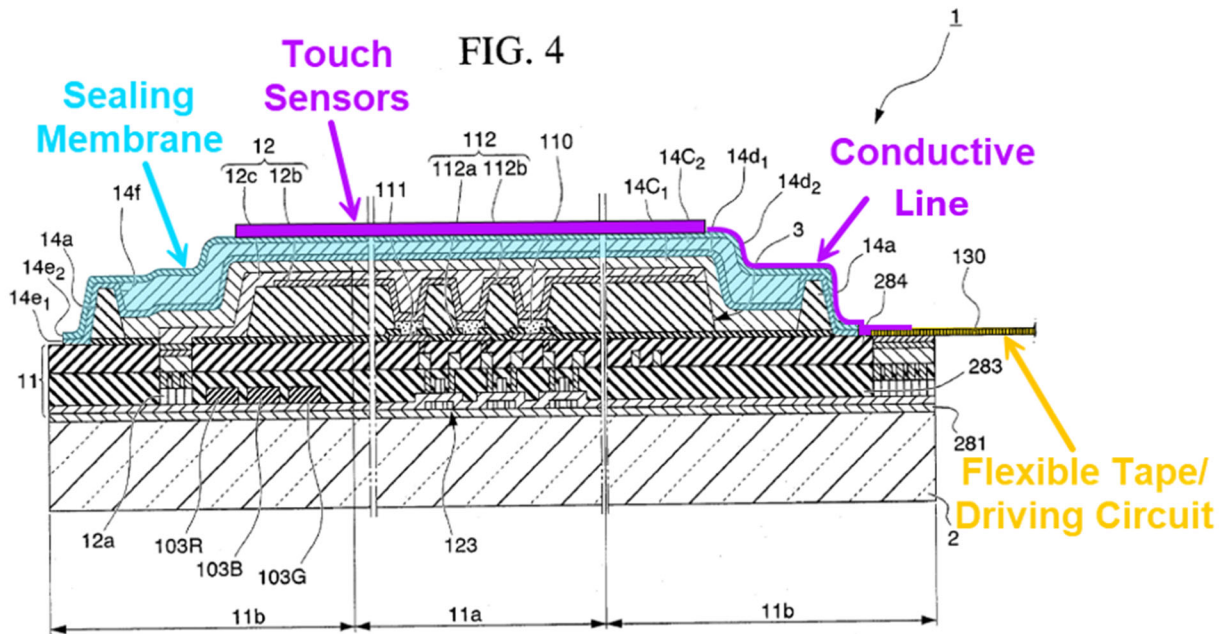
Imamura, Fig. 2 (annotated).

319. And Imamura combined with Yang teach or suggest conductive lines for the touch-sensor panel that have a first portion formed on Imamura's sealing

membrane in the first area, and a second portion that traverses Imamura's sealing membrane edge and substrate to connect to a driving circuit in the second area as I explained in §X.C.2.j (1[i]).



Imamura, Fig. 2 (annotated).



Id., Fig. 4 (annotated).

320. Accordingly, *Imamura* combined with *Yang* teach or suggest the first portion of the conductive lines is located on *Imamura*'s sealing membrane and a second portion is located on the second area of *Imamura*'s substrate, and wherein first portions of the sensing lines are located on a same layer (e.g., *Imamura*'s sealing membrane layer, before being connected to the touch sensors on their own respective layers).

321. To the extent this limitation requires *all* first portions to be on the same layer, however, such an arrangement would have been obvious. *See, e.g.*, U.S. Publication 2010/0214247 (Ex-1040) to Tang, et al. ("*Tang*"), ¶3 ("This invention

relates to a capacitive touch panel, more particularly to a capacitive touch panel including a patterned conductive layer having two dimensionally arranged first and second electrodes and first and second conductive lines which are formed directly on the **same surface of a substrate**”) (emphasis added). Specifically, it was extremely old and well-known in the art that capacitive touch-sensor panels conventionally use two sets of touch-pad arrays—one for each (x, y) direction—that are electrically insulated from one another. Yang discloses one way to form the two touch-sensor arrays: one set of touch sensor pads and their connections in one direction are formed on one layer, and touch sensor pads and their connections to create an array in a different direction are formed on another layer, with the two layers separated by insulation. *See, e.g., Yang*, Fig. 3 (showing electrode layers 300 and 500 provided as separate layers, each oriented in a specific direction). But an alternative arrangement was just as well-known in the art, in which all touch sensor pads are formed on the same layer, with “bridge” connections where the arrays would otherwise intersect, with insulation covering at least where the bridge is formed. *See, e.g., Chen*, Figs. 4A, 4B, 7:56-8:38; *Jang*, Fig. 3E; *Chih-Yung*, Figs. 2F, 3, 4.

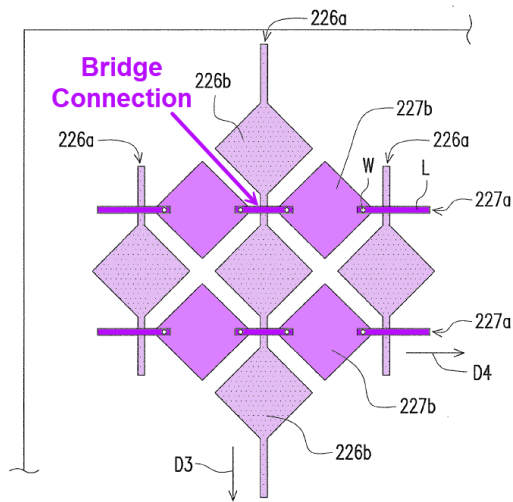


FIG. 4B

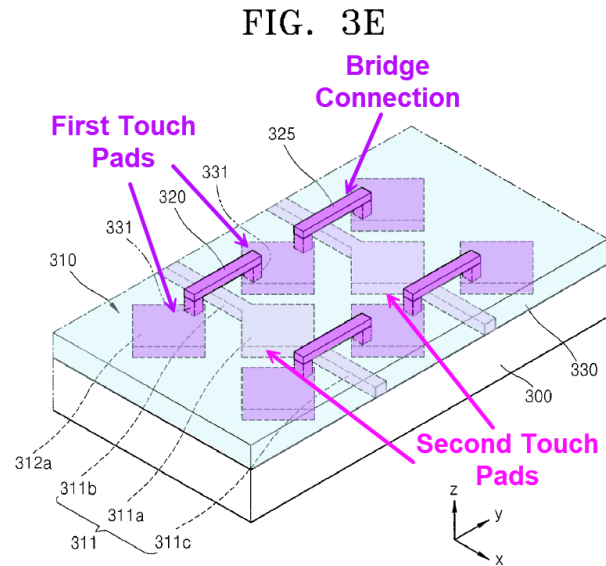


FIG. 3E

Chen, Figs. 4B; *Jang* Fig. 3E (annotated).

322. A POSITA would have considered forming Yang's touch sensors using either configuration as an obvious design choice. But when forming all touch electrodes on a single layer, with one set of touch sensor pads connected using a bridge, a POSITA would have appreciated that *all* "first portions" of Yang's conductive lines would be on the same layer to connect to each set of electrodes.

4. Claim 3: The display according to claim 2, wherein second portions of the sensing lines are located on a different layer from the first portions of the sensing lines.

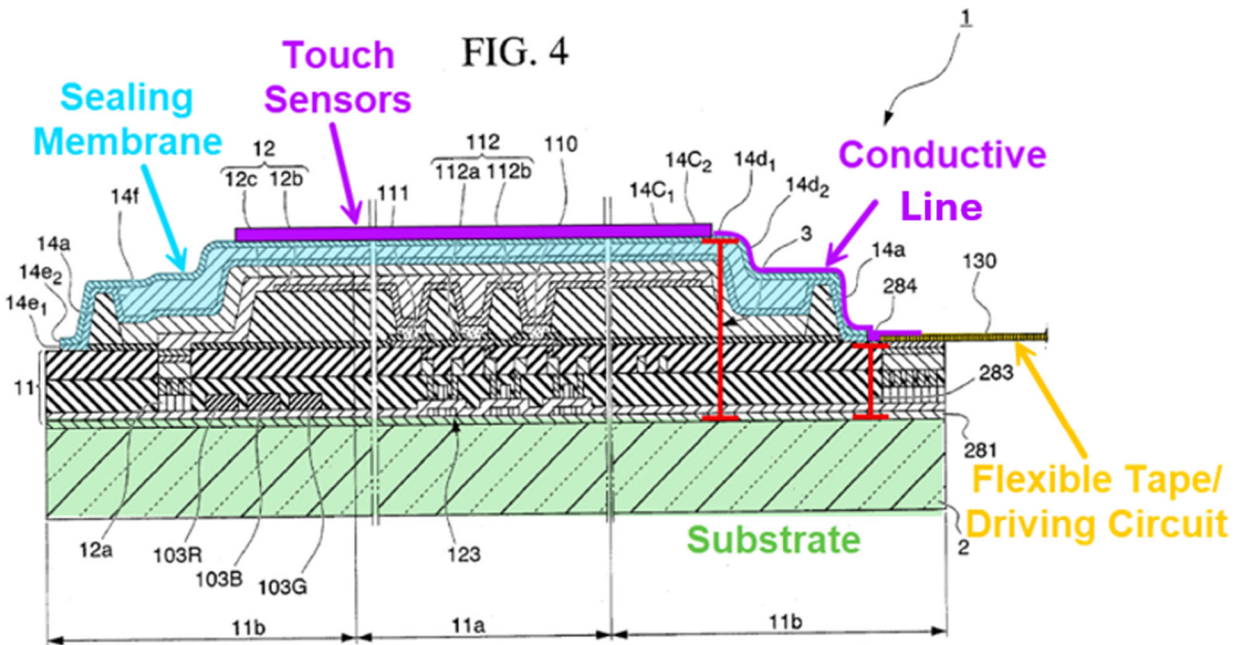
323. In my opinion, Imamura combined with Yang teaches or suggests this additional limitation for the same reasons as I explained above in §§X.C.2.f (1[e]),

X.C.2.k (1[j]) (explaining first portion provided on Imamura’s sealing membrane and second portion above the (lower) substrate (2)).

5. Claim 4: The display according to claim 1, wherein a first distance between first portions of the sensing lines and the substrate is greater than a second distance between second portions of the sensing lines and the substrate.

324. In my opinion, Imamura combined with Yang teaches or suggests this additional limitation.

325. Because the combination of Imamura and Yang produce “first portions” of the conductive lines located on Imamura’s sealing membrane to connect to the touch sensors formed on or above that layer, but “second portions” are provided on or near the substrate (§X.C.2.f (1[e])), a POSITA would have understood that the combination produces first portions of the conductive lines at a first distance from the substrate that is greater than the distance between the second portions of the conductive lines and the substrate.



Imamura, Fig. 4 (annotated).

6. **Claim 5: The display according to claim 1, wherein the sensing lines are electrically connected to the driving circuit through wiring lines.**

326. In my opinion, *Imamura* in view of *Yang* teaches this additional limitation for the same reasons as I explained above in §X.C.2.g (1[f]).

7. **Claim 6: The display according to claim 1, wherein the sensing lines include a different material from the sensing cells.**

327. In my opinion, *Imamura* in view of *Yang* and *Sakamoto* teaches claim 6.

328. Although *Yang* does not expressly explain the materials used for the conductive wires and touch electrodes, a POSITA would have understood that they

could be different materials. Specifically, Yang's electrodes were intended to cover a display region of the display (*Yang*, ¶33, Figs. 2, 3), which would have informed a POSITA that they were likely transparent conductive materials (such as ITO or IZO), which were extremely old and well-known electrode materials for touch panels. *See also, e.g., Chen*, 6:15-40; *Barbier*, ¶3; *Bouten*, 3:30-41. Yang refers to "conducting wires" for the sensing lines (*see, e.g., Yang* ¶42), which a POSITA would have understood refers to a metal wire material. A POSITA would have understood that metal wires were often used for connections because they provided far less electrical resistance than transparent conductive materials (like ITO and IZO), and thus could be made to have a smaller cross-sectional area when, e.g., forty or more connections are required in the border area surrounding a touch panel display. *Barrett*, pp. 3-5. Mobile device applications like smartphone with small screens require narrow borders to maximize the size of the screen in smaller implementations, and is therefore ripe for fine line silver printing at only 50-100 microns wide. *Id.*

329. Moreover, the selection of particular materials was an obvious design choice because most touch panels used similar materials: a cover glass, optical bonding adhesive, indium tin oxide (ITO), and glass subject to variations provided

unique applications and user needs. *Id.*, 4-6 (describing iPhone materials); *see also* U.S. Publication 2010/0182250A1 to Kang, et al. (Ex-1039), Figs. 2-3, ¶¶16, 18, 75.

8. Claim 7: The display according to claim 1, wherein the driving circuit is located on the second area of the substrate.

330. In my opinion, Imamura in view of Yang teaches this additional limitation.

331. Imamura teaches a “drive circuit” for the display located on flexible tape 130. *Imamura*, ¶¶196, 208. A POSITA would have understood that, upon integrating Yang’s touch panel with Imamura’s display, either two different “back-end” driving circuits would be provided (one for the display panel, and one for the touch panel), or alternatively Imamura’s driving circuit and Yang’s “back-end” processor would be integrated to drive both the display and touch-sensor panels. §X.C.2.g (1[f]). In either case, a POSITA would have appreciated that the driving circuit driving Yang’s touch-sensor electrodes would be located on a second (non-display) area of the substrate—whether directly on Imamura’s substrate (2) or flexible tape (130) provided in the second (non-display) area on the substrate (2).

9. Claim 8: The display according to claim 7, further comprising a flexible printed circuit board (FPCB) attached to the second area of the substrate.

332. In my opinion, Imamura teaches or suggests this additional limitation.

334. Although Imamura does not expressly state that the “flexible tape” is a “printed circuit board,” a POSITA would have been motivated to form and had a reasonable expectation of success in forming Imamura’s “flexible tape” as a “printed circuit board” because Imamura’s flexible tape was intended to house interconnected electrical components, and printed circuit boards were known to provide means of printing circuit interconnections on a substrate housing electrical components. Indeed, others in the art used flexible printed circuit boards to house off-display touch-sensor components. *See, e.g., Hotelling*, ¶78.

10. Claim 9: The display according to claim 8, wherein the sensing lines are electrically connected to the driving circuit through the FPCB.

335. In my opinion, Imamura in view of Yang teach this additional limitation for the same reasons as I explained above in §§X.C.2.g (1[f]), X.C.9 (cl. 8).

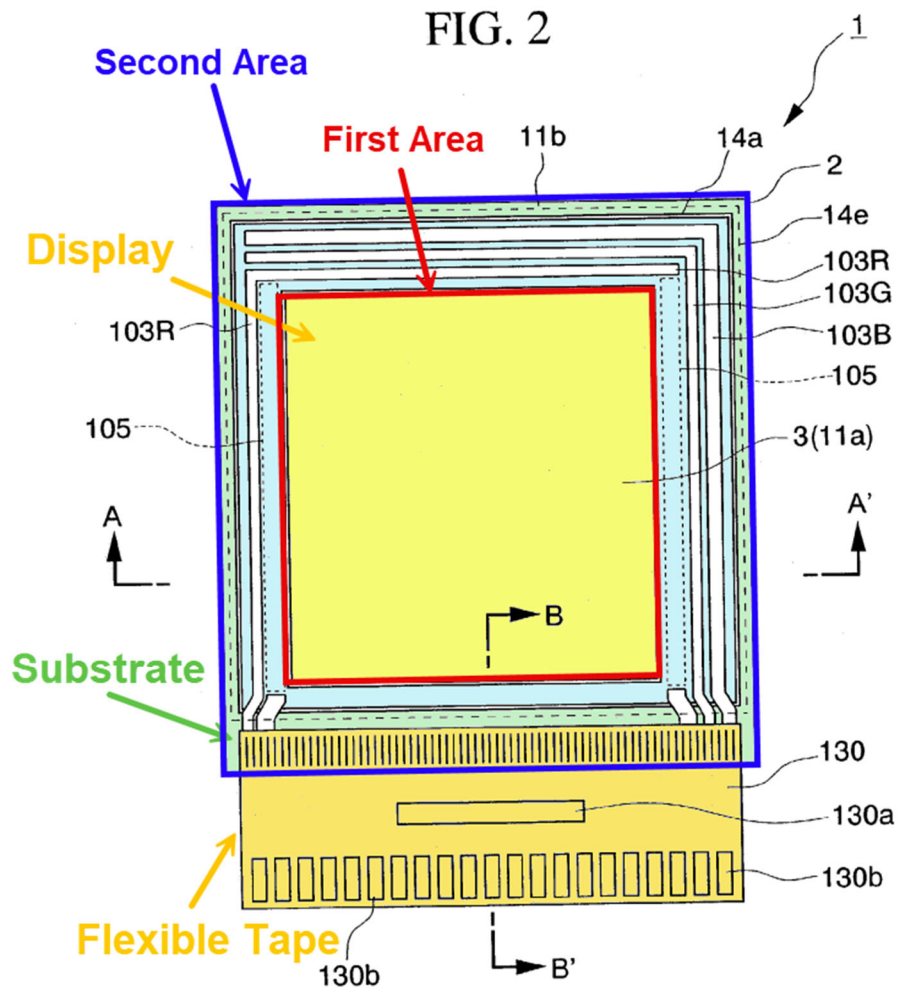
11. Claim 10: The display according to claim 1, wherein the sensing lines are arranged outside the pixel area.

336. In my opinion, Imamura in view of Yang teaches this additional limitation for the same reasons as I explained above in §§X.C.2.a (1[pre]), X.C.2.b (1[a], teaching a display pixel area), X.C.2.f (1[e]), X.C.2.k (1[i], teaching first, inclined, second sensing lines portions outside the display pixel area).

12. Claim 11: The display according to claim 1, wherein the first area has a greater area than the second area.

337. In my opinion, Imamura teaches or suggests this additional limitation.

338. Imamura depicts a first (display) that appears approximately of greater area size than the second (non-display) areas:



Imamura, Fig. 2 (annotated). Although a POSITA would have understood that *Imamura* is not drawn to scale, a POSITA would have understood that display areas

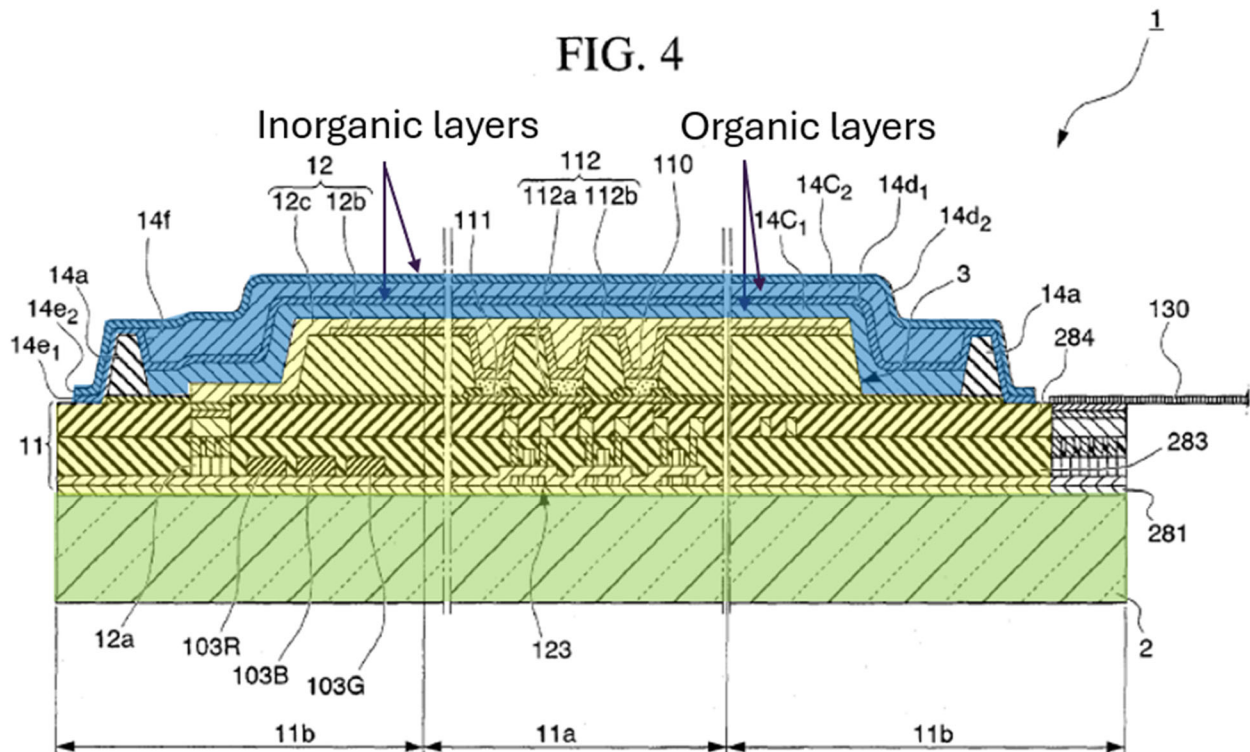
are typically much larger than the non-display areas in an OLED display. *See, e.g., Lee '560*, Figs. 1, 7. That is because a display area must be big enough to be viewable by a user, but non-display areas must only be big enough to house the wiring and processors needed to operate the display, which were known to be far smaller than the display itself. *See Sakamoto*, ¶¶2-5, which shows a wiring arrangement design to minimize frame width to “to increase the proportion of the display portion relative to the housing of an information display terminal.”

339. For these reasons, a POSITA would have understood that Chen’s first (display) area is greater than the second (non-display) area.

13. Claim 12: The display according to claim 1, wherein the sealing thin film includes at least one organic layer and at least one inorganic layer.

340. In my opinion, Imamura discloses or suggests this additional limitation.

341. Imamura discloses that the multilayered sealing membrane includes alternating flattening resin layers (e.g., 14c1-2) made of “polyacrylic resin”—an “organic layer,” as claimed. Barrier layers (e.g., 14d) are made of “an inorganic membrane such as SiO₂”:



Imamura, Fig. 4 (annotated), ¶¶114-15.

- 14. Claim 13: The display according to claim 1, wherein the first connection patterns are respectively patterned to have independent patterns in upper or lower layers of the first sensing cells so that the first connection patterns are electrically connected to the first sensing cells at upper or lower portions of the first sensing cells.**

342. In my opinion, *Imamura* in view of *Yang* and *Sakamoto* teaches claim 13.

343. Although *Yang* provides two sets of electrodes and their respective connection patterns on two different material layers, a POSITA would have considered it obvious to provide all electrodes on a single layer, and connect one set

of electrodes together using a bridge on a different material layer as I explained above in §X.C.3 (cl. 2). In doing so, a POSITA would have appreciated that the bridges (“first connection patterns,” as claimed) would be patterned independently from the Yang’s electrodes (350, 550) in an upper layer of the electrodes because the bridges would be formed on a separate material layer above Yang’s interstitial insulation layer (250).

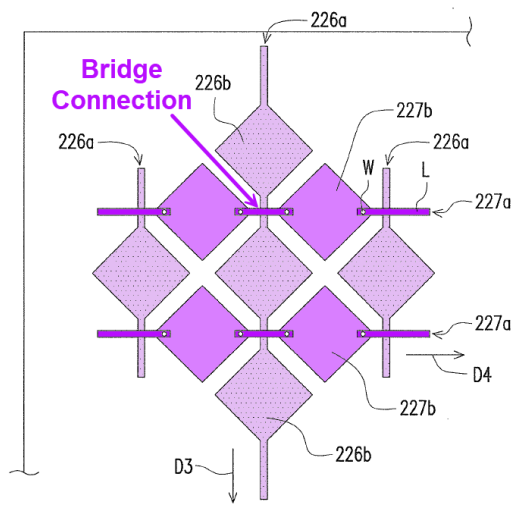
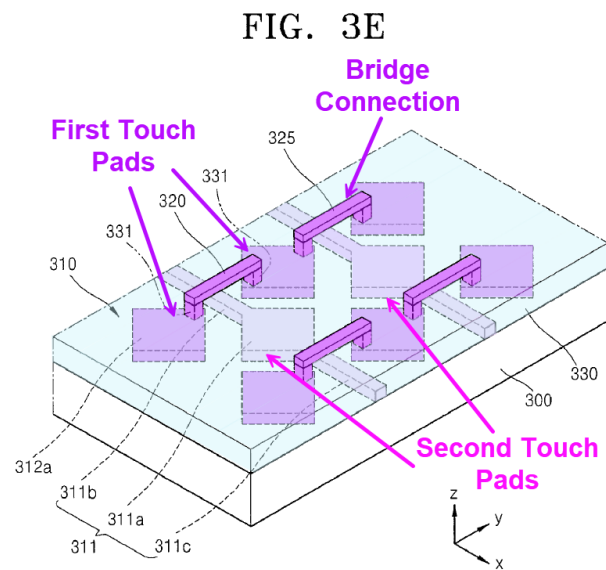


FIG. 4B



Chen, Figs. 4B; *Jang* Fig. 3E (annotated).

XI. SUMMARY AND ADDITIONAL REMARKS

344. It is my opinion that each of Grounds 1A-B and 2 renders the Challenged Claims unpatentable as obvious, as I explained in the paragraphs preceding.

345. I currently hold the opinions expressed in this declaration based on the information available to me at this time. I may, however, form additional or new opinions should additional information or insights be made available, or upon further consideration.