

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MANUFACTURING RESOURCES INTERNATIONAL, INC.,

Petitioner

v.

SAMSUNG ELECTRONICS CO., LTD.,

Patent Owner

U.S. Patent No. 8,842,253

Filing Date: February 28, 2013

Issue Date: September 23, 2014

Title: Liquid Crystal Display Device Having Air Conditioner

U.S. Patent No. 8,223,311

Filing Date: June 5, 2009

Issue Date: July 17, 2012

Title: Liquid Crystal Display Device Including Airflow Channel

DECLARATION OF DR. CARL D. MEINHART

IN SUPPORT OF

PETITION FOR *INTER PARTES* REVIEW

Case Nos.: IPR2023-01202, IPR2023-01203

TABLE OF CONTENTS

I.	Introduction.....	4
A.	Engagement.....	4
II.	Materials Considered.....	7
III.	Applicable Legal Standards.....	8
A.	A Person of Ordinary Skill in the Art	8
B.	Prior Art.....	10
C.	Obviousness.....	10
IV.	Overview of the Challenged Patents	12
V.	Claim Construction.....	14
VI.	Overview of Certain Prior Art References	14
A.	Nagayama – Japanese Patent Publication JP2006-163217A (Exhibits 1005-1006).....	14
B.	Karppanen – WO 2007/116125 (Exhibit 1008).....	15
C.	Gromatzky – U.S. Patent No. 6,493,440 (Exhibit 1007)	16
D.	Matsuoka – U.S. Patent No. 6,104,451 (Exhibit 1009)	17
E.	Utsunomiya – WO 2008/050660 (Exhibit 1010).....	18
F.	Burke – U.S. Patent No. 6,825,828 (Exhibit 1011)	19
G.	Hannemann – German Utility Model DE 202007000047 (Exs. 1012-1013)	20
VII.	Summary of Grounds.....	21
VIII.	Motivations to Combine	21
A.	Nagayama and Gromatzky	25
B.	Nagayama and Gromatzky with Matsuoka	27
C.	Nagayama, Gromatzky, and Matsuoka with Utsunomiya	30
D.	Karppanen and Gromatzky.....	32
E.	Karppanen with Utsunomiya or Karppanen with Gromatzky and Utsunomiya.....	34

IX.	'253 Patent – Nagayama Grounds	37
A.	Claims 1-2, 4-12, and 14-20	37
X.	'253 Patent – Karppanen Grounds.....	69
A.	Claims 1-2, 4-12, and 14-20	69
XI.	'311 Patent – Nagayama Grounds	102
A.	Claims 1-7 and 9-13	102
XII.	'311 Patent – Karppanen Grounds.....	133
A.	Claims 1-7 and 9-13	133
XIII.	Conclusion	164

I, Carl D. Meinhart, Ph.D., declare as follows:

I. Introduction.

1. My name is Carl Meinhart. I am a Professor of Mechanical Engineering at the University of California – Santa Barbara (“UCSB”) and have been employed there as a professor, associate professor, or assistant professor since 1996. Among other things, I have been teaching undergraduate courses on fluid mechanics and thermodynamics as well as graduate courses on microscale flow transport phenomena. I have served as an advisor to dozens of graduate and post-doctoral students from the late-1990s through today.

A. Engagement

2. I have been retained by Petitioner Manufacturing Resources International, Inc. (“MRI” or “Petitioner”) to provide my expert opinions in this declaration with respect to the *inter partes* review (“IPR”) that has been instituted before the United States Patent and Trademark Office (“USPTO”). My declaration sets forth my expert opinions based on my expert knowledge related to the technology of U.S. Patent Nos. 8,842,253 (the “253 Patent”) which is titled “Liquid Crystal Display Device Having Air Conditioner,” and 8,223,311 the (“311 Patent”), which is titled “Liquid Crystal Display Device Including Airflow Channel.”

3. Petitioner has asked me to provide my independent analysis and assessment of the validity of the '253 Patent and the '311 Patent (the "Challenged Patents").

4. Petitioner is paying a rate of \$825 per hour for my consulting services, with a small portion of that amount paid to the search service I am contracted to, including for my work in the preparation of this Declaration. I have no stake in either of the parties or in the outcome of this matter.

5. In forming my opinions, I have relied on my knowledge and experience in the design of electronic cooling systems using knowledge in the fields of fluid mechanics and heat transfer. For purposes of my analysis, I considered the validity based upon the knowledge of a person of ordinary skill in the art as I discuss below. My educational background, career history, publications, and other relevant qualifications are set forth in my curriculum vitae, appended as Exhibit 1004 hereto.

6. In addition to my academic appointments, I served as a Summer Faculty Fellow for NASA Johnson Space Center and previously was a research scientist at Ford Motor Company. I served as the Chief Technology Officer at SpectraFluidics Inc., and was a Co-Founder of Pi-MEMS, Inc. and a Founder of Ti-MEMS, Inc. I currently serve as the Chief Executive Officer of Numerical Design, Inc. I have also previously served as an industry consultant and expert

witness, including on the subjects of fluid diagnostic instrumentation, heat transfer, microfluidic designs, DNA sequencing, medical devices, and MEMS-based oscillators. In addition, I also have 23 years of experience in using COMSOL Multiphysics simulations, and for the past 11 years, I have been a COMSOL Certified Consultant.

7. My research interests include micro-resolution particle image velocimetry for micro-scale flow, enhancing immunoassays and stem cell culturing techniques, Ti-based thermal ground planes for cooling IC chips, and developing free surface fluidics using surface-enhanced Raman spectroscopy for trace chemical detection.

8. My graduate education includes an M.S. in Theoretical and Applied Mechanics, and Ph.D. in Theoretical and Applied Mechanics from the University of Illinois at Urbana-Champaign in 1991 and 1994.

9. Over the years I have been an invited or keynote speaker or seminar presenter at many national and international conferences, including on the topics of microfluidic devices, flow, imaging, velocimetry, BioMEMS & biomedical Nanotech, Nanomedicine, Biological Diagnostics, Micro and NanoTechnology, miniaturization of analytical instruments and micro-systems, Lab on a Chip.

10. I am listed as an inventor or co-inventor on more than 18 issued United States patents and I am the author or co-author of well over 150 scientific

publications and conference papers. My work has been published in many journals, including The Proceedings of the National Academy of Sciences; The Journal of Biomedical Microdevices; Biomicrofluidics; Lab on a Chip; Micro and Nanofluidics; The Journal of Physical Chemistry, Analytical Chemistry; Nanomedicine: Nanotechnology, Biology and Medicine; Nanoscale; Journal of Colloid and Interfacial Science; Analyst; Electrochimica Acta; ACS Applied Material Interfaces; Material Research Letters; Physics Review of Fluids; Journal of Fluid Mechanics; Journal of Fluids Engineering; ACS Nano; Physics of Fluids; Journal of Chromatography A; Langmuir; Journal of Nanophotonics; Journal of Heat Transfer; Journal of Physics; Annual Review of Fluid Mechanics; and Experiments in Fluids.

11. I have served as a reviewer and/or referee for many publications, including The Proceedings of the National Academy of Science, The Journal of Fluid Mechanics, Experiments in Fluids, ASME Journal of Fluids Engineering, among others. I am currently a founding associate editor of the journal FLOW.

12. I have worked in the field fluid mechanics and transport for over 33 years, including conducting research and authoring numerous publications.

II. Materials Considered

13. In preparing this declaration, I reviewed the Challenged Patents and the prosecution history of each. I also considered various other materials that I

have cited in my declaration, such as websites. I also considered the materials listed in the table below, which I used in conjunction with my experience and qualifications to consider the various grounds of invalidity presented in the Petition and to form my opinions on the matters as is set forth herein.

Exhibit or Paper No.	Document Description
1005	JP2006-163217A to Nagayama (“Nagayama”)
1006	Certified Translation of Nagayama
1007	U.S. 6,493,440 to Gromatzky (“Gromatzky”)
1008	WO 2007/116125 to Karppanen (“Karppanen”)
1009	U.S. 6,104,451 to Matsuoka, et al. (“Matsuoka”)
1010	WO 2008/050660A2 to Utsunomiya (“Utsunomiya”)
1011	U.S. Patent No. 6,825,828 to Burke, et al. (“Burke”)
1012	German Utility Model DE 20 2007 000 047 U1 to Hannemann (“Hannemann”)
1013	Certified Translation of Hannemann

III. Applicable Legal Standards

A. A Person of Ordinary Skill in the Art

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

15. Upon consideration, in my opinion, a person of ordinary skill in the art of the Challenged Patents is someone with at least Bachelor of Science degree in mechanical engineering, electrical engineering, or a similar degree with one or two years of graduate school training or one to two years of industry experience in the fields of mechanical design, fluid mechanics, heat transfer, or electronics cooling.

16. Lack of work experience could have been remedied by additional education, and vice versa. Such academic and industry experience would be necessary to appreciate what was obvious and/or anticipated in the industry and what a POSITA would have thought and understood at the time.

17. The earliest priority date given on the face of the '253 Patent and '311 Patent is June 5, 2009; however, I understand that the Patent Owner has asserted an earlier priority date of April 22, 2008. For purposes of my analysis below, I am assuming that the earliest priority date for both the Challenged Patents is April 22, 2008; however, I am providing no opinion as to whether Patent Owner is entitled to a priority date earlier than the June 5, 2009 date listed on the face of the Challenged Patents.

18. As of the relevant time frame for the Challenged Patents, I possessed at least such experience and knowledge of a POSITA; hence, I am qualified to opine as to the validity of the Challenged Patents.

B. Prior Art

19. It is my understanding that each of the references cited in the Petitions are prior art to the Challenged Patents.

C. Obviousness

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

- a. combination that unites that unites old elements with no change in their respective functions is unpatentable. As a result, the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results,
- b. a predictable variation of a work in the same or a different field of endeavor is likely obvious if a person of ordinary skill would be able to implement the variation,
- c. an invention is obvious if it is the use of a known technique to improve a similar device in the same way, unless the actual application of the technique would have been beyond the skill of the person of ordinary skill in the art. In this case, a key inquiry is whether the improvement is more than the predictable use of prior art elements according to their established functions,
- d. an invention is obvious if there existed at the time of invention a known problem for which there was an obvious solution encompassed by the patent's claims,
- e. inventions that were "obvious to try" — chosen from a finite number of identified, predictable solutions, with a reasonable expectation of success — are likely obvious,

- f. known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art, and
- g. an explicit teaching, suggestion, or motivation in the art to combine references, while not a requirement for a finding of obviousness, remains “a helpful insight” upon which a finding of obviousness may be based.

IV. Overview of the Challenged Patents

21. The Challenged Patents have essentially the same disclosure and so my overview here is made with respect to the '311 Patent; however, the overview is applicable to both.

22. The '311 Patent relates to “a liquid crystal display device with a heat dissipation structure to cool the liquid panel of the device.” '311 Patent, 1:16-19. The patent discloses an LCD panel within a housing. '311 Patent, 4:53-64. The gaps between the LCD panel and front, top, and rear of the housing form three respective channels. '311 Patent, 5:17-33. The first channel is defined by the space between a front protection panel and the LCD. '311 Patent, 5:17-23. A second channel is defined between the LCD assembly and the top of the housing. '311 Patent, 5:25-27. A third channel is defined between the LCD assembly and the rear

of the housing. '311 Patent, 5:27-29. A fan blows air through the channels, with cool air entering below the LCD screen at the base, passing over the front, top, and then rear of the LCD assembly. '311 Patent, 5:42-59, Fig. 2. Though these three channels are described as discrete channels, no physical barrier is disclosed described to physically delineate clear boundaries between the first, second, and third channels, which form a continuous passageway for air around the LCD assembly. '311 Patent Fig. 2.

23. To provide cooling, the '311 patent explains that the air flow rate of the cooling fan may be responsive to a temperature sensor measurement of the air emerging from the channel. '311 Patent, 9:38-48. A flow rate controller may be configured to control the cooling fan according to the temperature reading. '311 Patent, 8:60-65. The sensor is described alternately as measuring air "having passed through the channel," '311 Patent, 3:1-4, and measuring the air "having passed through the first channel," '311 Patent, 3:30-34.

24. The air flow within the channel may also be turbulent, rather than laminar, which is said to promote heat removal, supposedly by better mixing of boundary layers. '311 Patent, 6:30-38. Turbulence may be achieved by maintaining a minimum flow velocity within the air channel. '311 Patent, 9:27-37. The '311 patent describes a front channel width of 5 to 25 mm as particularly desirable. '311

Patent, 10:14-18. This range is said to balance the requirements for airflow rate, pressure differential, and turbulence. '311 Patent, 7:17-26.

V. Claim Construction

25. I have been informed and understand that in an *inter partes* review claim terms are construed according to their ordinary and customary meaning as understood by one of ordinary skill in the art in view of the specification and the prosecution history of the patent. As explained in further detail below, under any reasonable construction, the claims are obvious in view of the prior art I address herein. Thus, I do not separately offer an opinion with respect to the proper construction of the terms of the claims of the Challenged Patents.

VI. Overview of Certain Prior Art References

26. In preparing my declaration, I have reviewed each of the prior art references cited above in the references considered. I include here a brief overview of each of the Nagayama, Gromatzky, Karppanen, Matsuoka, Ustunomiya, Burke, and Hannemann references before proceeding with my opinions as to why claims 1, 2, 4-12, and 14-20 of the '253 Patent and claims 1-7 and 9-13 of the '311 Patent are each invalid in view of the prior art.

A. Nagayama – Japanese Patent Publication JP2006-163217A (Exhibits 1005-1006)

27. Nagayama describes “an outdoor display device using a flat panel type display device as a display section.” Ex. 1006, ¶ 1. The application discloses

an LCD panel that is contained within the device and is viewable through a front transparent plate. Ex. 1006, ¶¶ 6, 17. A gap is created between the LCD panel and a front transparent plate to provide a channel for air flow. Ex. 1006, ¶ 20. Fans may be positioned in different locations, according to difference embodiments, to generate airflow through the front gap. 1006, ¶ 22. A dust filter may also be provided to clean the air. Ex. 1006, ¶ 39.

28. Nagayama also provides a temperature sensor attached to the rear of the LCD panel. Ex. 1006, ¶ 71. A fan or fans can be controlled by a temperature control board in response to the temperature readings of the sensor, such as by individually controlling a plurality of fans, or by controlling the rotational speed of one or more of the fans. Ex. 1006, ¶¶ 78-82, 84, 91-92, Figs. 11-12.

B. Karppanen – WO 2007/116125 (Exhibit 1008)

29. Karppanen discloses “an electronic information board comprising a frame, a flat display element, such as a TFT LCD display or plasma display, for displaying information, and electronic equipment for controlling the display element.” Ex. 1008, 3:16-18. Karppanen discloses an LCD display within a display casing. Ex. 1008, 3:16-25. The display casing includes a transparent front plate, an edge, and a back wall. Ex. 1008, 3:31-32. The display element is physically connected to the housing by support elements such there are air gaps between the display and the front and rear walls to allow airflow. Ex. 1008, 3:32-4:2. One or

more fans provide air circulation. Ex. 1008, 4:3-8. The airflow covers both the front and back of the display element for effective cooling. Ex. 1008, 4:9-10.

30. The display casing may be sealed to protect against the elements for outdoor use. Ex. 1008, 7:16-19. The display, electronic, and cooling components may also be placed in separate casings. Ex. 1008, 3:18-30. Transducers that measure the temperature, i.e., temperature sensors, may be placed in the device and display casings. Ex. 1008, 9:14-16. A control unit controls the circulating fans based on the measured temperature from the transducer(s). Ex. 1008, 9:16-18.

C. Gromatzky – U.S. Patent No. 6,493,440 (Exhibit 1007)

31. Gromatzky discloses a “thermal management system for a LCD display in a thin depth, environmentally-sealed enclosure.” Ex. 1007, 1:7-9. Gromatzky discloses an LCD display within a housing. Ex. 1007, 2:64-3:2. The front portion of the housing contains a transparent lens to allow the contained LCD display to be viewed. Ex. 1007, 3:10-12. Between the lens and LCD display is a space of 9.4 mm to allow air to be routed across the LCD module for thermal management. Ex. 1007, 4:39-45. Further air spaces are provided by gaps between the top and bottom of the LCD module and the enclosure. Ex. 1007, 4:45-48. A fan is provided to circulate air through the airflow path around the LCD module. Ex. 1007, 4:52-59. Sources of external heat, such as sunlight, may also be dissipated. Ex. 1007, 3:34-38.

32. Gromatzky describes that either laminar flow or turbulent flow may be used within the gap. Ex. 1007, 5:4-18. A laminar flow fan is said to permit a more compact configuration. Ex. 1007, 5:9-13. But Gromatzky also discloses that “the present invention may use any type of fan 32, including those that generate turbulent air.” Ex. 1007, 5:15-18.

D. Matsuoka – U.S. Patent No. 6,104,451 (Exhibit 1009)

33. Matsuoka relates to a “thin display unit such as a liquid-crystal display.” Ex. 1009, 1:5-9. The invention is directed to improving LCD display units for improved structural strength, cooling, and radio frequency shielding. Ex. 1009, 1:31-62. Matsuoka discloses an LCD within a housing. Ex. 1009, 8:62-9:1. The interior of the housing is divided into several different sections. For example, Matsuoka includes a “first unit-storing section 210a” positioned below two other portions of the housing, including the second and third “unit-storing sections” 220a, 230a. Ex. 1009, 3:38-4:7, Fig. 1. Matsuoka designates “second unit-storing section 220a” within the second enclosure for storing the liquid-crystal unit. Ex. 1009, 3:66-4:2. A space is reserved between the back of the liquid-crystal unit and a back enclosure plane, leaving room for electronics, wiring, and a route for heat dissipation. Ex. 1009, 5:13-23.

34. An aperture is provided near the top of the LCD unit-storing section. Ex. 1009, 5:24-26. Matsuoka discloses that the air gap around the section formed

by fixing ribs allows heat removal to occur with a free convection chimney effect. Ex. 1009, 5:26-33. Alternatively, a blower can also create forced convection for improved heat removal effectiveness. Ex. 1009, 5:33-36.

E. Utsunomiya – WO 2008/050660 (Exhibit 1010)

35. Utsunomiya relates to “an apparatus for cooling a heat generating spot (area) of an electronic device . . . and a liquid-crystal projector apparatus which includes the apparatus for cooling a heat generating spot of an electronic device.” Ex. 1010, 1:8-14. Utsunomiya provides several liquid crystal panels to modulate red, green, and blue color channels in a projector. Ex. 1010, 2:1-7. Each panel receives colored light split from a white light lamp. Ex. 1010, 2:1-7. Polarizer plates absorb much of this illumination, generating significant heat. Ex. 1010, 4:19-24.

36. Utsunomiya discloses embodiments for creating enhanced cooling flows by adding an additional cooling fan. Ex. 1010, 17:11-16. An air gap is provided on each side of a liquid crystal panel between the panel and an input and output polarizer plate. Ex. 1010, Fig. 13. The output flow of the two fans is directed to each air gap, colliding near the center and diverging outwards towards the panel and polarizer surfaces. Ex. 1010, Fig. 13, 17:21-18:13. Image light from the liquid crystal panel travels through the region of airflow. Ex. 1010, Fig. 13.

37. Utsunomiya also provides details regarding cooling parameters for LCD panels. In particular it describes the relationship between air flow speed and LCD panel temperature under certain environmental conditions.

F. Burke – U.S. Patent No. 6,825,828 (Exhibit 1011)

38. Burke describes a “backlit liquid crystal display (LCD) monitor comprising a backlight assembly, a cooling assembly, a rear cover assembly and a controller.” Ex. 1011, Abstract. Its “controller monitors temperature and controls cooling accordingly.” Ex. 1011, Abstract. To cool the LCD monitor, Burke uses a cooling assembly that includes “a light sensor on the top surface of the cooling assembly and the light sensor has an axis that is perpendicular to the bulb axes of the fluorescent bulbs, a temperature sensor, a heat sink on the bottom surface of the cooling assembly, and an air inlet and an air outlet in fluid communication with the closed air space and positioned for causing air to flow across the bulbs.” Ex. 1011, 1:43-49.

39. Burke also discloses that its device may use multiple temperature sensors and that the temperature sensors may be positioned at different locations within the LCD monitor, such as “one temperature sensor 502 may monitor the temperature in the electronics chamber and another temperature sensor 502 may monitor ambient temperature in the closed air space, or backlight chamber, between the backlight assembly 100 and the cooling assembly 300.” Ex. 1011,

6:24-37. The temperature information from the temperature sensors is then used by a controller, which controls fan speeds based on the temperature sensed by the temperature sensors. Ex. “1011, 6:38-45.

G. Hannemann – German Utility Model DE 202007000047 (Exs. 1012-1013)

40. Hannemann describes a “flatscreen with an LCD matrix that is arranged between a glass plate and a flat illumination device, respectively by maintaining an air gap.” Ex. 1013, ¶ 2. Its device is designed to be used to display information “in particular at bright ambient light or direct incident light over a large temperature range, both in interior and in exterior applications” and that it “improves the ability to recognize the rendered visual information at high ambient light and in a large temperature range Ex. 1013, ¶¶ 6-8.

41. To accommodate the large temperature range, the display “has climate control devices that supply the volumetric flow channel with a cooling or heating medium.” Ex. 1013, ¶ 14. To monitor the temperature of the device, Hannemann uses “at least one temperature sensor that is advantageously arranged in the upper region of the display unit.” Ex. 1013, ¶ 19. However, Hannemann also discloses that “[t]he number of the temperature sensors and their physical location within the display unit can vary without modifying the spirit of the invention.” Ex. 1013, ¶ 19. The temperature sensors may then be used to “regulate the cooling or heating” of the device. Ex. 1013, ¶ 19.

VII. Summary of Grounds

42. In the following sections, I provide my detailed invalidity analysis for each of the Challenged Patents. The following table summarizes the claims I analyzed and the corresponding combination of references on which I relied:

Patent	Claim(s)	References
'253 Patent	1, 2, 4-7, 9-12, 14-20	Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA
'253 Patent	8, 19	Nagayama, Gromatzky, Matsuoka, Utsunomiya, and Knowledge of a POSITA
'253 Patent	1, 2, 4-7, 9, 11, 12, 14-17, 20	Karppanen and the knowledge of a POSITA
'253 Patent	8, 19	Karppanen, Utsunomiya and the knowledge of a POSITA
'253 Patent	10, 18	Karppanen, Gromatzky and the knowledge of a POSITA
'311 Patent	1-3, 5-7, 9, 11-13	Nagayama, Gromatzky, and the knowledge of a POSITA
'311 Patent	4, 10	Nagayama, Gromatzky, Utsunomiya and the knowledge of a POSITA
'311 Patent	1-3, 5-7, 9, 11-13	Karppanen, Gromatzky, and the knowledge of a POSITA
'311 Patent	13	Karppanen and the knowledge of a POSITA
'311 Patent	4, 10	Karppanen, Gromatzky, Utsunomiya and the knowledge of a POSITA

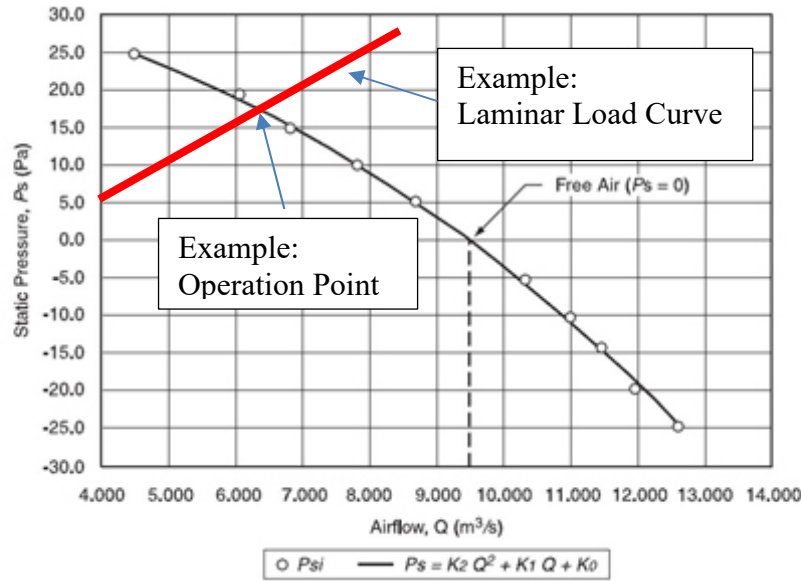
VIII. Motivations to Combine

43. In my analysis below, in some cases I rely on the combined teachings of multiple references to establish that a claim or a claim limitation is obvious. As I discussed above, I understand that to combine the teachings of multiple references, there must be some reason within the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art teachings to arrive at

the claimed invention. I have been informed that this is generally referred to as a “motivation to combine.” Because I believe there is a motivation to combine the prior art references I summarized above in the ways I do in my analysis below, I have provided the following sections to provide corresponding motivations.

44. In my expert opinion and using the knowledge of a POSITA, many of the claims recited in these two patents are merely ordinary design choices for electronic cooling systems that any POSITA working in this field would use when designing cooling systems for display devices such as those in the Challenged Patent. For example, the Challenged Patents both involve forcing air through a gap formed between a display panel and a plate. Designing such gaps is performed using standard engineering knowledge in the fields of fluid dynamics and heat transfer.

45. When designing electronic cooling systems that utilize a fan to propel air flow through a duct, such as a duct defined by two parallel plates, engineers often rely on fan curves supplied by fan manufactures. A typical fan curve is shown below (<https://www.axair-fans.co.uk/all-technical-information/read-fan-curves/>).



46. The fan curve shows that with a high static pressure resistance, the flowrate decreases. At a lower static pressure resistance, the flowrate increases. When the flow resistance from a chosen duct is overlaid on the fan curve (example is depicted in red), the intersection of the two curves provides the designed operating point.

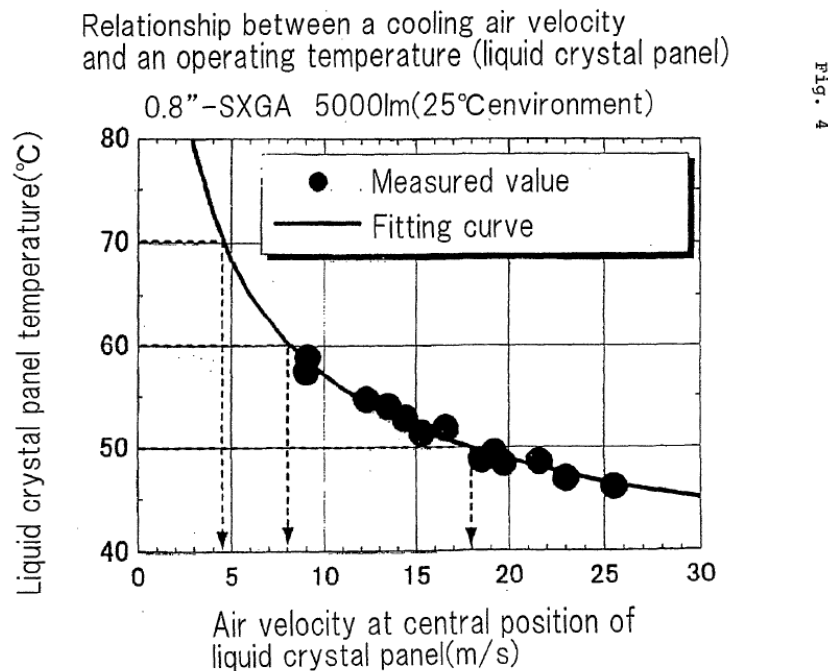
47. The volumetric flowrate Q for laminar flow between parallel plates with gap $2h$ for a given pressure gradient dp/dx can be written as

$$Q = \frac{bh^3}{3\mu} \frac{dp}{dx}$$

where μ is the dynamic viscosity, and b is the transverse width. For a given pressure gradient, the flowrate Q scales with the gap $2h$ cubed. Therefore, doubling the gap will increase the flowrate by a factor of 8. In addition, for a given duct, the pressure gradient scales linearly with the flowrate, $\left(\frac{dp}{dx}\right) \sim Q$.

48. For turbulent flow, there is a similar relationship where flow rate increases dramatically with the gap $2h$. For a fully developed turbulent flow, the Darcy friction factor, f , can be assumed constant. In this case, the pressure gradient (i.e., pressure drop) scales with the square of the flowrate, $\left(\frac{dp}{dx}\right) \sim Q^2$.

49. When designing electronic cooling systems, engineers often utilize cooling performance as a function of flowrate, Q , or average velocity, V . The flowrate is equal the cross-sectional area multiplied by the average velocity, $Q = A \times V$. A typical cooling curve has been provided by Utsunomiya and given below.¹



50. These types of curves have the same characteristics where the temperature of the surface to be cooled scales with $T \sim V^{-n}$, where n is a positive

¹ These equations and principles were well known to a POSITA before the relevant priority dates and are what I regularly taught in my undergraduate fluid mechanics classes at UC-Santa Barbara.

number. As can be seen from the cooling curve, the cooling is improved (i.e., lower temperature) when the velocity is increased. However, as the velocity is further increased to very large values, there are diminishing returns. In other words, an engineer will pick a velocity that cools the LC panel sufficiently such that the surface temperature is maintained below a critical value (in this case 70°C), and then use a velocity larger than that for a factor of safety. However, excessively high velocities of say $V = 30$ m/s will require much higher fan power and will not improve cooling performance significantly.

51. Thus, when designing conventional cooling systems for electronic devices, a POSITA would employ these concepts, equations, and relationships as part of the conventional engineering process. In addition, the POSITA would engage in making trade-offs or compromises based on the information discussed above, such as with respect to air flow rate versus power consumption or selecting a suitable size for a gap based on the cooling fan to be used. Below, I provide more detailed discussion explaining the invalidity of each of the challenged claims of the Challenged Patents, but such conventional design decisions and tradeoffs feature prominently in a number of the challenged claims.

A. Nagayama and Gromatzky

52. Both Nagayama and Gromatzky provide display devices intended to be used in outdoor environments. Ex. 1006, ¶ 1 (“The present invention relates to a

display device, and more particularly to an outdoor display device using a flat panel type display device as a display section.”), Ex. 1007, 1:66-2:2 (“The present invention relates to a thermal management system for a liquid crystal display (LCD) that is placed inside a thin depth enclosure and may be incorporated into an outdoor device.”). In addition, each is concerned with cooling their respective devices. Ex. 1006, ¶ 1; Ex. 1007, 2:53-62. Consequently, a POSITA working with Nagayama would recognize that teachings from Gromatzky may be relevant. For example, a POSITA considering Nagayama’s teaching of an air channel formed between its display panel 13 and its transparent plate 23 to allow cooling air flow would not find any details within Nagayama regarding how to size the air channel. Thus, a POSITA considering how to size the air channel would look to other information in the art about such gaps.

53. In this case, Gromatzky also describes a display device that includes an LCD module that has a transparent lens positioned to allow a user to view the LCD module through the transparent lens. Ex. 1007, 3:10-14. And like Nagayama, Gromatzky teaches creating a gap between its LCD module its transparent lens to allow air flow through the gap to cool the LCD module. Ex. 1007, 4:39-45. Gromatzky also provides specific sizing for the gap of 9.4 millimeters. Thus, a person considering the air channel taught by Nagayama would be motivated to find sizing information for such air channels in similar devices and would turn to

Gromatzky's teaching of a 9.4 millimeter gap as being suitable for a device similar to Nagayama's. The use of such a gap size would have been simply the use of a known design parameter in a device employing the same kind of gap. Using this gap spacing would have been simply known elements in the prior art to achieve predictable results, namely protecting the display from damage and allowing air to be routed across the display. Similarly, while Nagayama discloses using fans to form an air flow through the front channel AC1, including the channel between the display element and front plate, it does not expressly disclose using fans to "impart turbulence to an air flow." Gromatzky describes using a fan with laminar air flow in such a channel to dissipate heat and notes, "the present invention may use any type of fan 32, including those that generate turbulent air. The fan 32 speed may also be adjusted to move air in the desired manner and efficiency." Ex. 1007, 5:17-20. A POSITA would recognize that Nagayama fans could be used to generate turbulent air flow, and using those fans to generate turbulent air flow would have been a simple design choice because turbulent air flow is an efficient air flow for removing heat in certain applications and would be motivated to use turbulent air flow to transfer heat away from the LCD display.

B. Nagayama and Gromatzky with Matsuoka

54. Like Nagayama and Gromatzky, Matsuoka describes an LCD display device. Ex. 1009, 1:62-2:9. In addition, each of these references employs

approaches to cooling their respective devices. Ex. 1009, 1:47-49. While Nagayama describes positioning fans in different locations within its device and dividing its interior into different sections to enable cooling air flow, a POSITA considering Nagayama would consider other design approaches to improve cooling of the Nagayama device. Ex. 1006, Fig. 7. For example, a POSITA would consider relocating electronic components, such as heat generating components like power supplies, to different areas within the Nagayama device to adjust cooling efficiencies.

55. Like Nagayama and Gromatzky, Matsuoka uses fans to circulate air past the components to be cooled, including the backlights and the LCD panel itself, which is contained in one portion of the Matsuoka housing. Ex. 1009, 5:24-36; *see also* Ex. 1009, 5:13-14. Further, like Nagayama, Matsuoka divides its device into different sections. For example, Matsuoka positions its power supply in one portion of the housing near the bottom of its display device, while it positions its display in another portion of the housing above the housing having the power supply. Matsuoka then uses fans to draw air in through the lower part of the housing to cool the power supply and then forcing it into the upper portion of the housing to cool the display panel, before the air exits the housing at the top. Ex. 1009, 4:52-5:37.

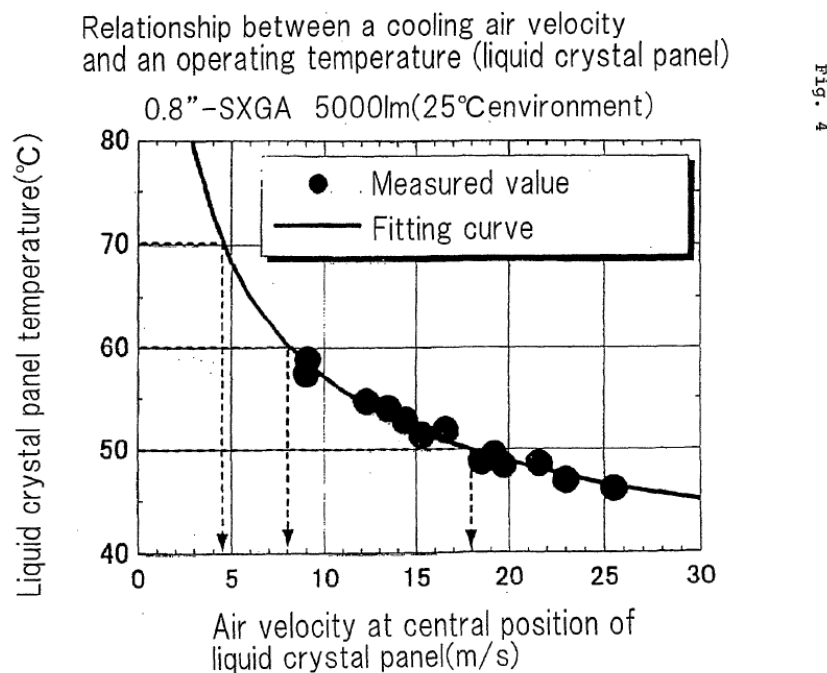
56. A POSITA would be motivated to modify the Nagayama or Gromatzky devices to employ a partition arrangement of a lower housing portion and an upper housing portion as taught by Matsuoka to effectively cool Nagayama's and Gromatzky's electronic components and its display. For example, the POSITA would be motivated to provide the separate upper and lower portions of the housing to enable a more efficient and direct flow of air from the intake air at the bottom of the device, which can be blown over electronic components stored there, and continuing upward past the display panel, before exiting the housing through an upper surface. In addition, by segregating thermal sources such as the power supply away from the display, it can also reduce heat transfer from the power supply to the display panel. Such a design does not involve multiple intake or exit ventilation holes, nor does it involve complex routing of cooling air through the device. Instead, it provides a simple design to allow ambient air to move into the bottom of the housing, upward past the components to be cooled, and out through the top of the housing. Thus, a POSITA considering ventilation and component placement configurations for the Nagayama and Gromatzky devices would be motivated to divide the housing into upper and lower sections, as taught by Matsuoka.

C. Nagayama, Gromatzky, and Matsuoka with Utsunomiya

57. Like Nagayama, Gromatzky, and Matsuoka, Utsunomiya describes techniques for thermal management of LCD devices. Ex. 1010, Abstract. Utsunomiya describes generating air flow over a liquid crystal unit using a fan to help extend the useful life of the liquid crystal unit. Ex. 1010, 1:8-14, 5:7-13. Similarly, both Nagayama and Gromatzky explain that cooling is beneficial. For example, Nagayama explains that if the liquid crystal panel temperature increases too much, “it will not function normally.” Ex. 1006, ¶ 6; *see also* Ex. 1006, ¶ 65 (operating temperature of 65 degrees Celsius without cooling), Fig. 2. Similarly, Gromatzky discloses that “some LCD modules 12 may need to be kept at temperatures at or lower than 70 degrees Celsius to operate properly.” Ex. 1007, 3:58-60. Thus, a POSITA considering the Nagayama device in conjunction with Gromatzky would be taught that LCD panels, such as those used in the Nagayama and Gromatzky devices should be operated in a temperature range below approximately 65-70 degrees Celsius.

58. Utsunomiya provides information about the amount of cooling provided by air flows having different velocities. Thus, a POSITA considering how to cool the Nagayama or Gromatzky display devices would look to information that characterizes the cooling effect of air flow generated by fans. Further, Nagayama teaches controlling its fans based on temperature sensors. Ex. 1006, ¶

74. Because Nagayama does not provide specific speeds at which to generate air flow based on temperature, a POSITA would look to the Utsunomiya reference for guidance on specific parameters for controlling the fans because they would have recognized that such parameters would be needed to design an effective cooling system for the device. In particular, Figure 4 shows air flow speeds in relation to display temperatures, which follows the well-known inverse exponential relationship between air velocity and display temperature. Thus, a POSITA would be motivated to use the relationships described by Utsunomiya between air flow speed and display temperatures when designing a fan controller that uses information from a temperature sensor to ensure that the flow velocity of air in the front channel is maintained at 4.5 m/s or more:



59. Based on the relationships from Utsunomiya, a POSITA would have understood flow rates that would be needed to cool LCD displays based on temperature sensor information. This modification is further suggested by Nagayama's explanation that it is solving issues related to cooling an outdoor display device: "if the device is installed on an outdoor road, etc.," and "a transparent plate is installed on the front of the liquid crystal panel so that it cannot be directly touched, the transparent plate suppresses the heat dissipation from the front of the liquid crystal panel, and the temperature of the liquid crystal panel increases and it will not function normally." Ex. 1006, ¶ 6. Nagayama states that "the present invention is made to resolve such problems..." Ex. 1006, ¶ 9.

D. Karppanen and Gromatzky

60. Both Karppanen and Gromatzky provide display devices intended to be used in outdoor environments. Ex. 1008, 3:16-20 ("The invention relates to an electronic information board comprising a frame, a flat display element, such as a TFT LCD display or plasma display, for displaying information, and electronic equipment for controlling the display element."), 5:26-30 ("Yet another advantage of the invention is that it is suitable for use both outdoors and indoors."), Ex. 1007, 1:66-2:2 ("The present invention relates to a thermal management system for a liquid crystal display (LCD) that is placed inside a thin depth enclosure and may be incorporated into an outdoor device."). In addition, each is concerned with cooling

their respective devices. Ex. 1008, 3:18-22, 4:3-10; Ex. 1007, 2:53-62.

Consequently, a POSITA working with Karppanen would recognize that teachings from Gromatzky may be relevant. For example, a POSITA considering Karppanen's teaching of an air channel formed between its display element 30 and its transparent front plate 54 to allow cooling air flow would not find any details within Karppanen regarding how to size the air channel. Thus, a POSITA considering how to size the air channel would look to other information in the art about such gaps.

61. In this case, Gromatzky also describes a display device that includes an LCD module that has a transparent lens positioned to allow a user to view the LCD module through the transparent lens. Ex. 1007, 3:10-14. And like Karppanen, Gromatzky teaches creating a gap between its LCD module its transparent lens to allow air flow through the gap to cool the LCD module. Ex. 1007, 4:39-45. Gromatzky also provides specific sizing for the gap of 9.4 millimeters. Thus, a person considering the gap between the display element 30 and the transparent front plate 54 taught by Karppanen would be motivated to find sizing information for such air channels in similar devices and would turn to Gromatzky's teaching of a 9.4 millimeter gap as being suitable for a device similar to Nagayama's. The use of such a gap size would have been simply the use of a known design parameter in a device employing the same kind of gap. Using this gap spacing would have been

simply known elements in the prior art to achieve predictable results, namely protecting the display from damage and allowing air to be routed across the display.

62. Similarly, while Karppanen discloses using fans to form an air flow through the display casing, including the channel between the display element and front plate, it does not expressly disclose using fans to “impart turbulence to an air flow.” Gromatzky describes using a fan with laminar air flow in such a channel to dissipate heat and notes, “the present invention may use any type of fan 32, including those that generate turbulent air. The fan 32 speed may also be adjusted to move air in the desired manner and efficiency.” Ex. 1007, 5:17-20. A POSITA would recognize that Karppanen’s fans could be used to generate turbulent air flow, and using those fans to generate turbulent air flow would have been a simple design choice because turbulent air flow is an efficient air flow for removing heat in certain applications and would be motivated to use turbulent air flow to transfer heat away from the LCD display.

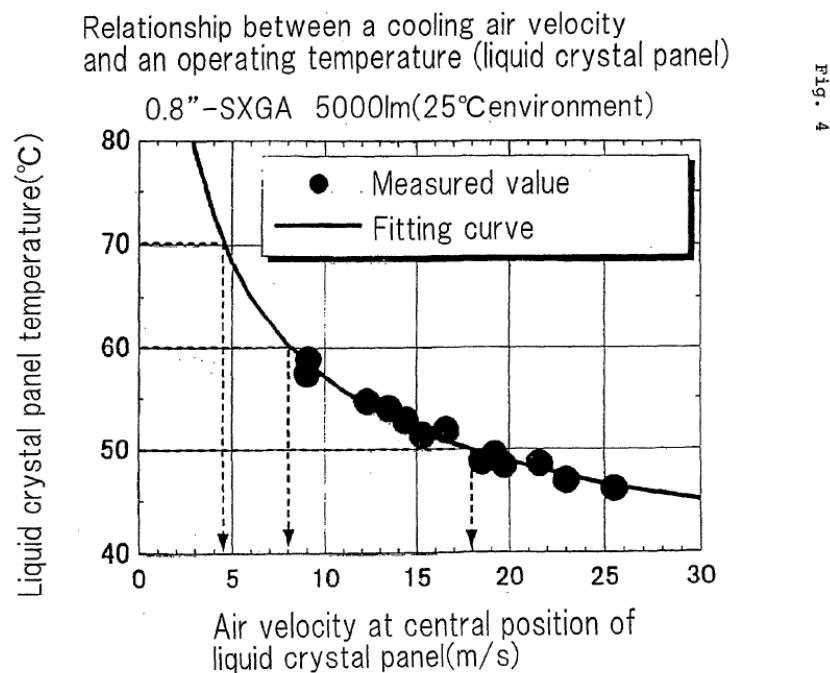
E. Karppanen with Utsunomiya or Karppanen with Gromatzky and Utsunomiya

63. Like Karppanen, Utsunomiya describes techniques for thermal management of LCD devices. Ex. 1010, Abstract. Utsunomiya describes generating air flow over a liquid crystal unit using a fan to help extend the useful life of the liquid crystal unit. Ex. 1010, 1:8-14, 5:7-13. Similarly, Karppanen

explains that cooling is beneficial. For example, Karppanen explains that “the LCD matrix of TFT LCD display elements becomes inoperative already at the temperature of 70°C.” Ex. 1008, 2:29-30. Similarly, Gromatzky discloses that “some LCD modules 12 may need to be kept at temperatures at or lower than 70 degrees Celsius to operate properly.” Ex. 1007, 3:58-60. Thus, a POSITA considering the Karppanen device alone, or in conjunction with Gromatzky, would be taught that LCD panels, such as those used in the Karppanen and Gromatzky devices should be operated in a temperature range below approximately 70 degrees Celsius.

64. Utsunomiya provides information about the amount of cooling provided by air flows having different velocities. Thus, a POSITA considering how to cool the Karppanen or Gromatzky display devices would look to information that characterizes the cooling effect of air flow generated by fans. Further, Karppanen teaches controlling its fans based on temperature sensors. Ex. 1008, 9:14-21. Because Karppanen does not provide specific speeds at which to generate air flow based on temperature, a POSITA would look to the Utsunomiya reference for guidance on specific parameters for controlling the fans because they would have recognized that such parameters would be needed to design an effective cooling system for the device. In particular, Figure 4 shows air flow speeds in relation to display temperatures, which follows the well-known inverse exponential

relationship between air velocity and display temperature. Thus, a POSITA would be motivated to use the relationships described by Utsunomiya between air flow speed and display temperatures when designing a fan controller that uses information from a temperature sensor to ensure that the flow velocity of air in the front channel is maintained at 4.5 m/s or more:



65. Based on the relationships from Utsunomiya, a POSITA would have understood flow rates that would be needed to cool LCD displays based on temperature sensor information. This modification is further suggested by Karppanen’s description of a goal of “provid[ing] an electronic information board which tolerates well external variations of temperature and is thereby suitable for installation outdoors.” Ex. 1008, 3:8-10.

IX. '253 Patent – Nagayama Grounds

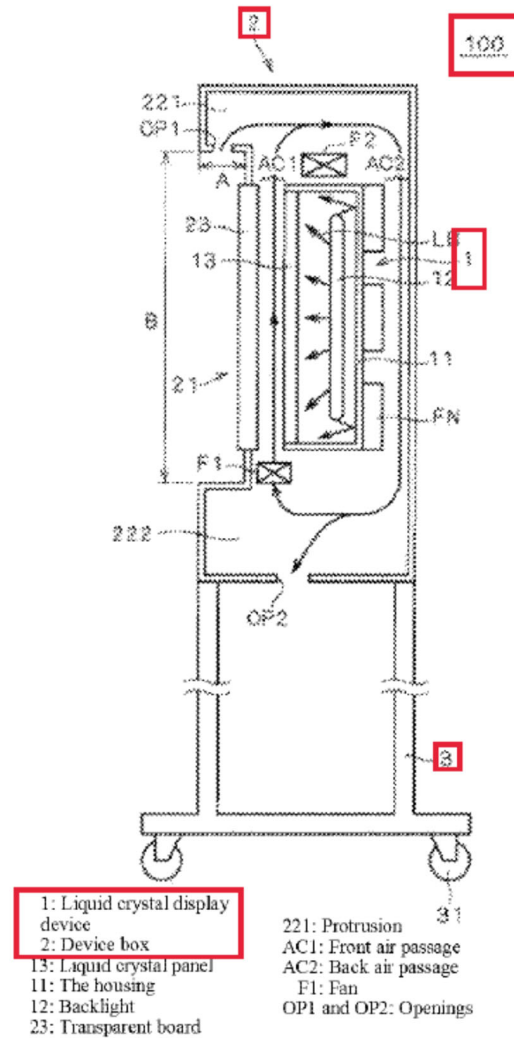
66. In the following sections, I set forth my analysis and conclusions as to the validity of claims 1, 2, 4-12, and 14-20 of the '253 patent based on Nagayama as the primary reference.

A. Claims 1-2, 4-12, and 14-20

1. Claim 1, Preamble – “A display device, comprising:”

67. I understand that ordinarily claim preambles are not a limiting part of a claim, but even if the preamble here is limiting, Nagayama teaches display devices. For example, Figure 1 of Nagayama shows an “outdoor display 100” that includes a “liquid crystal display device 1” that is stored within a “device box 2” that is supported by multiple legs 3. Ex. 1006, Fig. 1, ¶ 13.

[FIG. 1]



68. Figures 3-9 also show display devices with similar configurations to the display device shown in Figure 1. Nagayama discloses that its display device is configured to “efficiently dissipate heat generated from a flat panel type display device.” Ex. 1006, p. 2, lines 1-2.

69. It is my opinion that the combination of the liquid crystal display device 1, the device box 2, and the supporting legs 3 shown in Figure 1 teach a “display device” as recited in the preamble. Further, it is my opinion that the other

embodiments depicted in Figures 3-9 also teach “display devices” that include a liquid crystal display device within a device box supported by legs.

70. Similarly, the Gromatzky reference discloses a display device that includes a liquid crystal display (“LCD”) positioned within an “environmentally-sealed enclosure 12.” Ex. 1007, 2:52-3:9. It describes that its disclosure relates to “a thermal management system for a thin depth LCD display enclosure.” Ex. 1007, 2:52-62.

71. In addition, Matsuoka discloses a display device that includes an LCD screen positioned within a housing. Ex. 1009, 3:12-47. Matsuoka also describes its display device provides improved thermal management to efficiently cool the LCD within the housing. Ex. 1009, 2:23-32.

72. Each of these references are directed to the same problem of thermal management of LCD screens that are enclosed within a housing. A POSITA would have been motivated to combine the teachings of Nagayama, Gromatzky, and Matsuoka to arrive at the claimed “display device.” Thus, it is my opinion that Nagayama, Gromatzky, Matsuoka and the knowledge of a POSITA make the preamble of claim 1 obvious.

(a) Claim 1a – “a housing”

73. As I discussed above with respect to the preamble, Nagayama teaches that its display devices include a liquid crystal display device 1 that is enclosed

within the display box 2, which provides a housing for the liquid crystal display device 1. Ex. 1006, p. 2, lines 4-8. It explains, with respect to “Means for solving the problems” section, that “the flat panel display device is housed in a device box.” Ex. 1006, ¶ 10. In addition, with respect to Figure 1, Nagayama states that its liquid crystal display 1 is “stored” in the device box 2. Ex. 1006, ¶ 13.

74. When it describes the device box 2 itself, Nagayama explains that the “device box 2 is configured to surround the liquid crystal display 1 and prevent the liquid crystal display 1 from being directly exposed to rainwater or dust.” Ex. 1006, ¶ 19. In addition, Nagayama teaches that the liquid crystal display 1 is completely sealed within the device box 2, except for one or more vents being provided to assist with cooling the liquid crystal display. Ex. 1006, ¶ 19 (“However, once the liquid crystal display 1 is completely sealed within the device box 2, heat emitted from the liquid crystal display 1 is transferred into the device box 2, so a vent is provided.”) Therefore, it is my opinion that the device box 2 is a housing. Therefore, it is my opinion that Nagayama discloses all aspects of claim 1a.

75. The Gromatzky reference also discloses a housing for an LCD screen. It describes an enclosure that is “environmentally-sealed” to “protect[] the internal components of the LCD display 10 from external elements that may affect the proper operation, such as water, dust, etc.,” which include an LCD module 26.

Gromatzky, 2:63-3:20. In addition, the Gromatzky housing also includes “a transparent lens 18 at the front portion 14 of the enclosure 12 for external viewing of the LCD display 10.” Gromatzky, 3:10-20. Therefore, it is my opinion that Gromatzky’s enclosure discloses the claimed housing.

76. Like Nagayama and Gromatzky, Matsuoka discloses an LCD screen that is positioned within a housing. Matsuoka discloses that a “display screen 101 of the liquid-crystal unit 100 is mounted within the aperture 1011 so as to be exposed to the front of the LCD.” Matsuoka, 3:38-47. Therefore, it is my opinion that Matsuoka discloses all aspects of claim 1a.

77. Therefore, it is my opinion that Nagayama, Gromatzky, Matsuoka and the knowledge of a POSITA render claim 1a obvious.

(b) Claim 1b – “a display assembly enclosed inside the housing to form a front channel between a display panel of the display assembly and a front side of the housing”

78. Nagayama teaches a liquid crystal display 1, which corresponds to the claimed display assembly. For example, Nagayama’s liquid crystal display 1 includes “a liquid crystal panel 13 (display panel), a backlight thereof (e.g., a fluorescent light) 12, and a housing 11 that houses the backlight 12 and also the drive circuit, etc. of the liquid crystal panel 13.” Nagayama, ¶ 15. In addition, as I discussed above with respect to claim 1a, Nagayama teaches that its liquid crystal display 1 is completely sealed within the device box 2. Ex. 1006, ¶ 19. Thus,

Nagayama discloses the claimed display assembly, which is enclosed inside a housing.

79. Nagayama explains that the device box 2 includes a transparent plate 23 that allows users to see the liquid crystal display 1 while it is enclosed within the device box 2. Ex. 1006, ¶ 17. To enable cooling of the liquid crystal display 1, Nagayama discloses leaving a gap between the liquid crystal display 1 and the transparent plate 23. Ex. 1006, ¶¶ 20, 28-30. This gap is referred to as “the front air passage AC1” and corresponds to the claimed “front channel between a display panel of the display assembly and a front side of the housing.” Ex. 1006, ¶ 20. Further, while this description relates to the embodiment shown in Figure 1, the embodiments shown in Figures 3-9 each employ such a gap between the liquid crystal display 1 and the transparent plate 23.

80. In addition to the Nagayama reference, the Gromatzky reference also discloses establishing a gap between a display panel and a front side of a housing. As I discussed above, Gromatzky discloses that its LCD display 10 includes a housing that protects an LCD module 26 from environmental hazards. The housing includes a “transparent lens 18” that allows viewing of the LCD module 26,” similar to how Nagayama’s transparent plate 23 allows a viewer to see its display panel. Ex. 1007, 3:10-20. And like Nagayama, Gromatzky discloses that its LCD module 26 is positioned away from the lens to “allow[] air to be routed across the

LCD module 26 for thermal management.” Ex. 1007, 4:26-51. The gap between the LCD module 26 and the transparent lens 18 corresponds to the claimed “front channel between a display panel of the display assembly and a front side of the housing.”

81. Therefore, it is my opinion that Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA make obvious all aspects of claim 1b.

(c) Claim 1c – “a flow control device to generate an air flow to the front channel and to control a velocity of the air flow according to a state of the display assembly.”

82. This claim limitation recites a “flow control device” that has two different functionalities: (1) generating an air flow to the front channel, and (2) controlling a velocity of the air according to a state of the display assembly. While a flow control device could control any kind of flow, the Challenged Patents specifically discuss flow control devices that are fans. ’253 Patent, 2:5-6 (“The flow control device may be a cooling fan to blow air to the channel.”). Thus, it is my opinion that a fan is a type of flow control device that can generate an air flow to the front channel, which was recited above in claim 1b.

83. The Nagayama reference discusses the use of fans to cool its LCD device 1 by blowing air within (or pulling air through) the front air passage AC1. Ex. 1006, ¶¶ 22, 28-30. As discussed above, the front air passage AC1 corresponds

to the channel recited in claim 1. Therefore, it is my opinion that Nagayama discloses “a flow control device to generate an air flow to the front channel.”

84. Similarly, the Gromatzky reference discloses the use of fans to cool its LCD module 26 by blowing air through the gap between the front of the LCD module 26 and the transparent lens 18. Ex. 1006, 4:26-51. As I discussed above with respect to claim 1b, the gap between the LCD module 26 and the transparent lens 18 corresponds to the claimed channel. Therefore, it is my opinion that Gromatzky discloses “a flow control device to generate an air flow to the front channel.”

85. With respect to the second functionality, “to control a velocity of the air flow according to a state of the display assembly,” I do not see a specific enumeration of different types of states that the claimed display assembly may have, though I understand that display assemblies can have at least an “off” state and an “on” state. I also understand that the ’253 Patent describes techniques for cooling display assemblies, thus a state may relate to the temperature of the display assembly. In addition, my experience with display assemblies, including those that employ backlights, informs me that backlight settings can affect the amount of heat generated by a display assembly. Thus, another possible state of the display assembly may be the intensity level of the display backlight. *See, e.g.*, Ex. 1007,

3:52-54. And because the claim recites “a state,” any state of the display assembly may be used.

86. While I note that the '253 Patent discusses adjusting fan speed based on temperatures, it is my understanding that limitations from the written description of a patent should not be read into the claims themselves. Instead, I understand that claims are read in light of the written description but are generally not limited by it. Thus, because this claim limitation recites a “state of the display assembly” rather than something specifically related to temperature, it is my opinion that “controlling a velocity of the air according to a state of the display assembly” can relate to any state of the display, which may include a power state, a backlight setting, a temperature of the display, or other possible states.

87. Nagayama discloses that a temperature sensor TS may be affixed to the liquid crystal panel to measure the temperature of the panel. Ex. 1006, ¶¶ 74-75, Fig. 9. Temperature information is provided by the temperature sensor TS to a “liquid crystal panel temperature control board TC,” which “controls the fans F71, F72 and heaters 1-1 I, H2 to achieve a preset temperature.” Ex. 1006, ¶ 74. I note that Figure 9 shows that fan F71 circulates air through the gap between the front face of the liquid crystal panel 13 and the transparent plate 23. Ex. 1006, Fig. 9, ¶ 72. Nagayama also discloses that as the sensed temperature changes, the fan’s rotational speed can be changed. Ex. 1006, ¶¶ 88-92. Thus, it is my opinion that

Nagayama discloses that it uses a temperature sensor to sense a state of the liquid crystal panel, i.e., a temperature of the liquid crystal panel, and to control fans F71 and F72, thereby controlling “a velocity of the air flow according to a state of the display assembly” as recited in claim 1c.

88. Therefore, it is my opinion that Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA render obvious claim 1c.

(d) Conclusion

89. In view of my analysis above, claim 1 is invalid based on the combination of Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA.

2. Claim 2 – “The display device according to claim 1, wherein: the housing partitioned into an upper space and a lower space disposed below the upper space and includes a fan to blow the air to front channel.”

90. As I discussed above with respect to claim 1, Nagayama discloses a display device that includes a housing and a fan that blows air through the gap between Nagayama’s LCD device 1 and the transparent plate 23. In addition, Nagayama discloses multiple embodiments with a fan positioned below the LCD display 1. Ex. 1006, Figs. 1 (F1), 4 (F21), 6 (F41, F42), 7 (F1), 8 (F1), 9 (F71, F72). I also see that Nagayama discloses dividing the volume within the housing into two spaces. For example, Figure 7 shows an embodiment where the display device 100E has a display box 2 with a partition wall PW2 that partitions the

housing. However, the embodiment shown in Figure 7 partitions the housing into a front portion and a rear portion. However, this discloses the concept of using a partition wall to partition a housing into having multiple interior spaces.

91. Matsuoka discloses a housing for an LCD display that is partitioned into lower and upper spaces. In particular, Figure 1 of Matsuoka shows a housing that is divided into a lower space and upper spaces. Matsuoka, Fig. 1. Matsuoka describes the lower space as being a “horizontal first enclosure 210” and the upper spaces as “vertical second enclosure 220” and “vertical third enclosure 230.” Further, Matsuoka discloses that air is taken into the lower space via apertures and a blower blows the air upward into the third vertical enclosure 230, one of the upper spaces. This is similar to the embodiment described with respect to Figure 2 of the '253 Patent, which includes air being blown by a cooling fan 32 from a lower portion of the housing through an air inlet 17 into an upper portion of the housing. Thus, Matsuoka discloses a housing configuration very similar to the configuration discussed by the '253 Patent.

92. In my opinion it would have been obvious to modify the Nagayama display device to use upper and lower spaces as one of many available design choices. Nagayama discloses multiple different airflow and venting configurations as well as dividing the interior portion of its device box 2 into multiple spaces. Ex. 1006, Figs. 1 and 3-9. Further, the guidance Nagayama gives regarding positioning

of a partition PW2 in Figure 7 is to ensure that “fresh outside air first cools only the front surface of the liquid crystal panel 13, so that the cooling efficiency of the front surface of the crystal panel 13 can be enhanced.” Ex. 1006, ¶ 63. Thus, using these design considerations and Nagayama’s discussion of its partition, one of skill in the art would consider other design options, such discussed in Matsuoka, where the partition separates that a lower portion of the housing from an upper portion of the housing. As with the embodiment shown in Nagayama Figure 7, the vertical enclosure 220 in Matsuoka is arranged to flow cool air over the LCD panel that is initially circulated by a fan 10 located in the lower portion of the housing.

93. Based on these teachings, a POSITA would be motivated to modify the Nagayama display box to direct cool air from an opening in the display box over the front panel of the display, while preventing warm air from being recirculated, by segregating the lower portion of the display box with a horizontal partition and suitable opening as used in Matsuoka, to ensure cool air can be directed over the front side of the Nagayama display module 26, and to prevent warm air from returning to the lower portion of the display box, where it may be recirculated, thereby reducing the cooling efficiency as taught by Nagayama. Further, because Nagayama already discloses ways to partition its display box into different spaces, a POSITA would have a reasonable expectation of success to

modify the Nagayama partition to create upper and lower spaces rather than the front and rear spaces shown in Nagayama Figure 7.

94. Therefore, it is my opinion that Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA render obvious claim 2.

3. Claim 4 – “The display device according to claim 2, wherein: the flow control device further includes a sensor to measure the state of the display assembly.”

95. As I discussed above with respect to claim 1c, Nagayama discloses affixing a temperature sensor to the liquid crystal panel to measure the temperature of the panel. Ex. 1006, ¶¶ 74-75, Fig. 9. In additional Nagayama discloses that temperature information is provided by the temperature sensor TS to a “liquid crystal panel temperature control board TC,” which “controls the fans F71, F72 and heaters 1-1 I, H2 to achieve a preset temperature.” Ex. 1006, ¶ 74. And while the fans and temperature sensor are not integrated into one another or the temperature control board, the arrangement and interconnection between these various components is a mere design choice. Thus, for the reasons given here and above with respect to claim 1c, it is my opinion that Nagayama discloses “the flow control device further includes a sensor to measure the state of the display assembly.”

96. Therefore, it is my opinion that Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA makes obvious claim 4.

4. Claim 5 – “The display device according to claim 4, wherein the flow control device further comprises: a flow rate controller to control a flow rate of the air in the fan such that the air in the front channel has a controlled flow velocity.”

97. As I discussed above with respect to claim 4, Nagayama discloses controlling fans based on temperature information provided by a temperature sensor TS. Ex. 1006, ¶¶ 74-75, Fig. 9. Nagayama describes that one way to control a fan based on temperature sensor is to control a frequency of a control inverter. Ex. 1006, ¶¶ 88-92. Nagayama discloses that the frequency of the control inverter increases as the sensed temperature increases, which increases the rotational speed of the fan. Ex. 1006, ¶¶ 90-92.

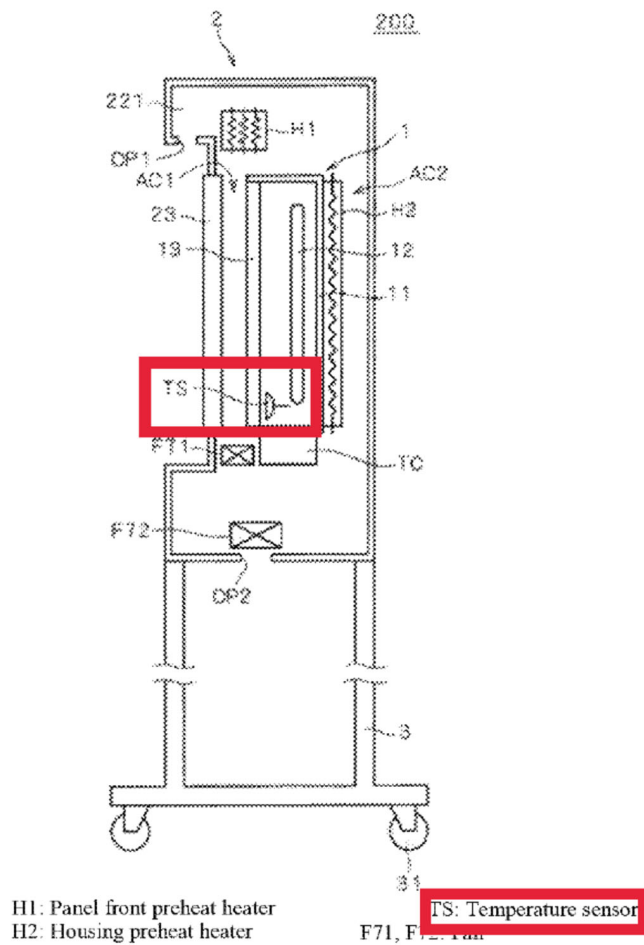
98. For example, Nagayama states that “[t]he frequency of the control inverter increases as the panel temperature rises, and the number of revolutions of the fan F71 also increases, resulting in an increase in cooling efficiency.” Ex. 1006, ¶ 91. “Thus, by controlling the rotational speed of the fan F71 by the inverter, changes in the panel temperature can be controlled gently, and it is possible to maintain a constant state of the panel temperature.” Ex. 1006, ¶ 92. By controlling the rotational speed of the fan, the Nagayama display device controls the flow velocity of air within the front channel. This is because flow velocity is proportional to fan rotational speed, and thus, an increase in fan rotational speed increases the flow velocity of the air. Similarly, reducing the fan rotational speed reduces the flow velocity of the air.

99. Therefore, it is my opinion that the combination of Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA make obvious claim 5.

5. Claim 6 – “The display device according to claim 5, wherein: the sensor is a temperature sensor to measure a temperature of the air having passed through the front channel, and to send a resulting signal to the flow rate controller.”

100. As I discussed above with respect to claim 1c, Nagayama discloses affixing a temperature sensor to a back surface of the liquid crystal panel 13. Ex. 1006, ¶¶ 74-75, Fig. 9. However, as can be seen in Figure 9, the temperature sensor is incorporated into the interior of the liquid crystal display device:

[FIG. 9]



101. However, LCD displays may not always come with integrated temperature sensors before the priority date of the '253 Patent. But even if they did, it would have been desirable to locate one or more temperature sensors at difference locations within a display device like Nagayama's. In fact, providing such instrumentation in different locations was a common approach before the priority date of the '253 Patent. For example, I reviewed the Burke reference which explained that it was known to position one or more temperature sensors within the housing of the device or within an electronics chamber of the device. Ex. 1011,

6:24-33. Similarly, the Hannemann reference explains that the number and position of temperature sensors may be varied as needed to allow for thermal regulation.

Ex. 1013, ¶ 19.

102. In the case of the Nagayama device, the temperature sensor TS will detect the temperature of the liquid crystal panel 13 at a specific location, which may be hotter or cooler than other portions of the display and may be hotter or cooler than the average temperature of the display as a whole. However, because air is blown through a channel, AC1, between the LCD panel 13 and the transparent panel 23 to cool the LCD panel 13, the temperature of the air exiting the channel would provide a more accurate indication of temperature of the LCD panel 13 because the air would have passed over a larger portion of the panel. Thus, a POSITA would be aware that positioning a temperature sensor near the exit of this channel would have likely provided more accurate information about the temperature of the whole LCD panel itself than only measuring at a specific location on the LCD panel. Moreover, Nagayama discloses that its LCD temperature control board TC receives signals from its temperature sensor. Ex. 1006, ¶ 74. Thus, an obvious design choice for a POSITA would have been to position a temperature sensor “to measure a temperature of the air having passed through the front channel, and to send a resulting signal to the flow rate controller” as recited in claim 6.

103. Further, as illustrated in Figure 10, the fans F71 and F72 and the temperature sensor TS are in communication with and controlled by the temperature control board TC. Thus, the temperature sensor sends a signal to the control board, which then sends a control signal to the fans based at least in part on the signal from the temperature sensor. In my opinion, one of skill in the art would understand that Nagayama discloses that the temperature sensor is indirectly “send[ing] a resulting signal to the flow rate controller.”

104. Therefore, it is my opinion that the combination of Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA make obvious claim 6.

6. Claim 7 – “The display device according to claim 2, wherein the front channel comprises: an air inlet to guide air into the channel and an air outlet to discharge air from the channel; and the fan is located near the air inlet.”

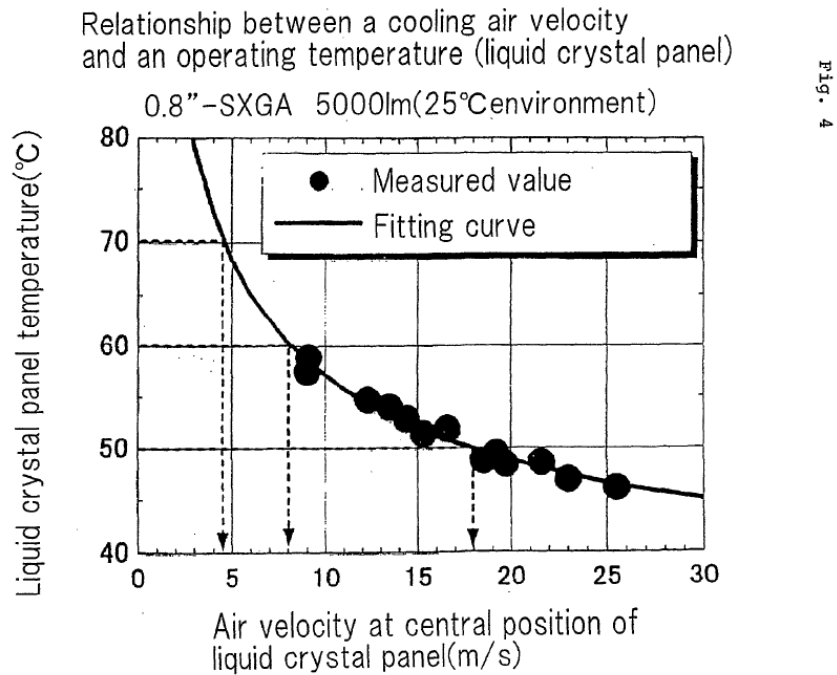
105. Nagayama discloses inlets and outlets to guide air into the channel, AC1. For example, Figure 3 shows a fan, F11, positioned at the top of airflow channel AC1, which serves as an inlet to the channel. Nagayama discloses that “a fan F11 (first fan) is arranged in the vicinity of the upper opening of the front are [sic] passage AC1.” Ex. 1006, ¶ 42. In addition, Nagayama’s device employs both an air inlet and an air outlet to guide air into the channel, AC1. As can be seen in Figure 3, air flows through AC1 and out of the bottom of the channel, which is the air outlet. Ex. 1006, Fig. 3. And as can be seen in Figure 3, fan F11 is positioned adjacent to the inlet of the channel, and thus is “near” the air inlet.

106. Therefore, it is my opinion that the combination of Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA make obvious claim 7.

7. Claim 8 – “The display device according to claim 2, wherein: the flow rate controller regulates the flow rate of the air in the fan such that the flow velocity of air in the front channel is maintained at 4 m/s or more.”

107. While each of Nagayama, Gromatzky, and Matsuoka disclose cooling systems for LCD screens, none discusses the specific flow velocity of air to be used. However, Nagayama shows a graph of temperatures that range from approximately 25 degrees Celsius to approximately 65 degrees Celsius. Further, Nagayama describes that a liquid crystal panel 13 operates at about 65 degrees Celsius without cooling, but that when cooled, its operating temperature can be dropped to about 55 degrees Celsius. Ex. 1006, ¶ 35. Similarly, Gromatzky discloses that “some LCD modules 12 may need to be kept at temperatures at or lower than 70 degrees Celsius to operate properly.” Ex. 1007, 3:58-60. Thus, one of skill in the art would be taught that an LCD display should be kept below 70 degrees Celsius to allow for proper operation.

108. However, the Utsunomiya reference discusses specific rates of cooling of LCD screens based on the velocity of cooling air. In particular, Utsunomiya provides a curve of LCD temperature versus air velocity. Ex. 1010, Fig. 4.



109. In describing this plot, Utsunomiya explains that “Fig. 4 is a graph showing the relationship between a panel cooling air velocity and the panel operating temperature in 0.8"-SXGA (5000-Im class, 25°C environment). For reducing the panel operating temperature from 70°C to 60°C ($\Delta T = -10^\circ\text{C}$), the air velocity may be simply increased from 4.5 m/s to 8 m/s ($\Delta V = +3.5$ m/s), whereas for reducing from 60°C to 50°C ($\Delta T = -10^\circ\text{C}$), the air velocity must be increased from 8 m/s to 18 m/s ($\Delta V = +10$ m/s), as can be seen from the graph.” Thus, Utsunomiya explains that to cool a panel temperature of 70 degrees C in a 25 degrees C environment to 60 degrees, the air velocity must increase from 4.5 meters per second to 8 meters per second.

110. And as discussed above, Gromatzky discloses that display panels, such as those used in Nagayama and Gromatzky, may be damaged at temperatures exceeding 70 degrees C. Thus, in designing a cooling system like Nagayama's or Gromatzky's, a POSITA would be aware of well-known characteristic relationships between fan speed and temperature, like is shown in Utsunomiya. Further, as I discussed above in the Motivation to Combine section, the relationship between fan speed and cooling effect, for both laminar and turbulent flows, were well-known prior to the priority dates of the Challenged Patents. See Section VIII. Further, a POSITA seeking to cool a device, such as Nagayama's or Gromatzky's, would have sought to set fan speeds in a manner to provide sufficient cooling of the LCD panel, depending on the type desired air flow (laminar or turbulent) while simultaneously prevent unreasonable power usage for high fan speeds, i.e., high air flowrates, as well as other considerations, such operating noise of cooling fans based on their rotational speed.

111. Thus, a POSITA considering Nagayama and Gromatzky, while aware of Utsunomiya, would be motivated to use the air flows disclosed by Utsunomiya as a basis for selecting suitable air flow speeds for use in the Karppanen device and it would have been obvious to try air flows at or above 4.5 meters per second to obtain the desirable cooling effect, without consuming too much power and generating too much noise.

112. Therefore, it is my opinion that claim 8 is obvious based on Nagayama, Gromatzky, Matsuoka, Utsunomiya, and the knowledge of a POSITA.

8. Claim 9 – “The display device according to claim 1, wherein the flow control device to generate an air flow to the front channel to control a velocity of the air flow according to a state of the housing.”

113. As I discussed above with respect to claim 6, a POSITA would have been presented with a design choice as to where to position one or more temperature sensors within the Nagayama device to provide temperature signals to its liquid crystal panel temperature control board. Further, as discussed above with respect to claim 6, it was known before the priority date of the '253 Patent to position temperature sensors to measure the temperature within the housing of a device, which is reflected in Burke as well as Hannemann, such as paragraph 19 in Hannemann.

114. Further, information about the temperature of the housing can be desirable when controlling cooling fans. For example, affixing a temperature transducer to the housing provides temperature related to potential thermal sources exterior to the housing, such as sunlight or a temperature of the air outside of the housing. Since Nagayama's device is intended to be used in outdoor environments, receiving temperature information about such external thermal sources can help adjust control of the cooling fans. Ex. 1006, claim 1 (“An outdoor display device comprising of a flat panel display device...”), ¶ 12 (“As Embodiment 1 of the

present invention, the configuration of an outdoor display 100 using a liquid crystal display device is described using FIG. 1.”). For example, if the temperature of the housing is relatively high as compared to a temperature of air exiting the channel between the display panel and the front plate, it may indicate that sunlight is striking the Karppanen device and thereby adding additional heat to the Karppanen device. This may be used to signal a change in the speed of cooling fans to help compensate for the temperature of the housing. Thus, a POSITA confronted with the design choice of where to position a temperature sensor in the Nagayama device would have selected the housing as one of a limited number of options available to sense temperature.

115. Therefore, it is my opinion that claim 9 is obvious based on Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA.

9. Claim 10 – “The display device according to claim 1, wherein: the front channel defined between the display panel assembly and the front side of the housing has a spacing distance in a range of 0.005 to 0.025 m.”

116. As I discussed above with respect to claim 1b, Nagayama and Gromatzky both disclose a display panel positioned within a housing and positioned to create a gap between the front of the display panel and a transparent panel in the housing. While Nagayama does not disclose the size of the gap between its liquid crystal panel 13 and the transparent panel 23, Gromatzky discloses that the channel created between its LCD panel and the transparent lens

18 is 9.4 millimeters, i.e., 0.0094 meters. Ex. 1007, 4:39-41 Because both Nagayama and Gromatzky cool their respective LCDs by circulating air through the gap between the display panel and the transparent panel, a POSITA seeking to implement Nagayama and provide a suitable gap would have looked to Gromatzky for guidance and would have been taught that a gap of 9.4 millimeters would be sufficient for cooling a liquid crystal display.

117. Therefore, it is my opinion that Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA makes obvious claim 10.

10. Claim 11 – “A display device, comprising:”

118. As I discussed above with respect to claim 1, each of Nagayama, Gromatzky, and Matsuoka disclose a display device. Therefore, the combination of Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA make obvious the preamble of claim 11.

(a) Claim 11a – “a housing;”

119. As I discussed above with respect to claim 1a, each of Nagayama, Gromatzky, and Matsuoka disclose a display device having a housing. Therefore, the combination of Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA make obvious claim 11a.

(b) Claim 11b – “a display assembly enclosed inside the housing;”

120. As I discussed above with respect to claim 1b, Nagayama and Gromatzky disclose a display device having a display assembly enclosed within a housing. In addition, Matsuoka discloses an LCD assembly positioned within a housing. Ex. 1009, 3:17-47. Therefore, the combination of Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA make obvious claim 11b.

(c) Claim 11c – “a sensor to measure a temperature of air in the housing;”

121. As I discussed above with respect to claim 6, it would have been an obvious design choice to position temperature sensors at different locations to measure a temperature of air in the housing and provide sensor signals to Nagayama’s liquid crystal panel temperature control board. Further, as I discussed above with respect to claim 9, affixing a temperature transducer to the housing provides temperature related to potential thermal sources exterior to the housing, such as sunlight or a temperature of the air outside of the housing. Similarly, positioning a temperature sensor to measure air temperature within the housing would provide information regarding how much external heat sources may be affecting the Nagayama device. Since Nagayama's device is intended to be used in outdoor environments, receiving temperature information about such external thermal sources can help adjust control of the cooling fans. Ex. 1006, claim 1 (“An

outdoor display device comprising of a flat panel display device...”), ¶ 12 (“As Embodiment 1 of the present invention, the configuration of an outdoor display 100 using a liquid crystal display device is described using FIG. 1.”). For example, if the temperature of air within the housing is relatively high, this may be used to signal a change in the speed of cooling fans to help compensate for the temperature of the housing. Thus, a POSITA confronted with the design choice of where to position a temperature sensor in the Nagayama device would have selected a location to measure the air temperature within the housing as one of a limited number of options available to sense temperature. Therefore, the combination of Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA make obvious claim 11c.

(d) Claim 11d – “a fan configured to blow the air around the display assembly; and”

122. As I discussed above with respect to claim 1c, Nagayama discloses using one or more fans to circulate air past the front side of the liquid crystal panel 13 of Nagayama’s display assembly. Ex. 1006, Figs. 1 and 3-9, ¶ 22. In addition, Nagayama discloses that air is circulated by the fans around the back side of the display assembly through a rear air passage AC2. Ex. 1006, ¶¶ 29-32. And while the description of the circulation is made with respect to the embodiment shown in Figure 1, Figures 3-9 each illustrate the use of a fan to blow air around the display assembly, as recited in claim 11d.

123. Therefore, it is my opinion that Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA make obvious claim 11d.

(e) Claim 11e – “a control device to control the fan to maintain a temperature of the housing”

124. As I discussed above with respect to claims 4 and 5, Nagayama discloses that signals from its temperature sensor TS are provided to the liquid crystal panel temperature control board TC, which “controls the fans F71, F72 and heaters 1-1 I, H2 to achieve a preset temperature.” Ex. 1006, ¶ 74. Further, and as discussed above with respect to claim 9 and 11c, it would have been a design choice to sense the temperature of air in the housing. In an instance where the POSITA made the design decision to measure the temperature of the housing as discussed above, temperature signals received by the liquid crystal panel temperature control board would be used to control the speed of Nagayama’s fan(s) to maintain the desired temperature for the housing. Ex. 1006, ¶¶ 88-92

125. Therefore, it is my opinion that Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA make obvious claim 11e.

(f) Claim 11f – “wherein the sensor transmits a resulting signal to the control device and the control device controls the fan based on the resulting signal.”

126. As I discussed above with respect to claims 5, Nagayama discloses that the liquid crystal panel temperature control board TC can control the rotational

speed of the fan(s) based on the temperature information received from the temperature sensor TS. Ex. 1006, ¶¶ 88-92.

127. Therefore, it is my opinion that Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA make obvious claim 11f.

11. Claim 12 – “The display device according to claim 11, wherein the display assembly is enclosed inside the housing to form a front channel between a display panel of the display assembly and a front side of the housing.”

128. As I discussed above with respect to claim 1b, Nagayama discloses “wherein the display assembly is enclosed inside the housing to form a front channel between a display panel of the display assembly and a front side of the housing.” Therefore, it is my opinion that Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA makes obvious claim 12 for the same reasons as I discussed above with respect to claim 1b.

12. Claim 14 – “The display device according to claim 13, wherein the control device controls a flow rate of the air in the fan such that the air in the front channel has a controlled flow velocity.”

129. As I discussed above with respect to claim 5, Nagayama discloses “wherein the flow control device further comprises: a flow rate controller to control a flow rate of the air in the fan such that the air in the front channel has a controlled flow velocity,” which recites essentially the same features as claim 14, though worded slightly differently.

130. Therefore, it is my opinion that Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA makes obvious claim 14 for the same reasons as I discussed above with respect to claim 5.

13. Claim 15 – “The display device according to claim 12, wherein: the front channel comprises an air inlet to guide air into the front channel and an air outlet to discharge air from the front channel; and the fan is located near the air inlet.”

131. As I discussed above with respect to claim 7, Nagayama discloses a configuration of its air circulation system “wherein the front channel comprises: an air inlet to guide air into the channel and an air outlet to discharge air from the channel; and the fan is located near the air inlet,” which recites the same features as claim 15. Therefore, it is my opinion that Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA makes obvious claim 15 for the same reasons as I discussed above with respect to claim 7.

14. Claim 16 – “The display device according to claim 12, wherein the sensor measures the temperature of the air having passed through the front channel and sends the resulting signal to the control device.”

132. As I discussed above with respect to claim 6, a POSITA would have been motivated as a design choice to position a temperature sensor in Nagayama’s display device “to measure a temperature of the air having passed through the front channel, and to send a resulting signal to the flow rate controller,” which recites the same features as claim 16, though with slightly different wording. Therefore, it

is my opinion that Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA make obvious claim 16 for the same reasons as I discussed above with respect to claim 6.

15. Claim 17 – “The display device according to claim 12, wherein the control device generates an air flow to the front channel to control a velocity of the air flow according to a state of the housing.”

133. As I discussed above with respect to claim 9, a POSITA would have been motivated as a design choice to position a temperature sensor in Nagayama’s display device to measure the temperature of the housing. Further, signals from such a temperature sensor would send signals to Nagayama’s liquid crystal panel temperature control board TC, which controls its fan(s) “to generate an air flow to the front channel to control a velocity of the air flow according to a state of the housing,” which recites the same features as claim 17, though with slightly different wording. Therefore, it is my opinion that Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA makes obvious claim 17 for the same reasons as I discussed above with respect to claim 9.

16. Claim 18 – “The display device according to claim 12, wherein the front channel defined between the display panel assembly and the front side of the housing has a spacing distance in a range of 0.005 to 0.025 m.”

134. As I discussed above with respect to claim 10, Nagayama, Gromatzky, and Matsuoka makes obvious “wherein: the front channel defined

between the display panel assembly and the front side of the housing has a spacing distance in a range of 0.005 to 0.025 m,” which recites the same features as claim 18. Therefore, it is my opinion that Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA make obvious claim 18 for the same reasons as I discussed above with respect to claim 10.

17. Claim 19 – “The display device according to claim 12, wherein the control device regulates a flow rate of the air in the fan such that a flow velocity of the air in the front channel is maintained at 4 m/s or more.”

135. As I discussed above with respect to claim 8, Nagayama, Gromatzky, and Matsuoka make obvious “wherein: the flow rate controller regulates the flow rate of the air in the fan such that the flow velocity of air in the front channel is maintained at 4 m/s or more,” which recites the same features as claim 19, though with slightly different wording. Therefore, it is my opinion that Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA make obvious claim 19 for the same reasons as I discussed above with respect to claim 8.

18. Claim 20 – “The display device according to claim 11, wherein the housing is partitioned into an upper space and a lower space in which the fan is disposed to blow the air to at least one of front side and back side of the display assembly.”

136. As I discussed above with respect to claim 2, Nagayama, Gromatzky, and Matsuoka makes obvious “wherein: the housing partitioned into an upper space and a lower space disposed below the upper space and includes a fan to blow

the air to front channel,” which is similar to the limitations in claim 20, except that claim 20 recites that “the is disposed to blow the air to at least one of front side and back side of the display assembly” rather than “to blow the air to front channel.” I interpret “at least one of front side and back side of the display assembly” to mean that the fan must blow air to either the front side or the back side of the display assembly. It can also cover blowing air to both the front and the back sides, but blowing to only one of the front or the back sides is sufficient to meet the claim limitation.

137. As discussed above with respect to claim 1c, Nagayama discloses air flowing through the front channel, AC1. Similarly, both Gromatzky and Matsuoka disclose using a fan to blow air over the front side or the back side of their display panels. Ex. 1007, Fig. 1 (30, 32), 4:52-63 (circulating air over the front and back of the LCD module 26); Ex. 1008, Fig. 1 (224), 5:24-37 (pulling air through the LCD storage section 220, 220a over the back of the LCD screen).

138. Therefore, it is my opinion that Nagayama, Gromatzky, Matsuoka, and the knowledge of a POSITA makes obvious claim 20 for these reasons as well as those discussed above with respect to claims 1c and 2.

X. '253 Patent – Karppanen Grounds

139. In the following sections, I set forth my analysis and conclusions as to the validity of claims 1, 2, 4-12, and 14-20 of the '253 patent based on Karppanen as the primary reference.

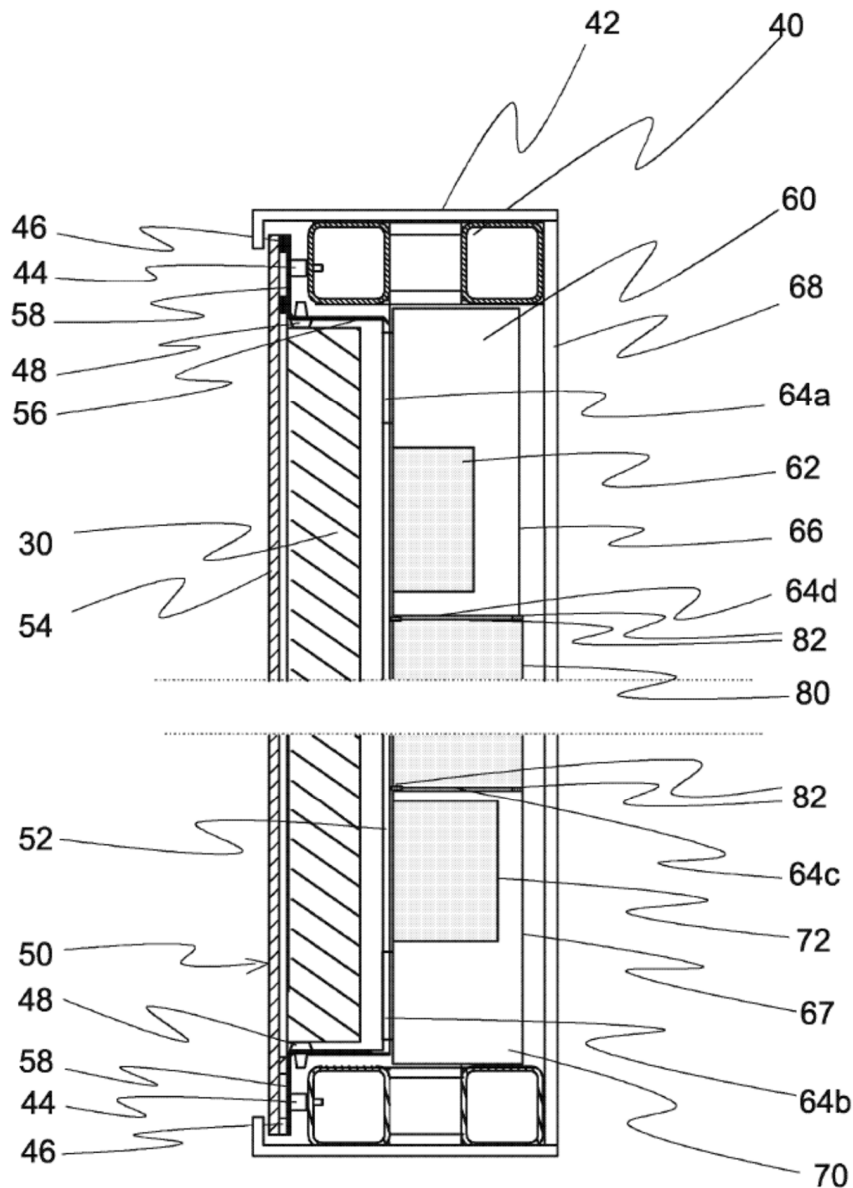
A. Claims 1-2, 4-12, and 14-20

140. It is my opinion that Karppanen in view Gromatzky and the knowledge of a POSITA renders claims 1-2, 4-7, 9, 11-12, 14-17, and 20 obvious. Karppanen discloses an electronic information board that includes an LCD display contained within a housing that has a cooling system designed to flow air over the front side of the LCD display. Further, as I discussed above with respect to the Nagayama grounds above in Section VIII, Gromatzky also discloses a display system that positions an LCD display screen within a housing that provides air cooling over the front surface of the LCD display screen. Thus, both of these references are directed to cooling display screens contained within housings. This is the same field of technology as the '253 Patent and, as I discussed above and in more detail below, it would have been obvious to combine the teachings of the Karppanen reference with the teachings of the Gromatzky reference.

1. Claim 1, Preamble – “A display device, comprising:”

141. I understand that claim preambles are not ordinarily a limitation on a patent claim, but even if the preamble of claim 1 is limiting, Karppanen discloses display devices. Ex. 1008, Abstract, 1:1-3, 1:13-28. For example, Karppanen

shows a display device, referred to as an “electronic information board,” that includes a “display element” 30, such as a thin-film transistor (“TFT”) LCD or plasma display. Ex. 1008, Fig. 1, 6:23-30.



142. Thus, it is my opinion that Karppanen discloses the preamble of claim

1.

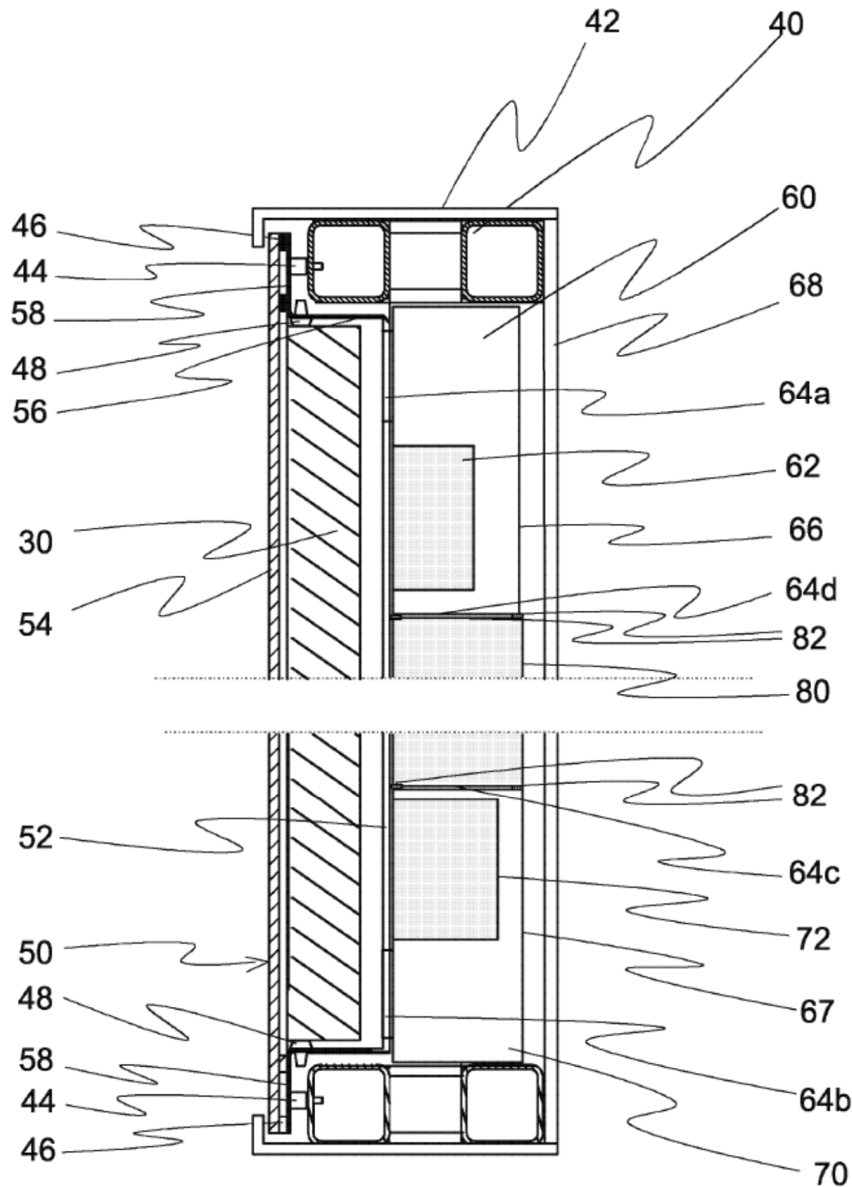
(a) Claim 1a – “a housing”

143. Karppanen discloses that its electronic information boards include housings. As I discussed above with respect to the preamble, Figure 1 of Karppanen shows an example of one electronic information board. It includes a frame 40 and lining plate 42, which provide at least a part of an enclosure for the display element 30. Ex. 1008, Figs. 1-2, 6:5-9. The frame 40 is depicted as four tubular members with square-shaped cross-sections, the top two of which are shown as overlaid by the lining plate 42. The lower two tubular members have a similar plate affixed beneath them. A “back cover” 68 is also affixed to the rear-most tubular members. Ex. 1008, Fig. 1. Side walls are also depicted in Figure 2, at least one of which has ventilation slots 78 formed in it. Ex. 1008, Fig. 2; see also Ex. 1008, 9:34-10:4. Thus, these components form a housing into which the display element is placed.

144. Karppanen also discloses that the display element 30 is inside of a “display casing” 50, which has “a back wall 52, a transparent front plate 54 and an edge part 56 having a flange-like fastening collar 58.” Ex. 1008, 6:9-12. The fastening collar 58 is then fastened to the frame 40 by fastening means 44. Ex. 1008, 6:10-12. And while Figure 1 only labels one edge part, the remainder of the description discloses that there are multiple edge parts, together with the back wall 52 and transparent front plate 54 fully enclose the display element 30. Ex. 1008,

6:9-16. For example, Karppanen discloses that “[t]he transparent front plate has been fastened to the fastening collar of the edge parts by means of flexible, vibration attenuating sealing elements 46 so that the edge parts of the front plate and the back wall *form a closed display casing*.” Ex. 1008, 6:13-16 (emphasis added). Thus, in addition to the frame 40, back cover 52, and side walls discussed above, the display casing 50 itself forms a housing. Each of these two structures independently is a housing, and Karppanen discloses that the display casing 50 is positioned within the housing formed by the frame 40, back cover 52, and side walls. Karppanen further shows a bottom plate in figure 2 covering the bottom part of the housing.

145. In addition, as can be seen in Figure 1 below, the transparent front plate 54 is positioned both at the front of the display casing 50 but is also positioned to the front of the housing formed by the frame 40, lining plate 42, back plate 68, the plate on the underside of the frame 40, and the side walls depicted in Figure 2, as discussed above. Thus, the transparent front plate forms the front of both housings.



146. Therefore, it is my opinion that Karppanen discloses claim 1a.

(b) Claim 1b – “a display assembly enclosed inside the housing to form a front channel between a display panel of the display assembly and a front side of the housing”

147. As I discussed above with respect to the preamble to claim 1 and claim 1a, Karppanen discloses that its electronic information board includes a display element 30. For example, Karppanen discloses that the display element “is

and the back cover 68, as discussed above with respect to claim 1a. Thus, Karppanen's display assembly is "enclosed inside the housing" as recited in claim 1b. Karppanen also discloses that it positions its display element 30 within the display casing 50 in such a way as to form a gap between the display element 30 and the transparent front plate 54. Ex. 1008, 3:31-4:2, 6:23-26. And as I noted above, the front plate 1b forms the front portion of both the display casing 50 and the housing formed by the frame 40 and other components discussed above. Thus, Karppanen's the gap formed between the display assembly and the transparent front plate 54 is "a front channel between a display panel of the display assembly and a front side of the housing."

149. Therefore, it is my opinion that Karppanen discloses claim 1b.

(c) Claim 1c – "a flow control device to generate an air flow to the front channel and to control a velocity of the air flow according to a state of the display assembly."

150. Karppanen describes that its electronic information board includes a cooling system that has "at least one circulating fan for forming an air flow through the display casing and the device casing." Ex. 1008, 4:3-5. It states that the "air flowing through the display and device casing 'rinses' the surfaces of the electronic devices and the display element, whereupon heat transfers effectively from these devices into the air flowing by." Ex. 1008, 4:6-8. And Karppanen specifically credits the gaps on the front and back sides of the display, which

allows the air to flow past both sides, as a part of the effectiveness of its cooling system. Ex. 1008, 4:9-10.

151. Figure 1 shows the structure of a “fan casing” 70, which includes one or more circulating fans 70. Ex. 1008, Fig. 1, 7:11-12. Karppanen describes that the fan casing 70 is attached to the rear of the device casing 50, and that an opening is provided in the back wall 52 of the device casing 50 to allow air flow from the circulating fans 70 to flow into the device casing 50 and around the display element 30. Ex. 1008, 7:11-21. Thus, Karppanen’s device uses the circulating fans 72 in the fan casing to create an air flow into the device casing 50, which guides the air flow around the front and back sides of the display element 30, as I discussed above.

152. In addition, Karppanen describes the path the air flow takes through its device. In particular, it describes that air from the circulating fans 72 passes upward through a cross-flow cell from flow hole 64c to 64d, at which time it is directed into flow hole 64a, which is formed in the upper part of the display casing 50. Ex. 1008, 8:9-14. The air flow then traverses the display casing 50, passing in front of and behind the display element 30, before exiting the bottom of the display casing 50 at flow hole 64b, where it encounters the circulating fans and begins the flow path again. Ex. 1008, 8:9-14.

153. Karppanen explains that it maintains the temperature of the device and display casings 50, 60 within “desired limits.” Ex. 1008, 9:9-11. To do so, it uses temperature transducers, which are “connected to the control unit in the device casing” and that the “control unit controls the operation of the circulating fans 72 based on the measured temperatures in accordance with a predetermined control logic.” Ex. 1008, 9:13-21. Therefore, it is my opinion that this means that the circulation fans are controlled by the control unit based on the sensed temperatures from the transducers. The sensed temperature is, in my opinion, a state.

154. Karppanen states that one of the purposes of its design is to improve temperature control for an electronic information board, including cooling the display element itself because it may be rendered inoperative or damaged at high temperatures. Ex. 1008, 2:27-34 (“For example, the LCD matrix of TFT LCD display elements becomes inoperative already at the temperature of 70°C.”). To obtain temperature information, Karppanen discloses that transducers may be placed in the device and display casings, thereby providing the ability to measure the temperatures of different components of the electronic information board. Ex. 1008, 9:14-16.

155. While Karppanen does not explicitly state where the transducers are positioned within display casing, since Karppanen is attempting to regulate the temperature of the display element to prevent damage, placing a transducer on the

display element to sense its temperature directly is at least implicit to Karppanen, but also would have been obvious to a POSITA. Ex. 1008, 1:20-22, 2:27-33. Further, placing a transducer within the display casing 50 where it would be in close proximity to the display element 30 would effectively measure the temperature of the display element 30 within a reasonable level of accuracy. Based on this, in my opinion, Karppanen discloses, at least implicitly, or makes obvious to a POSITA controlling the operation of the circulating fans based on a sensed temperature of the display element 30. Thus, the control unit in combination with the circulation fans and the transducers provide a “a flow control device to generate an air flow to the front channel and to control a velocity of the air flow according to a state of the display assembly” as recited in claim 1c.

156. Therefore, it is my opinion that Karppanen discloses or makes obvious claim 1c.

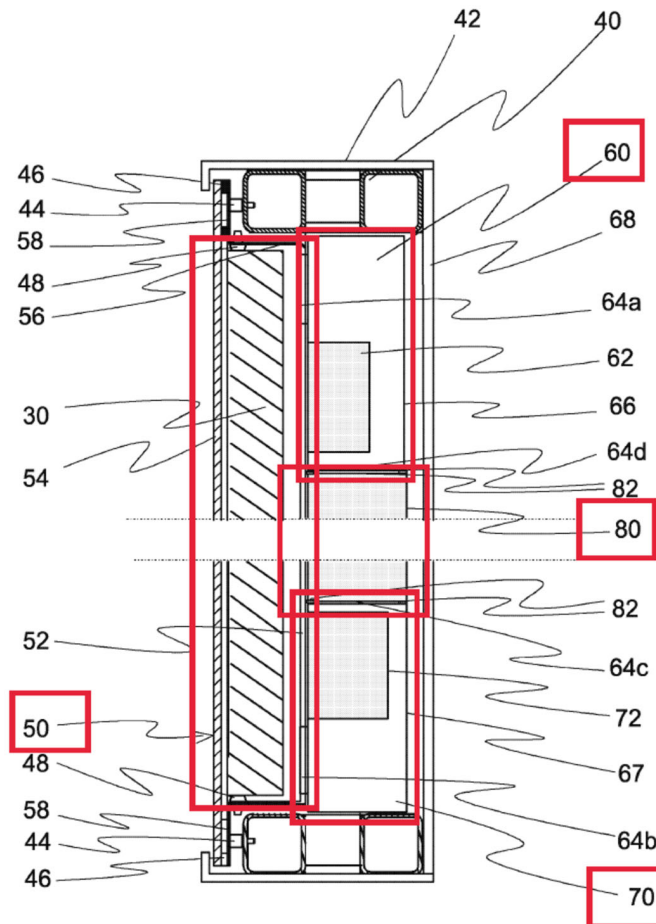
(d) Conclusion

157. In view of my analysis above, claim 1 is invalid based on Karppanen.

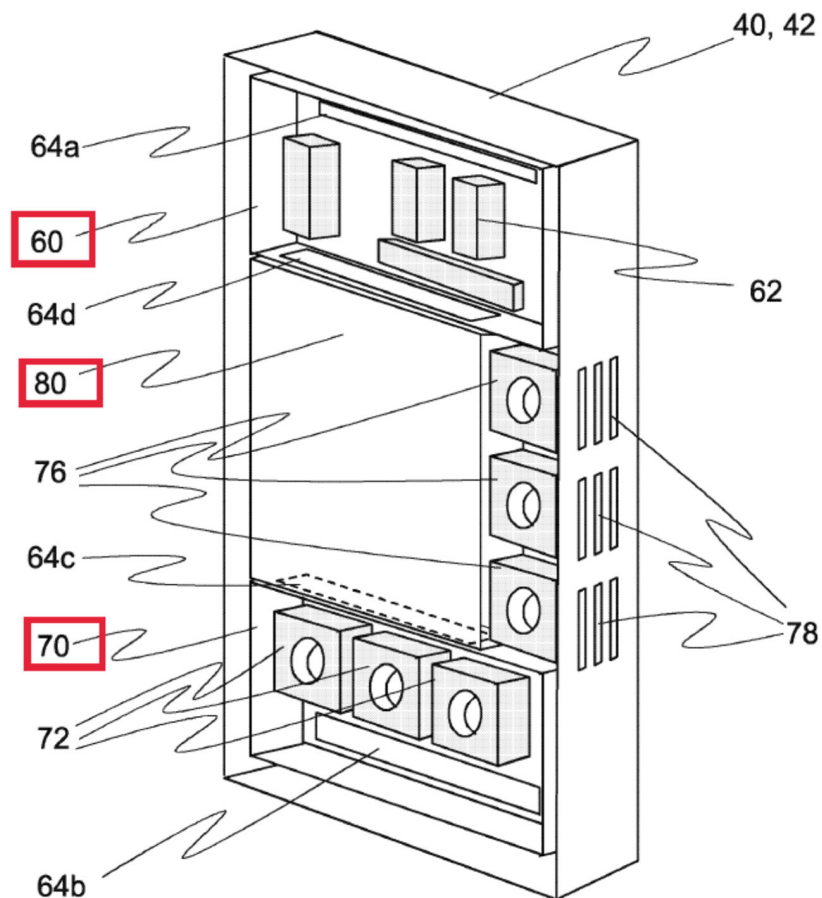
2. Claim 2 – “The display device according to claim 1, wherein: the housing partitioned into an upper space and a lower space disposed below the upper space and includes a fan to blow the air to front channel.”

158. Karppanen divides its housing into different spaces and therefore discloses this claim. For example, Karppanen describes that inside of the frame 40, lining plate 42, side walls depicted in Figure 2, and back plate 68 are positioned at

fan casing 70, cross-flow cell 80, device casing 60, and display casing 50. Ex. 1008, Figs. 1-2, 6:5-22, 6:31-8:2. Each of these are disclosed as being discrete spaces within the frame 40 and are visible as separate spaces in Figure 1:



159. As can be seen in Figure 1, the device casing 60 sits above the cross-flow cell 80, which sits above the fan casing 70. Thus, the device casing 60 could be the claimed upper space and either the cross-flow cell 80 or the fan casing 70 could be the lower space. Further, the cross-flow cell 80 could be the claimed upper space and the fan casing 70 could be the lower space. These spaces are also shown in Figure 2:



160. Alternatively, Karppanen discusses the display casing 50 having both an upper part and a lower part: “When the circulating fans are in operation, the air flows from the fan casing through the third flow hole 64c to the cross-flow cell, from the cross-flow cell through the fourth flow hole 64d to the device casing 60, from the device casing through the first flow hole 64a to *the upper part of the display casing 50* and through the second flow hole 64b in *the lower part of the display casing* back to the fan casing, after which a new circuit begins.” Ex. 1008, 8:9-14. Thus, Karppanen discloses that its housing is “partitioned into an upper space and a lower space disposed below the upper space.”

161. As discussed above with respect to claim 1c, Karppanen also includes one or more fans, such as within the fan casing 70, “to blow the air to front channel.” Karppanen states that air from the circulating fans 72 (within the fan casing) passes upward through the cross-flow cell 80 from flow hole 64c to 64d, at which time it is directed into flow hole 64a, which is formed in the upper part of the display casing 50. Ex. 1008, 8:9-14. The air flow then traverses the display casing 50, passing in front of and behind the display element 30, before exiting the bottom of the display casing 50 at flow hole 64b, where it encounters the circulating fans and begins the flow path again. Ex. 1008, 8:9-14.

162. And as I discussed with respect to claim 1c, Karppanen describes that the “air flowing through the display and device casing “rinses” the surfaces of the electronic devices and the display element, whereupon heat transfers effectively from these devices into the air flowing by.” Ex. 1008, 4:6-8. Karppanen specifically credits the gaps on the front and back sides of the display, which allows the air to flow past both sides, as a part of the effectiveness of its cooling system. Ex. 1008, 4:9-10. Thus, Karppanen describes that air circulated by its circulating fans passes through the cross-flow cell 80, the device casing 60, into the display casing 50, where it flows over the front surface of the display element between the transparent front plate 52, and back into the fan casing 70. In my

opinion, this discloses that Karppanen's housing includes "a fan to blow the air to front channel."

163. Therefore, it is my opinion that Karppanen discloses all the additional limitations of claim 2.

3. Claim 4 – "The display device according to claim 2, wherein: the flow control device further includes a sensor to measure the state of the display assembly."

164. As I discussed above with respect to claim 1c, Karppanen discloses that it uses transducers, which are sensors, to measure the state of the display assembly. *See, e.g.*, Ex. 1008, 9:13-21. And I have already established above with respect to claim 1c that the transducers are a part of the flow control device. And while the fans and temperature sensor are not integrated into one another or the temperature control board, the arrangement and interconnection between these various components is a mere design choice.

165. Therefore, it is my opinion that Karppanen discloses all the additional limitations of claim 4.

4. Claim 5 – "The display device according to claim 4, wherein the flow control device further comprises: a flow rate controller to control a flow rate of the air in the fan such that the air in the front channel has a controlled flow velocity."

166. As I discussed above with respect to claim 1c, the claimed flow rate controller includes Karppanen's control unit in combination with the circulation fans and the transducers. Karppanen's control unit "controls the operation of the

circulating fans 72 based on the measured temperatures in accordance with a predetermined control logic.” Ex. 1008, 9:16-18. Thus, Karppanen discloses that air circulation, i.e., air flow, is regulated by its control unit based on signals sent by the transducers based on the sensed temperature. Thus, Karppanen discloses, or at least suggests to a POSITA, sending signals to adjust the rotational speed of the fans based on a sensed temperature, which controls the flow velocity, and therefore the flow rate of the air, that passes through the display casing between the front of the display element 30 and the transparent front plate.

167. Therefore, it is my opinion that Karppanen discloses or make obvious, with the knowledges of a POSITA, claim 5.

5. Claim 6 – “The display device according to claim 5, wherein: the sensor is a temperature sensor to measure a temperature of the air having passed through the front channel, and to send a resulting signal to the flow rate controller.”

168. As I discussed above with respect to claim 1c, Karppanen describes using a transducer to sense a state of the display assembly and, as discussed with respect to claim 5, that Karppanen uses signals from the sensor to control the operation of the circulating fans. Karppanen discloses that transducers are positioned within the device casing and display casing but does not identify where in the display casing the transducer is located. However, a POSITA incorporating instrumentation into an electronic display board, such as Karppanen’s, to sense temperature and to control cooling fans based on the temperature would position

one or more temperature sensors in locations to sense temperatures that indicate the temperatures of certain electronics. In the case of the display casing, a POSITA would want to position the transducer to obtain temperature information about the display element 30.

169. My understanding is that prior to the priority date of the '253 Patent, it was known to position temperature sensors at different locations within a display device. For example, I reviewed the Burke reference which explained that it was known to position one or more temperature sensors within the housing of the device or within an electronics chamber of the device. Ex. 1011, 6:24-33.

Similarly, the Hannemann reference explains that the number and position of temperature sensors may be varied as needed to allow for thermal regulation. Ex. 1013, ¶ 19. Utilizing one or more temperature sensors and the decision of where and how many temperature sensors to utilize are simply a design choice based on the anticipated use case for the device, such as will it be utilized indoors or outdoors.

170. In the case of Karppanen, one option would be to affix a transducer to the display element itself 30; however, because the display element may be obtained from a supplier as a self-contained unit, useful attachment points for a temperature sensor may be limited. For example, affixing the temperature sensor to the front of the display element 30 may partially obscure a portion of the display

element, making the sensor visible to the viewer and degrading the quality of the picture. Thus, an alternative option would be to locate the temperature sensor in a region of air flow immediately downstream from the display element, after air has flown past the display. In such a configuration, the temperature of the air flow at that point would provide a good indication of the temperature of the display element itself. This is because air is blown through gap between the display element and the front plate to cool the LCD panel, the temperature of the air exiting the channel would provide an accurate indication of the temperature of the LCD panel because the air would have passed over a larger portion of the panel. Further, such a placement aligns with Karppanen's express description "control[ing] the operation of the circulating fans 72 based on the measured temperatures" as determined by the transducers. Ex. 1008, 9:14-17. Thus, a POSITA would be aware that positioning a temperature sensor at the exit of this channel would provide accurate information about the temperature of the whole LCD panel. Further, such a placement aligns with Karppanen's express description "control[ing] the operation of the circulating fans 72 based on the measured temperatures" as determined by the transducers. Ex. 1008, 9:14-17. Therefore, as one of a few available locations to position temperature sensor, it would have been obvious to a POSITA to position Karppanen's transducer "to measure a temperature of the air having passed through the front channel." Further,

Karppanen discloses that signals from its temperature sensors are sent to its control unit to control its circulation fans. Ex. 1008, 9:14-18.

171. For at least these reasons, and those given above with respect to claims 1c and 5, claim 6 would have been obvious based on Karppanen and the knowledge of a POSITA.

6. Claim 7 – “The display device according to claim 2, wherein the front channel comprises: an air inlet to guide air into the channel and an air outlet to discharge air from the channel; and the fan is located near the air inlet.”

172. As I discussed above with respect to claims 1c and 2, Karppanen uses a circulating fan to blow air into the display casing, where the air “rinses” the display element 30, after which the air exits the display casing to be recirculated. Karppanen describes the specific airflow path as proceeding from the circulating fans 72 through the cross-flow cell 80, through “first flow hole” 64a into the display casing 50, down through the display casing and over the front side of the display element 30, and out of the display casing via second flow hole 64b to begin a new circuit. Ex. 1008, 8:3-21. Each of these flow holes is positioned to guide into or out of the front channel. Thus, it is my opinion that the front channel “comprises” these two flow holes. And in the configuration explicitly described in Karppanen, first flow hole 64a constitutes “an air inlet to guide air into the channel” and second flow hole 64b constitutes “an air outlet to discharge air from

the channel.” However, a POSITA would recognize that the direction of the air flow is arbitrary in the Karppanen device.

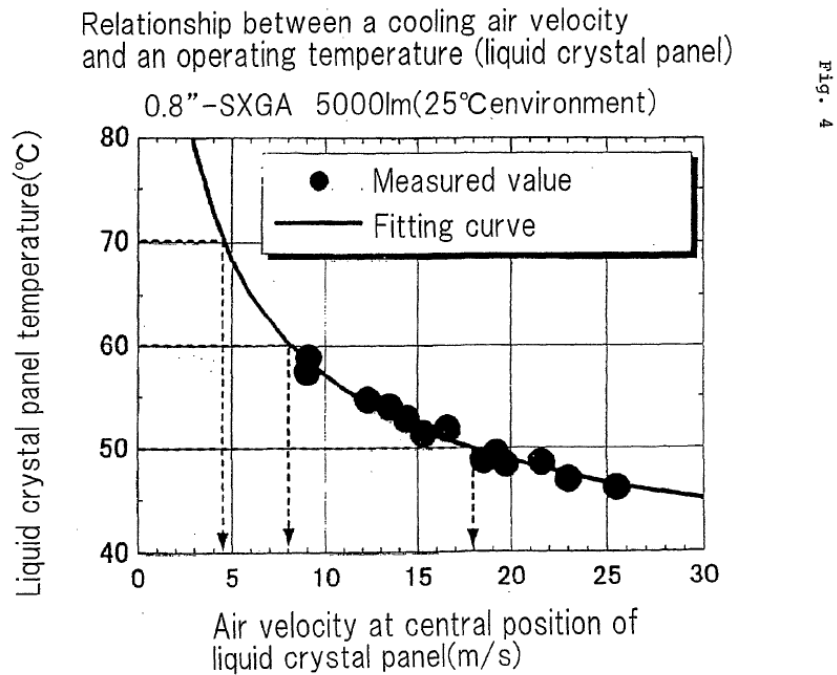
173. But while Karppanen describes the airflow above, it does not provide any reason for circulating the air in one direction or the other. Further, a POSITA would recognize that reversing the direction of the air flow to blow air into the display casing 64b would circulate air that has just been cooled by the cross-flow cell 80. Thus, the air blown into the display casing would be the coolest air available within the circulation loop. In the configuration described by Karppanen, the air first flows through the device casing, where it will be heated by the electronic components within the device casing, before passing into the display casing and through the channel formed between the front of the display element and the transparent plate. Thus, the cooling efficiency for the display element 30 will be less than if the air was blown into flow hole 64b immediately after having been cooled by the cross-flow cell 80. Further, Karppanen specifically explains the importance of cooling the display element 30 itself. Karppanen, 2:15-3:4. Thus, a POSITA considering the Karppanen device would be motivated to reverse the direction of the circulating air flow within Karppanen by reversing the direction of the circulating fans 72 to blow cooler air over the front of the display element and more effectively cool the display element 30.

174. In such a configuration, the second flow hole 64b would constitute “an air inlet to guide air into the channel,” while the first flow hole 64a would constitute “an air outlet to discharge air from the channel.” Further, when the second flow hold 64b serves as the air inlet, the circulating fans are “located near the air inlet.”

175. Thus, it is my opinion that claim 7 is obvious based on Karppanen and the knowledge of a POSITA.

7. Claim 8 – “The display device according to claim 2, wherein: the flow rate controller regulates the flow rate of the air in the fan such that the flow velocity of air in the front channel is maintained at 4 m/s or more.”

176. As discussed above, Karppanen discloses all aspects of claims 1 and 2; however, Karppanen does not specifically discuss the velocity of air flow in the gap formed between the display element 30 and the transparent front plate 54. However, Utsunomiya provides information explaining the need for sufficient air flow velocity to cool an LCD panel. In particular, Utsunomiya’s Figure 4 provides a plot that illustrates the relationship between cool air velocity and operating temperature of the LCD panel:



177. In describing this plot, Utsunomiya explains that “Fig. 4 is a graph showing the relationship between a panel cooling air velocity and the panel operating temperature in 0.8"-SXGA (5000-Im class, 25°C environment). For reducing the panel operating temperature from 70°C to 60°C ($\Delta T = -10^\circ\text{C}$), the air velocity may be simply increased from 4.5 m/s to 8 m/s ($\Delta V = +3.5$ m/s), whereas for reducing from 60°C to 50°C ($\Delta T = -10^\circ\text{C}$), the air velocity must be increased from 8 m/s to 18 m/s ($\Delta V = +10$ m/s), as can be seen from the graph.” Thus, Utsunomiya explains that to cool a panel temperature of 70 degrees C in a 25 degrees C environment to 60 degrees, the air velocity must increase from 4.5 meters per second to 8 meters per second.

178. In designing a cooling system like Karppanen's, a POSITA would be aware of well-known characteristics relationships between fan speed and temperature, like what is shown in Utsunomiya. Further, as I discussed above in the Motivation to Combine section, the characteristic relationships between fan speed and cooling effect for both laminar and turbulent flows were well-known prior to the priority dates of the Challenged Patents. See Section VIII. Further, a POSITA seeking to cool a device, such as Karppanen's would have sought to set fan speeds in a manner to provide sufficient cooling of the LCD panel, while simultaneously prevent unreasonable power usage for high fan speeds, i.e., high air flowrates, as well as other considerations, such operating noise of cooling fans based on their rotational speed. Thus, a POSITA considering Karppanen, while aware of Utsunomiya, would be motivated to use the air flows disclosed by Utsunomiya as a basis for selecting suitable air flow speeds for use in the Karppanen device, based on the type of desired air flow (laminar or turbulent), and it would have been obvious to try air flows at or above 4.5 meters per second to obtain the desirable cooling effect, without consuming too much power and generating too much noise..

179. Therefore, it is my opinion that claim 8 is obvious based on Karppanen, Utsunomiya, and the knowledge of a POSITA.

8. Claim 9 – “The display device according to claim 1, wherein the flow control device to generate an air flow to the front channel to control a velocity of the air flow according to a state of the housing.”

180. The limitation in claim 9 is nearly identical to the limitation in claim 1c; however, claim 9 recites the state of the housing rather than the state of the display assembly. Since claim 9 is a dependent claim, I interpret this claim to mean that the flow control device controls the velocity of air flow based on the state of the display assembly, as in claim 1c, and the state of the housing, as in claim 9. Karppanen discloses, or at least makes obvious claim 1c, as I discussed above.

181. Karppanen also discloses that it may use multiple transducers, in the display casing 50 and the device casing 60. Ex. 1008, 9:14-16. Each of these casings is located within the Karppanen housing. Thus, if the transducer in the display casing 50 is measuring the temperature of the display element 30, as I discussed above with respect to claim 1c, the transducer in the device casing 60 provides temperature data about another part of the housing of the electronic information board, which is a “state of the housing.” Further, Karppanen discloses that its “control unit controls the operation of the circulating fans 72 based on the measured temperatures in accordance with a predetermined control logic. With the help of the internal cooling air circulation generated with circulating fans, the temperatures of the inner parts of the display casing and the device casing can be standardized and the heat can be effectively transferred away from the inside of the

casings.” Ex. 1008, 9:13-21. This portion of Karppanen refers to multiple temperatures within the different parts of the electronic information board, such to sense the temperature within the housing or of the housing itself. Thus, Karppanen suggests that temperature transducers may be in multiple locations, including within the housing or affixed to the housing.

182. Further, information about the temperature of the housing can be desirable when controlling cooling fans. For example, affixing a temperature transducer to the housing provides temperature related to potential thermal sources exterior to the housing, such as sunlight or a temperature of the air outside of the housing. Since Karppanen’s device is intended to be used in outdoor environments, receiving temperature information about such external thermal sources can help adjust control of the cooling fans. For example, if the temperature of the housing is relatively high as compared to a temperature of air exiting the channel between the display panel and the front plate, it may indicate that sunlight is striking the Karppanen device and thereby adding additional heat to the Karppanen device. This may be used to signal a change in the speed of cooling fans to help compensate for the temperature of the housing.

183. Thus, it is my opinion that Karppanen makes obvious “wherein the flow control device to generate an air flow to the front channel to control a velocity of the air flow according to a state of the housing” as recited in claim 9.

184. Therefore, it is my opinion that Karppanen discloses or make obvious, with the knowledge of a POSITA, claim 9.

9. Claim 10 – “The display device according to claim 1, wherein: the front channel defined between the display panel assembly and the front side of the housing has a spacing distance in a range of 0.005 to 0.025 m.”

185. As I discussed above with respect to claim 1, Karppanen discloses all aspects of claim 1. And while it discloses the claimed “front channel,” it does not provide specific sizing for the gap between the display element 30 and the transparent front plate 54. However, Gromatzky discloses that a suitable size for a gap between a front of a display panel and a transparent panel of a housing is 9.4 millimeters, or 0.0094 meters. Ex. 1007, 4:39-41. Because 0.0094 meters is within the range of 0.005 and 0.025 meters, Gromatzky discloses the claimed spacing distance. Because Karppanen and Gromatzky are both providing display devices having the same type of gap between display assemblies and transparent portions of a housing, a POSITA aware of Gromatzky would be taught to space the Karppanen display element 9.4 millimeters from the transparent front plate 54. In particular, Gromatzky teaches that such a spacing “also allows air to be routed across the LCD module 26 for thermal management.” Ex. 1007, 4:42-45. Thus, Gromatzky teaches a particular spacing to enable air to be blown through the 9.4-millimeter gap to help cool the LCD module, i.e., the display element, as Karppanen does.

186. Therefore, it is my opinion that Karppanen Gromatzky, and the knowledge of a POSITA make obvious claim 10.

10. Claim 11 – “A display device, comprising:”

187. As I discussed above with respect to claim 1, Karppanen discloses a display device. Therefore, Karppanen discloses the preamble of claim 11 for the same reasons as I gave above with respect to the preamble of claim 1.

(a) Claim 11a – “a housing;”

188. As I discussed above with respect to claim 1a, Karppanen discloses a display device having a housing. Therefore, Karppanen discloses claim 11a for the same reasons as I gave above with respect to claim 1a.

(b) Claim 11b – “a display assembly enclosed inside the housing;”

189. As I discussed above with respect to claim 1b, Karppanen discloses a display assembly that is enclosed inside the housing of the electronic information board. Therefore, Karppanen discloses claim 11b for these reasons and the same reasons as I gave above with respect to claim 1b.

(c) Claim 11c – “a sensor to measure a temperature of air in the housing;”

190. As I discussed above with respect to claim 6, Karppanen discloses that its electronic information board includes transducers within the device and display casings, and that a POSITA would view the positioning of temperature sensors as a matter of design choice. Because a transducer placed into either of these casings is

within Karppanen's housing, these transducers measure the temperature of air in the housing. And while Karppanen does not explicitly state where in the device and display casings the transducers are placed, it is at least implicit, as well as obvious to a POSITA at the time the '253 Patent was filed, to position one or more transducers to measure air temperature within the device or display casing, which measures the temperature of air within the housing.

191. Thus, Karppanen discloses or makes obvious, with the knowledge of a POSITA, claim 11c.

(d) Claim 11d – “a fan configured to blow the air around the display assembly; and”

192. As I discussed above with respect to claim 1c, Karppanen discloses the use of one or more fans to blow air past around the display element 30 so that the air “rinses’ the surfaces of the electronic devices and the display element.” Ex. 1008, 4:6-8. By “rinsing” the surfaces of the display element, Karppanen means that the air is blown around the display assembly.

193. Therefore, it is my opinion that Karppanen discloses claim 11d for these reasons and the same reasons as I discussed above with respect to claim 1c.

(e) Claim 11e – “a control device to control the fan to maintain a temperature of the housing”

194. As I discussed above with respect to claims 1c and 6, Karppanen discloses a flow control device that includes the control unit in combination with

the circulation fans and the transducers. The control unit is described as controlling the fans in the Karppanen device. Ex. 1008, 9:9-21. The fans circulate air through the housing of the electronic information board and through different spaces within the housing, including the fan casing, the cross-flow cell, the device casing, and the display casing. Ex. 1008, 8:6-21. Because Karppanen describes that transducers are placed both within the device casing and the display casing, both of which are within the Karppanen housing, the transducers measure the temperature of the air in the housing. Further Karppanen describes that “[w]ith the help of the internal cooling air circulation generated with circulating fans, the temperatures of the inner parts of the display casing and the device casing can be standardized and the heat can be effectively transferred away from the inside of the casings.” Ex. 1008, 9:18-21. By “standardizing” the temperatures, Karppanen is disclosing “maintain[ing] a temperature of the housing.”

195. Therefore, it is my opinion that Karppanen discloses claim 11e for these reasons and the same reasons as I discussed above with respect to claims 1c and 6.

(f) Claim 11f – “wherein the sensor transmits a resulting signal to the control device and the control device controls the fan based on the resulting signal.”

196. As I discussed above with respect to claim 1c, Karppanen discloses that its control unit controls the operation of the circulating fans based on

temperatures, which are measured by transducers connected to the control unit. While Karppanen does not explicitly describe the signals sent by the transducers, the transducers must be sending temperature information of some kind to the control unit. And it is inherent or implicit, or at least obvious, that the transducers send signals to the control unit.

197. Therefore, it is my opinion that Karppanen discloses or makes obvious, with the knowledge of a POSITA, claim 11f for these reasons and the same reasons as I discussed above with respect to claim 1c.

11. Claim 12 – “The display device according to claim 11, wherein the display assembly is enclosed inside the housing to form a front channel between a display panel of the display assembly and a front side of the housing.”

198. As I discussed above with respect to claim 1b, Karppanen discloses “wherein the display assembly is enclosed inside the housing to form a front channel between a display panel of the display assembly and a front side of the housing.” Therefore, it is my opinion that Karppanen discloses or makes obvious, with the knowledge of a POSITA, claim 12 for the same reasons as I discussed above with respect to claim 1b.

12. Claim 14 – “The display device according to claim 13, wherein the control device controls a flow rate of the air in the fan such that the air in the front channel has a controlled flow velocity.”

199. As I discussed above with respect to claim 5, Karppanen discloses “wherein the flow control device further comprises: a flow rate controller to control a flow rate of the air in the fan such that the air in the front channel has a controlled flow velocity,” which recites essentially the same features as claim 14, though worded slightly differently. Therefore, it is my opinion that Karppanen discloses or makes obvious, with the knowledge of a POSITA, claim 14 for the same reasons as I discussed above with respect to claim 5.

13. Claim 15 – “The display device according to claim 12, wherein: the front channel comprises an air inlet to guide air into the front channel and an air outlet to discharge air from the front channel; and the fan is located near the air inlet.”

200. As I discussed above with respect to claim 7, Karppanen makes obvious a configuration of its air circulation system “wherein the front channel comprises: an air inlet to guide air into the channel and an air outlet to discharge air from the channel; and the fan is located near the air inlet,” which recites the same features as claim 15. Therefore, it is my opinion that Karppanen makes obvious, with the knowledge of a POSITA, claim 15 for the same reasons as I discussed above with respect to claim 7.

14. Claim 16 – “The display device according to claim 12, wherein the sensor measures the temperature of the air having passed through the front channel and sends the resulting signal to the control device.”

201. As I discussed above with respect to claim 6, Karppanen and the knowledge of a POSITA makes obvious “wherein: the sensor is a temperature sensor to measure a temperature of the air having passed through the front channel, and to send a resulting signal to the flow rate controller,” which recites the same features as claim 16, though with slightly different wording. Therefore, it is my opinion that Karppanen makes obvious, with the knowledge of a POSITA, claim 16 for the same reasons as I discussed above with respect to claim 6.

15. Claim 17 – “The display device according to claim 12, wherein the control device generates an air flow to the front channel to control a velocity of the air flow according to a state of the housing.”

202. As I discussed above with respect to claim 9, Karppanen discloses “wherein the flow control device to generate an air flow to the front channel to control a velocity of the air flow according to a state of the housing,” which recites the same features as claim 17, though with slightly different wording. Therefore, it is my opinion that Karppanen and the knowledge of a POSITA makes obvious claim 17 for the same reasons as I discussed above with respect to claim 9.

16. Claim 18 – “The display device according to claim 12, wherein the front channel defined between the display panel assembly and the front side of the housing has a spacing distance in a range of 0.005 to 0.025 m.”

203. As I discussed above with respect to claim 10, Karppanen and Gromatzky makes obvious “wherein: the front channel defined between the display panel assembly and the front side of the housing has a spacing distance in a range of 0.005 to 0.025 m,” which recites the same features as claim 18. Therefore, it is my opinion that Karppanen, Gromatzky, and the knowledge of a POSITA makes obvious claim 18 for the same reasons as I discussed above with respect to claim 10.

17. Claim 19 – “The display device according to claim 12, wherein the control device regulates a flow rate of the air in the fan such that a flow velocity of the air in the front channel is maintained at 4 m/s or more.”

204. As I discussed above with respect to claim 8, Karppanen and Utsunomiya make obvious “wherein: the flow rate controller regulates the flow rate of the air in the fan such that the flow velocity of air in the front channel is maintained at 4 m/s or more,” which recites the same features as claim 19, though with slightly different wording. Therefore, it is my opinion that Karppanen, Utsunomiya, and the knowledge of a POSITA makes obvious claim 19 for the same reasons as I discussed above with respect to claim 8.

18. Claim 20 – “The display device according to claim 11, wherein the housing is partitioned into an upper space and a lower space in which the fan is disposed to blow the air to at least one of front side and back side of the display assembly.”

205. As I discussed above with respect to claim 2, Karppanen discloses “wherein: the housing partitioned into an upper space and a lower space disposed below the upper space and includes a fan to blow the air to front channel,” which is similar to the limitations in claim 20, except that claim 20 recites that “the is disposed to blow the air to at least one of front side and back side of the display assembly” rather than “to blow the air to front channel.” However, as I discussed above with respect to claim 20 in the Nagayama grounds, I interpret “at least one of front side and back side of the display assembly” to mean that the fan must blow air to either the front side or the back side of the display assembly.

206. In Karppanen, the front channel is between the front side of the display element, which I identified as the display assembly, and the transparent plate. Thus, by disclosing air flowing through the front channel, Karppanen discloses air flowing to the front side of the display assembly. In addition, as I discussed with respect to claim 1c, Karppanen discloses “air flowing through the display and device casing ‘rinses’ the surfaces of the electronic devices and the display element, whereupon heat transfers effectively from these devices into the air flowing by.” Ex. 1008, 9:11-14. Air flow over the “surfaces” of the display

element discloses air flowing over at least the front and back sides of the display element, i.e., the claimed “display assembly.”

207. Therefore, it is my opinion that Karppanen discloses claim 20 for these reasons as well as those discussed above with respect to claims 1c and 2.

XI. '311 Patent – Nagayama Grounds

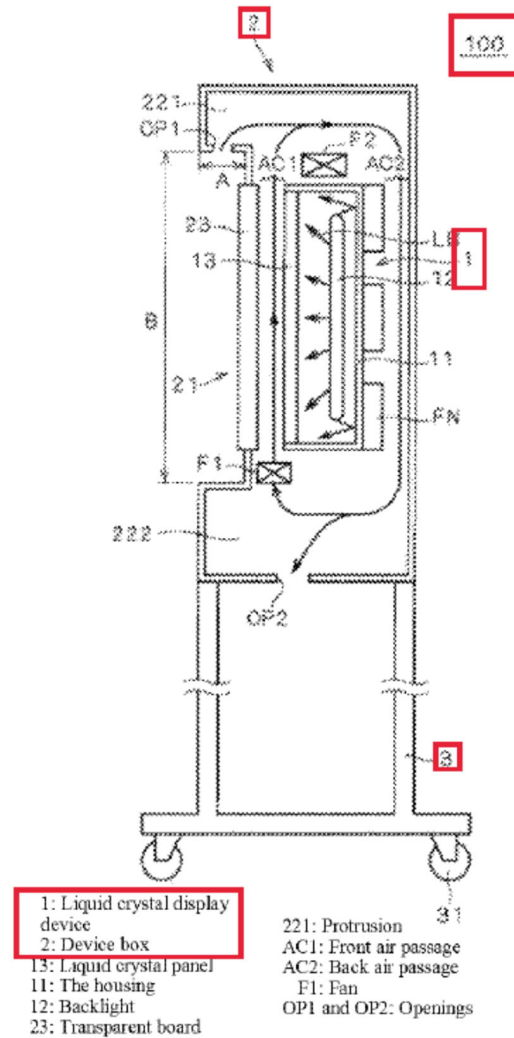
208. In the following sections, I set forth my analysis and conclusions as to the validity of claims 1-7 and 9-13 of the '311 patent based on Nagayama as the primary reference.

A. Claims 1-7 and 9-13

1. Claim 1, Preamble – “A liquid crystal display device, comprising:”

209. As I discussed above, I understand that ordinarily claim preambles are not a limiting part of a claim, but even if the preamble here is limiting, Nagayama teaches liquid crystal display devices. For example, Figure 1 of Nagayama shows an “outdoor display 100” that includes a “liquid crystal display device 1” that is stored within a “device box 2” that is supported by multiple legs 3. Ex. 1006, Fig. 1, ¶ 13.

[FIG. 1]



210. Figures 3-9 also show display devices with similar configurations to the display device shown in Figure 1. Nagayama discloses that its display device is configured to “efficiently dissipate heat generated from a flat panel type display device.” Ex. 1006, p. 2, lines 1-2.

211. Similarly, the Gromatzky reference discloses a display device that includes a liquid crystal display (“LCD”) positioned within an “environmentally-sealed enclosure 12.” Ex. 1007, 2:52-3:9. It describes that its disclosure relates to

“a thermal management system for a thin depth LCD display enclosure.” Ex. 1007, 2:52-62.

212. Each of these references is directed to the same problem of thermal management of LCD screens that are enclosed within a housing. A POSITA would have been motivated to combine the teachings of Nagayama and Gromatzky to arrive at the claimed “liquid crystal display device.”

213. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make the preamble of claim 1 obvious.

(a) Claim 1a – “a liquid crystal panel;”

214. Nagayama teaches a liquid crystal display 1 and explains that its “outdoor display 100 is broadly divided into a liquid crystal display 1, a device box 2 in which it is stored.” Ex. 1006, ¶ 13. For example, Nagayama’s liquid crystal display 1 includes “a liquid crystal panel 13 (display panel), a backlight thereof (e.g., a fluorescent light) 12, and a housing 11 that houses the backlight 12 and also the drive circuit, etc. of the liquid crystal panel 13.” Ex. 1006, ¶ 15.

215. Like Nagayama, Gromatzky describes a display device that has a thermal management system for an LCD display. Ex. 1007, 2:31-62. Gromatzky’s LCD display includes an LCD module 26 that is positioned between a transparent lens on a front portion of the Gromatzky device and a backlight assembly. Ex.

1007, 2:15-27; see also Ex. 1007, Abstract, 4:32-36. Thus, both Nagayama and Gromatzky disclose the claimed “liquid display panel.”

216. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 1a obvious.

(b) Claim 1b – “a protection panel separated from the liquid crystal panel by a channel;”

217. Nagayama discloses that its liquid crystal display device 1, which I discussed above with respect to claim 1a, is positioned near a transparent plate 23 to allow a viewer to see the liquid crystal display device 1. In addition, Nagayama describes that the liquid crystal display device 1 is positioned so that “there is a gap between the two, and the gap is referred to as the front air passage AC1.” Ex. 1006, ¶ 20, Fig. 1.

218. I further note that Nagayama describes that the transparent plate 23 “is used here because it has high ability to withstand impact for protection of the liquid crystal panel 13 and UV shielding for prevention of deterioration of the liquid crystal panel 13, despite transparency.” Ex. 1006, ¶ 18. Thus, the transparent plate 23 constitutes “a protection panel” and because Nagayama explains there is a gap between the transparent plate 23 and the liquid crystal display device, the transparent plate is “separated from the liquid crystal panel by a channel.”

219. Similar to Nagayama, Gromatzky describes an LCD display 10 that comprises an “environmentally-sealed enclosure 12 that has a front portion 14 and

a rear portion 16” and that the “environmentally-sealed enclosure 12 protects the internal components of the LCD display 10 from external elements that may affect the proper operation, such as water, dust, etc.” Ex. 1007, 2:63-3:2. At the front portion 14 is a transparent lens 18 that “protects the internal components of the LCD display 10 and also allows the LCD module 26 to be viewed from outside of the enclosure 12.” Ex. 1007, 3:12-14. Thus, Gromatzky’s transparent lens 18 constitutes a “protection panel.”

220. In addition, Gromatzky describes that the LCD module 26, which I identified as the liquid crystal panel in claim 1a, “is placed approximately 9.4 millimeters from the lens 18” and that this “[s]pacing between the lens 18 and the LCD module 26 also allows air to be routed across the LCD module 26 for thermal management.” Ex. 1007, 4:39-44, Fig. 1; *see also* Ex. 1007, 4:32-36. Thus, Gromatzky also discloses a “protection panel separated from the liquid crystal panel by a channel.”

221. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 1b obvious.

(c) Claim 1c – “a flow control device to impart turbulence to an air flow in the channel, the flow control device comprising:”

222. As I discussed above with respect to claim 1c of the ’253 Patent, while a flow control device could control any kind of flow, the Challenged Patents

specifically discusses flow control devices that are fans. '253 Patent, 2:5-6 (“The flow control device may be a cooling fan to blow air to the channel.”). Thus, it is my opinion that a fan is a type of flow control device that can generate an air flow to the channel, which was recited above in claim 1b.

223. Nagayama uses fans to cool its LCD device 1 by blowing air within (or pulling air through) the front air passage AC1. Ex. 1006, ¶¶ 22, 28-30. As discussed above, the front air passage AC1 corresponds to the channel recited in claim 1. Thus, Nagayama discloses a flow control device that provides an air flow in the channel, AC1, but Nagayama does not discuss whether the air flow is turbulent or not.

224. However, as I discussed above with respect to claim 1b, Gromatzky discloses that a channel, like Nagayama's, is formed between the LCD module 26 and the transparent lens 18, through which air may be blown. Ex. 1007, 4:39-44. Gromatzky discloses that a fan 32 is used to circulate air through the channel to cool the LCD module 26. Ex. 1007, 4:52-56. In addition, Gromatzky describes that one embodiment of its device provides a laminar flow by using a laminar flow fan. 4:64-67. However, Gromatzky is explicit that “[t]he fan 32 may be any type of air movement device that can create the airflow path 30” and that fans “that generate turbulent air” may be used as well.” Ex. 1007, 4:64-65, 5:17-20.

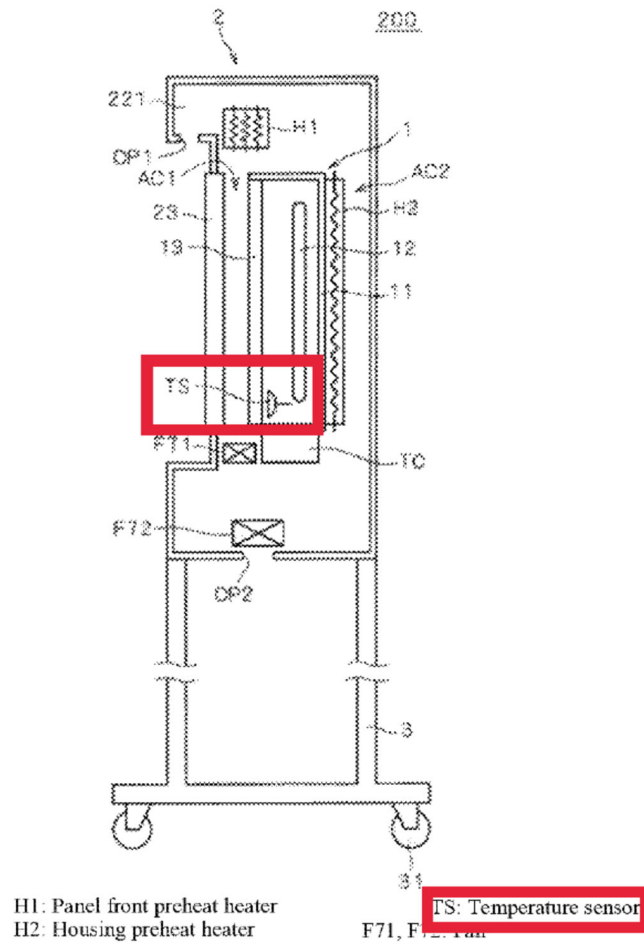
225. A POSITA selecting types of fans to use within the Nagayama device to generate an air flow through AC1 would know from Gromatzky that any type of fan could be used, including fans that generate turbulent air. Because the POSITA only has a limited number of options regarding air flow—laminar and turbulent—it would have been obvious to try a fan that generates turbulent air.

226. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 1c obvious.

(d) Claim 1d – “a temperature sensor to measure the temperature of air discharged from the channel; and”

227. Nagayama discloses affixing a temperature sensor to a back surface of the liquid crystal panel 13. Ex. 1006, ¶¶ 74-75, Fig. 9. However, as can be seen in Figure 9, the temperature sensor is incorporated into the interior of the liquid crystal display device:

[FIG. 9]



228. However, LCD displays may not always come with integrated temperature sensors before the priority date of the '311 Patent. But even if they did, it would have been desirable to locate one or more temperature sensors at different locations within a display device like Nagayama's. In fact, providing such instrumentation in different locations was a common approach before the priority date of the '311 Patent. For example, I reviewed the Burke reference which explained that it was known to position one or more temperature sensors within the housing of the device or within an electronics chamber of the device. Ex. 1011,

6:24-33. Similarly, the Hannemann reference explains that the number and position of temperature sensors may be varied as needed to allow for thermal regulation.

Ex. 1013, ¶ 19.

229. In the case of the Nagayama device, the temperature sensor TS will detect the temperature of the liquid crystal panel 13 at a specific location, which may be hotter or cooler than other portions of the display and may be hotter or cooler than the average temperature of the display as a whole. However, because air is blown through a channel, AC1, between the LCD panel 13 and the transparent panel 23 to cool the LCD panel 13, the temperature of the air exiting the channel would provide a more accurate indication of the temperature of the LCD panel 13 because the air would have passed over a larger portion of the panel. Thus, a POSITA would be aware that positioning a temperature sensor near the exit of this channel would have likely provided more accurate information about the temperature of the whole LCD panel itself 13 than only measuring at a specific location on the LCD panel. Thus, an obvious design choice for a POSITA would have been to position “a temperature sensor to measure the temperature of air discharged from the channel” as recited in claim 1d.

230. Therefore, it is my opinion that the combination of Nagayama, Gromatzky, and the knowledge of a POSITA make obvious claim 1d.

(e) Claim 1e – “a flow rate controller to control air flow through the channel according to the measured temperature.”

231. The Nagayama reference discusses the use of fans to cool its LCD device 1 by blowing air within the front air passage AC1. Ex. 1006, ¶¶ 22, 28-30. As discussed above, the front air passage AC1 corresponds to the channel recited in claim 1 of the '311 Patent. Therefore, it is my opinion that Nagayama discloses “a flow control device to generate an air flow to the front channel.”

232. Similarly, the Gromatzky reference discloses the use of fans to cool its LCD module 26 by blowing air through the gap between the front of the LCD module 26 and the transparent lens 18. Ex. 1006, 4:26-51. As I discussed above with respect to claim 1b, the gap between the LCD module 26 and the transparent lens 18 corresponds to the claimed channel. Therefore, it is my opinion that Gromatzky discloses “a flow control device to generate an air flow to the front channel.”

233. Nagayama discloses that temperature information is provided by the temperature sensor TS to a “liquid crystal panel temperature control board TC,” which “controls the fans F71, F72 and heaters 1-1 I, H2 to achieve a preset temperature.” Ex. 1006, ¶ 74. For example, I note that Figure 9 shows that fan F71 circulates air through the gap between the front face of the liquid crystal panel 13 and the transparent plate 23. Ex. 1006, Fig. 9, ¶ 72. Nagayama also discloses that

as the sensed temperature changes, the fan's rotational speed can be changed. Ex. 1006, ¶¶ 88-92. Thus, it is my opinion that Nagayama discloses that it uses a temperature sensor to sense a state of the liquid crystal panel and to control fans F71 and F72, thereby controlling "a velocity of the air flow according to a state of the display assembly" as recited in claim 1e.

234. Therefore, it is my opinion that the combination of Nagayama, Gromatzky, and the knowledge of a POSITA make obvious claim 1e.

2. Claim 2 – "The liquid crystal display device according to claim 1, wherein the channel comprises: an air inlet to guide air into the channel; and an air outlet to discharge air from the channel."

235. Nagayama discloses inlets and outlets to guide air into the channel, AC1. For example, Figure 3 shows a fan, F11, positioned at the top of airflow channel AC1, which serves as an inlet to the channel. Nagayama discloses that "a fan F11 (first fan) is arranged in the vicinity of the upper opening of the front are [sic] passage AC1." Ex. 1006, ¶ 42. In addition, Nagayama's device employs both an air inlet and an air outlet to guide air into the channel, AC1. As can be seen in Figure 3, air flows through AC1 and out of the bottom of the channel, which is the air outlet. Ex. 1006, Fig. 3. And as can be seen in Figure 3, fan F11 is positioned adjacent to the inlet of the channel, and thus is "near" the air inlet.

236. Therefore, it is my opinion that the combination of Nagayama, Gromatzky, and the knowledge of a POSITA makes claim 2 obvious.

3. Claim 3 – “The liquid crystal display device according to claim 2, wherein the flow control device further comprises a fan to force air through the channel, wherein the flow rate controller controls the fan according to the detected temperature.”

237. As I discussed above with respect to claim 1e, Nagayama’s device employs one or more fans to blow air into the front channel or pull air through the front channel, AC1, based on the temperature sensed by its temperature sensor. Ex. 1006, ¶¶ 72-75, 88-92.

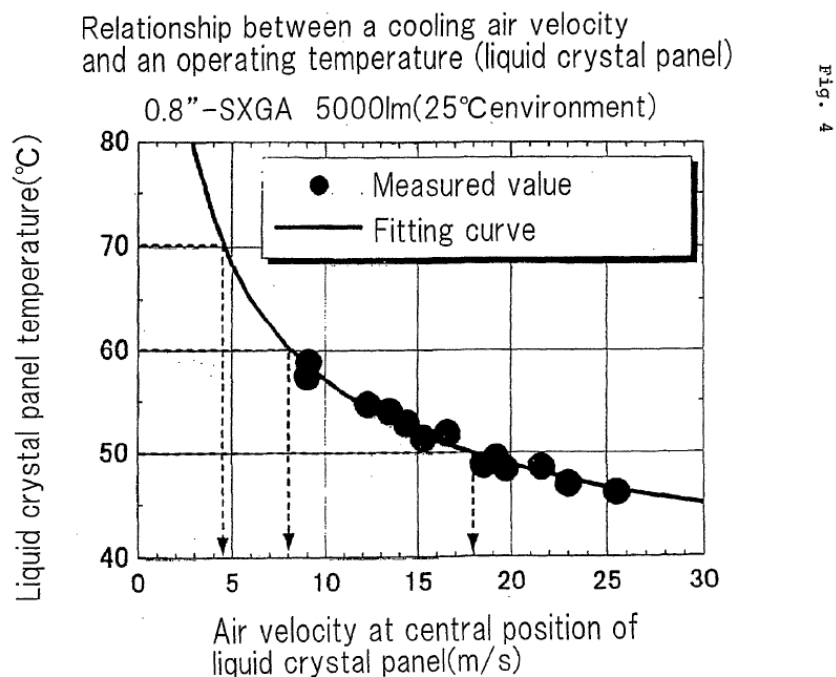
238. Therefore, it is my opinion that the combination of Nagayama, Gromatzky, and the knowledge of a POSITA makes claim 3 obvious.

4. Claim 4 – “The liquid crystal display device according to claim 3, wherein: the flow rate controller controls fan such that the air in the channel has a velocity in a range of 4 to 14 m/s.”

239. While each of Nagayama and Gromatzky disclose cooling systems for LCD screens, none discusses the specific flow velocity of air to be used. However, Nagayama shows a graph of temperatures that range from approximately 25 degrees Celsius to approximately 65 degrees Celsius. Further, Nagayama describes that a liquid crystal panel 13 operates at about 65 degrees Celsius without cooling, but that when cooled, its operating temperature can be dropped to about 55 degrees Celsius. Ex. 1006, ¶ 35. Similarly, Gromatzky discloses that “some LCD modules 12 may need to be kept at temperatures at or lower than 70 degrees Celsius to operate properly.” Ex. 1007, 3:58-60. Thus, one of skill in the art would be taught

that an LCD display should be kept below 70 degrees Celsius to allow for proper operation.

240. However, the Utsunomiya reference discusses specific rates of cooling of LCD screens based on the velocity of cooling air. In particular, Utsunomiya provides a curve of LCD temperature versus air velocity. Ex. 1010, Fig. 4.



241. In describing this plot, Utsunomiya explains that “Fig. 4 is a graph showing the relationship between a panel cooling air velocity and the panel operating temperature in 0.8"-SXGA (5000-lm class, 25°C environment). For reducing the panel operating temperature from 70°C to 60°C ($\Delta T = -10^\circ\text{C}$), the air velocity may be simply increased from 4.5 m/s to 8 m/s ($\Delta V = +3.5$ m/s), whereas

for reducing from 60°C to 50°C ($\Delta T = -10^\circ\text{C}$), the air velocity must be increased from 8 m/s to 18 m/s ($\Delta V = +10$ m/s), as can be seen from the graph.” Thus, Utsunomiya explains that to cool a panel temperature of 70 degrees C in a 25 degrees C environment to 60 degrees, the air velocity must increase from 4.5 meters per second to 8 meters per second. And as discussed above, Gromatzky discloses that display panels, such as those used in Nagayama and Gromatzky, may be damaged at temperatures exceeding 70 degrees C.

242. Thus, in designing a cooling system like Nagayama’s or Gromatzky’s, a POSITA would be aware of well-known characteristic relationships between fan speed and temperature, like is shown in Utsunomiya. Further, as I discussed above in the Motivation to Combine section, the relationship between fan speed and cooling effect, for both laminar and turbulent air flows, was well-known prior to the priority dates of the Challenged Patents. See Section VIII. Further, a POSITA seeking to cool a device, such as Nagayama’s or Gromatzky’s, would have sought to set fan speeds in a manner to provide sufficient cooling of the LCD panel, while simultaneously prevent unreasonable power usage for high fan speeds, i.e., high air flowrates, as well as other considerations, such operating noise of cooling fans based on their rotational speed.

243. Thus, a POSITA considering Nagayama and Gromatzky, while aware of Utsunomiya, would be motivated to use the air flows disclosed by Utsunomiya

as a basis for selecting suitable air flow speeds for use in the Karppanen device and it would have been obvious to try air flows at or above 4.5 meters per second to obtain the desirable cooling effect. Further, to limit power consumption and noise, and noting the diminishing returns in cooling for ever-increasing air flow velocity, it would have been obvious for a POSITA to select an upper bound for its air flow velocity. Based on the curve shown in Utsunomiya, at 14 meters per second, the incremental increase in cooling effectiveness has already dropped significantly. Thus, a POSITA would have been motivated to select lower and upper bounds for air flow velocity to provide sufficient cooling to keep the panel temperature below 70 degrees, while limiting power consumption by establishing an upper limit on air flow velocity. And it would have been obvious to try a lower bound of 4.5 meters per second and an upper bound of 14 meters per second from a limited set of options for air flow velocity based on cooling effectiveness, power consumption, and operating noise.

244. Therefore, it is my opinion that claim 4 is obvious based on Nagayama, Gromatzky, Utsunomiya, and the knowledge of a POSITA.

5. Claim 5 – “The liquid crystal display device according to claim 2, further comprising dust filters disposed in the air inlet and the air outlet.”

245. Nagayama discloses that filters are positioned within the air inlet, OP1: “In addition, in order to improve reliability, a filter shall be provided in the

opening OP1, which is the air intake port, to prevent dust from entering the device.” Ex. 1006, ¶ 39; *see also* Ex. 1006, ¶¶ 53-54. And while Nagayama explicitly discusses filters for the air inlet, Nagayama explains that “[t]he device box 2 is configured to surround the liquid crystal display 1 and prevent the liquid crystal display 1 from being directly exposed to rainwater or dust.” Ex. 1006, ¶ 19. Thus, these teachings show that the Nagayama design is specifically concerned about preventing ingress of dust or other contaminants, like water. Moreover, a POSITA is aware that the LCD panel itself is a sensitive component, and Nagayama specifically provides a plate to protect the panel from damage. Thus, providing filters at the entry and exit of the front air channel, AC1, would have been an obvious place to insert additional air filters. For example, during maintenance of the device, the housing of the Nagayama device would be opened, thereby allowing contaminants to bypass the filters at the opening, OP1. Once the device is closed, such contaminants would be free to blow throughout the housing, including through AC1. Thus, to prevent such contaminants from striking the LCD panel, a POSITA would be motivated to install filters in each of the inlets and outlets of front channel AC1 of the Nagayama device.

246. Therefore, it is my opinion that the combination of Nagayama, Gromatzky, and the knowledge of a POSITA makes claim 3 obvious.

6. Claim 6 – “The liquid crystal display device according to claim 1, wherein: the width of the channel is in a range of 5 to 25 mm.”

247. As I discussed above with respect to claim 1b, Nagayama and Gromatzky both disclose a display panel positioned within a housing and positioned to create a gap between the front of the display panel and a transparent panel in the housing. While Nagayama does not disclose the size of the gap between its liquid crystal panel 13 and the transparent panel 23, Gromatzky discloses that the channel created between its LCD panel and the transparent lens 18 is 9.4 millimeters. Ex. 1007, 4:39-41. Because both Nagayama and Gromatzky cool their respective LCDs by circulating air through the gap between the display panel and the transparent panel, a POSITA seeking to implement Nagayama and provide a suitable gap would have looked to Gromatzky for guidance and would have been taught that a gap of 9.4 millimeters, which is within the claimed range of 5 to 25 millimeters, would be sufficient for cooling a liquid crystal display.

248. Therefore, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA makes obvious claim 6.

7. Claim 7 – “The liquid crystal display device according to claim 1, further comprising: a housing enclosing the liquid crystal panel, wherein the protection panel is made of a transparent material and is entirely located at a front side of the housing.”

249. As I discussed above with respect to claim 1b, Nagayama discloses that its liquid crystal display device 1 is positioned near a transparent plate 23 to

allow a viewer to see the liquid crystal display device 1. In addition, Nagayama states that air channel AC1 is a *front* air passage, indicating that the transparent plate 23 is located at the front of the device. In addition, because “front” and “rear” are relative terms, I note that the ’311 Patent describes the “front” relative to the side of the LCD panel that displays images or video so that they can be seen through its protection panel “provided at the front side of the housing 10,” which aligns with its use in Nagayama. ’311 Patent, 4:53-64. In addition, as is shown in Nagayama at Figure 1, the transparent plate is located entirely at the front side of the housing. Ex. 1006, Fig. 1, *see also* Ex. 1006, Figs. 3-9.

250. Therefore, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA makes obvious claim 7.

8. Claim 9, Preamble – “A liquid crystal display device, comprising:”

251. As I discussed above with respect to the preamble of claim 1, both Nagayama and Gromatzky disclose a “liquid crystal display device.” Each of these references is directed to the same problem of thermal management of LCD screens that are enclosed within a housing. A POSITA would have been motivated to combine the teachings of Nagayama and Gromatzky to arrive at the claimed “liquid crystal display device.”

252. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make the preamble of claim 9 obvious for at least the same reason as the preamble of claim 1.

(a) Claim 9a – “a liquid crystal panel;”

253. As I discussed above with respect to claim 1a, both Nagayama and Gromatzky disclose a “liquid crystal panel.”

254. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 9a obvious for at least the same reasons as claim 1a.

(b) Claim 9b – “a protection panel arranged a predetermined distance from the liquid crystal panel; and”

255. As I discussed above with respect to claim 1b, both Nagayama and Gromatzky disclose protection panels arranged to form a gap between the protection panel and the liquid crystal panel. Ex. 1006, ¶¶ 18, 20, Fig. 1; Ex. 1007, 2:63-3:2, 3:12-14. Further, as I discussed above with respect to claim 6, Gromatzky discloses that its protection panel “is placed approximately 9.4 millimeters from the lens 18,” which I interpret to be a “predetermined distance from the liquid crystal panel” as recited in claim 9b, and that this “[s]pacing between the lens 18 and the LCD module 26 also allows air to be routed across the LCD module 26 for thermal management.” Ex. 1007, 4:39-44, Fig. 1; *see also* Ex. 1007, 4:32-36.

256. Because both Nagayama and Gromatzky cool their respective LCDs by circulating air through the gap between the display panel and the transparent panel, a POSITA seeking to implement Nagayama and provide a suitable gap would have looked to Gromatzky for guidance and would have been taught that a predetermined gap of 9.4 millimeters would be sufficient for cooling a liquid crystal display.

257. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 9b obvious for at least the same reasons as claim 1b.

(c) Claim 9c – “a flow control device to detect temperature variation caused by heat incident on a front side of the liquid crystal panel, and to control a flow rate of air blowing toward a channel, which is defined between the liquid crystal panel and the protection panel.”

258. As I discussed above with respect to claims 1c, 1d, 1e, and 3, Nagayama discloses that it positions a temperature sensor on the back surface of the liquid crystal panel 13. Ex. 1006, ¶¶ 74-75, Fig. 9. Thus, Nagayama’s temperature sensor senses the temperature of the liquid crystal panel 13. The temperature of the liquid crystal panel 13 will be affected by heat generated by the liquid crystal panel 13 itself, but also other sources of thermal energy, including the backlight 12 and any incident light, such as sunlight, travelling through the transparent plate 23 and shining on the liquid crystal panel 13. Thus, if incident light affects the temperature of the liquid crystal panel 13, the temperature sensor

TS will detect the changed temperature and send corresponding signals to the “liquid crystal panel temperature control board TC,” which “controls the fans F71, F72 and heaters 1-1 I, H2 to achieve a preset temperature.” Ex. 1006, ¶ 74. These fans thus blow air into the front channel, AC1, based on the temperature sensed by its temperature sensor. Ex. 1006, ¶¶ 72-75, 88-92.

259. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 9c obvious for at least the same reasons as claims 1c, 1d, 1e, and 3.

9. Claim 10 – “The liquid crystal display device according to claim 9, wherein: the flow control device has a flow rate controller to regulate the flow rate of the air such that air in the channel has a flow velocity of not less than 4 m/s when the channel defined between the liquid crystal panel and the protection panel has a spacing distance in a range of 5 to 25 mm.”

260. As I discussed above with respect to claim 4, it would have been obvious, based on Nagayama, Gromatzky, Utsunomiya, and the knowledge of a POSITA to maintain an air flow velocity of 4 m/s or greater in the front air channel, AC1. Further, as I discussed above with respect to claim 6, Gromatzky discloses that the channel created between its LCD panel and the transparent lens 18 is 9.4 millimeters. Ex. 1007, 4:39-41.

261. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 10 obvious.

10. Claim 11 – “The liquid crystal display device according to claim 10, wherein: the flow control device further includes a temperature sensor to detect a temperature variation of the air having passed through the channel, and the flow rate controller is operated according to a signal transmitted from the temperature sensor.”

262. As I discussed above with respect to claims 1d and 1e, Nagayama discloses affixing a temperature sensor to a back surface of the liquid crystal panel 13. Ex. 1006, ¶¶ 74-75, Fig. 9. However, as can be seen in Figure 9, the temperature sensor is incorporated into the interior of the liquid crystal display device. But as discussed above with respect to claim 1d, LCD displays did not always come with integrated temperature sensors before the priority date of the '311 Patent. Thus, a POSITA seeking to adequately cool an LCD display based on its temperature as taught by Nagayama would instead need to incorporate a temperature sensor into the Nagayama device at an alternate location. In fact, providing such instrumentation in different locations was a common approach before the priority date of the '311 Patent. For example, I reviewed the Burke reference which explained that it was known to position one or more temperature sensors within the housing of the device or within an electronics chamber of the device. Ex. 1011, 6:24-33. Similarly, the Hannemann reference explains that the number and position of temperature sensors may be varied as needed to allow for thermal regulation. Ex. 1013, ¶ 19.

263. In the case of the Nagayama device, air is blown through a channel, AC1, between the LCD panel 13 and the transparent panel 23 to cool the LCD panel 13. Thus, a POSITA would be aware that positioning a temperature sensor near the exit of this channel would provide information about the temperature of the LCD panel itself 13. Thus, an obvious design choice for a POSITA would have been to position “a temperature sensor to measure the temperature of air discharged from the channel” as recited in claim 1d.

264. While claim 11 recites “a temperature sensor to detect a temperature variation of the air having passed through the channel,” positioning a temperature sensor to measure the temperature of air passing through the channel will output signals indicating whatever temperature the air is that is passing out of the channel. As that temperature changes over time, the outputted signals will reflect those changes. Thus, it would have been obvious that employing the design choice to positioning a temperature sensor as discussed above would provide “a temperature sensor to detect a temperature variation of the air having passed through the channel.”

265. As I discussed above with respect to claim 1e, temperature information is provided by Nagayama’s temperature sensor TS to a “liquid crystal panel temperature control board TC,” which “controls the fans F71, F72 and heaters 1-1 I, H2 to achieve a preset temperature.” Ex. 1006, ¶ 74. For example, I

note that Figure 9 shows that fan F71 circulates air through the gap between the front face of the liquid crystal panel 13 and the transparent plate 23. Ex. 1006, Fig. 9, ¶ 72. Nagayama also discloses that as the sensed temperature changes, the fan's rotational speed can be changed. Ex. 1006, ¶¶ 88-92.

266. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 11 obvious for the reasons above and at least the same reasons as claims 1d-1e.

11. Claim 12, preamble – “A display device, comprising:”

267. As I discussed above with respect to the preamble of claim 1, both Nagayama and Gromatzky disclose a liquid crystal display device. Each of these references is directed to the same problem of thermal management of LCD screens that are enclosed within a housing. A POSITA would have been motivated to combine the teachings of Nagayama and Gromatzky to arrive at the claimed “display device.”

268. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make the preamble of claim 12 obvious for at least the same reason as the preamble of claim 1.

(a) Claim 12a – “a liquid crystal panel to display an image;”

269. As I discussed above with respect to claim 1a, both Nagayama and Gromatzky disclose that their respective display devices include a liquid crystal panel that display images. Ex. 1006, ¶ 15; Ex. 1007, 2:31-62.

270. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 12a obvious for at least the same reason as claim 1a.

(b) Claim 12b – “a protection panel to protect the liquid crystal panel; and”

271. As I discussed above with respect to claim 1b, both Nagayama and Gromatzky disclose a “protection panel” and that the protection panels in both references “protect the liquid crystal panel.” Ex. 1006, ¶ 18; Ex. 1007, 2:63-3:2, 3:12-14.

272. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 12b obvious for at least the same reason as claim 1b.

(c) Claim 12c – “a channel formed between the liquid crystal panel and the protection panel to pass air therebetween to remove heat from a front side of the liquid crystal panel,”

273. As I discussed above with respect to claims 1b and 12b, both Nagayama and Gromatzky disclose a “protection panel” and that the protection panels in both references “protect the liquid crystal panel.” Ex. 1006, ¶ 18; Ex. 1007, 2:63-3:2, 3:12-14. In addition, Nagayama describes that the liquid crystal

display device 1 is positioned so that “there is a gap between the two, and the gap is referred to as the front air passage AC1.” Ex. 1006, ¶ 20, Fig. 1. Similarly, Gromatzky describes that its LCD module 26, which I identified as the liquid crystal panel in claim 1a, “is placed approximately 9.4 millimeters from the lens 18” and that this “[s]pacing between the lens 18 and the LCD module 26 also allows air to be routed across the LCD module 26 for thermal management.” Ex. 1007, 4:39-44, Fig. 1; *see also* Ex. 1007, 4:32-36. Each of these channels is at the front side of their respective LCD panels.

274. Both Nagayama and Gromatzky disclose that the channels formed between their display panels and protection panels are provided to enable cooling of the display panels. Ex. 1006, ¶ 29 (“Therefore, a gap is provided between the liquid crystal panel 13 and the transparent plate 23 to form the front air passage AC1, and a configuration is adopted to cool the front surface of the liquid crystal panel 13 by sending air to the front air passage AC1 by the fan F1.”); Ex. 1007, 4:26-63 (“In order to dissipate heat in the ambient air in the enclosure 12, a fan 32 is placed in the airflow path 30.”), Fig. 1 (26, 30, 32).

275. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 12c obvious as discussed above and for at least the same reason as claim 1b.

(d) Claim 12d – “wherein a distance between the liquid crystal panel and the protection panel is in a range of 5 mm to 25 mm.”

276. As I discussed above with respect to claim 6, Gromatzky discloses that the channel created between its LCD panel and the transparent lens 18 is 9.4 millimeters. Ex. 1007, 4:39-41. Because both Nagayama and Gromatzky cool their respective LCDs by circulating air through the gap between the display panel and the transparent panel, a POSITA seeking to implement Nagayama and provide a suitable gap would have looked to Gromatzky for guidance and would have been taught that a gap of 9.4 millimeters, which is within the claimed range of 5 to 25 millimeters, would be sufficient for cooling a liquid crystal display.

277. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 12d obvious for at least the same reason as claim 6.

12. Claim 13, preamble – “A display device, comprising:”

278. As I discussed above with respect to the preamble of claim 1, both Nagayama and Gromatzky disclose a liquid crystal display device. Each of these references is directed to the same problem of thermal management of LCD screens that are enclosed within a housing. A POSITA would have been motivated to combine the teachings of Nagayama and Gromatzky to arrive at the claimed “display device.”

279. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make the preamble of claim 13 obvious for at least the same reason as the preambles of claims 1 and 12.

(a) Claim 13a – “a liquid crystal panel to display an image;”

280. As I discussed above with respect to claims 1a and 12a, both Nagayama and Gromatzky disclose that their respective display devices include a liquid crystal panel that display images. Ex. 1006, ¶ 15; Ex. 1007, 2:31-62.

281. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 13a obvious for at least the same reason as claims 1a and 12a.

(b) Claim 13b – “a protection panel to protect the liquid crystal panel;”

282. As I discussed above with respect to claims 1b and 12b, both Nagayama and Gromatzky disclose a “protection panel” and that the protection panels in both references “protect the liquid crystal panel.” Ex. 1006, ¶ 18; Ex. 1007, 2:63-3:2, 3:12-14.

283. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 13b obvious for at least the same reason as claims 1b and 12b.

(c) Claim 13c – “a channel formed between the liquid crystal panel and the protection panel; and”

284. As I discussed above with respect to claims 1b and 12c, both Nagayama and Gromatzky disclose a “protection panel” and that the protection panels in both references “protect the liquid crystal panel.” Ex. 1006, ¶ 18; Ex. 1007, 2:63-3:2, 3:12-14. In addition, Nagayama describes that the liquid crystal display device 1 is positioned so that “there is a gap between the two, and the gap is referred to as the front air passage AC1.” Ex. 1006, ¶ 20, Fig. 1. Similarly, Gromatzky describes that its LCD module 26, which I identified as the liquid crystal panel in claim 1a, “is placed approximately 9.4 millimeters from the lens 18” and that this “[s]pacing between the lens 18 and the LCD module 26 also allows air to be routed across the LCD module 26 for thermal management.” Ex. 1007, 4:39-44, Fig. 1; *see also* Ex. 1007, 4:32-36.

285. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 13c obvious for at least the same reason as claims 1b and 12c.

(d) Claim 13d – “a flow control device to control the flow rate of air in the channel to remove heat from a front side of the liquid crystal panel, the flow control device comprising:”

286. As I discussed above with respect to claim 1e, the Nagayama reference discusses the use of fans to cool its LCD device 1 by blowing air within

the front air passage AC1. Ex. 1006, ¶¶ 22, 28-30. As discussed above, the front air passage AC1 corresponds to the channel recited in claims 1b and 13c of the '311 Patent.

287. Similarly, the Gromatzky reference discloses the use of fans to cool its LCD module 26 by blowing air through the gap between the front of the LCD module 26 and the transparent lens 18. Ex. 1006, 4:26-51. As I discussed above with respect to claims 1b and 13c, the gap between the LCD module 26 and the transparent lens 18 corresponds to the claimed channel.

288. Further, as I discussed above with respect to claim 12c, both Nagayama and Gromatzky disclose that the channels formed between their display panels and protection panels are provided to enable cooling of the display panels. Ex. 1006, ¶ 29 (“Therefore, a gap is provided between the liquid crystal panel 13 and the transparent plate 23 to form the front air passage AC1, and a configuration is adopted to cool the front surface of the liquid crystal panel 13 by sending air to the front air passage AC1 by the fan F1.”); Ex. 1007, 4:26-63 (“In order to dissipate heat in the ambient air in the enclosure 12, a fan 32 is placed in the airflow path 30.”), Fig. 1 (26, 30, 32).

289. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 13d obvious for at least the same reason as claims 1e and 12c.

(e) Claim 13e – “a fan to force air through the channel;”

290. As I discussed above with respect to claims 1e and 3, Nagayama’s device employs one or more fans to blow air into the front channel, AC1, based on the temperature sensed by its temperature sensor. Ex. 1006, ¶¶ 72-75, 88-92.

291. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 13e obvious for at least the same reason as claims 1e and 3.

(f) Claim 13f – “a temperature sensor to measure the temperature of air discharged from the channel; and”

292. As I discussed above with respect to claim 1d, it would have been obvious to modify Nagayama to locate a temperature sensor to measure the temperature of air discharged from the front channel, AC1.

293. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 13f obvious for at least the same reason as claims 1d.

(g) Claim 13g – “a flow rate controller control the fan according to the measured temperature to regulate the flow rate of the air in the channel.”

294. As I discussed above with respect to claim 1e, Nagayama discloses that temperature information is provided by the temperature sensor TS to a “liquid crystal panel temperature control board TC,” which “controls the fans F71, F72 and heaters 1-1 I, H2 to achieve a preset temperature.” Ex. 1006, ¶ 74. For example, I note that Figure 9 shows that fan F71 circulates air through the gap

between the front face of the liquid crystal panel 13 and the transparent plate 23.

Ex. 1006, Fig. 9, ¶ 72. Nagayama also discloses that as the sensed temperature changes, the fan's rotational speed can be changed. Ex. 1006, ¶¶ 88-92. By changing the fan's rotational speed, the flow rate of the air is regulated.

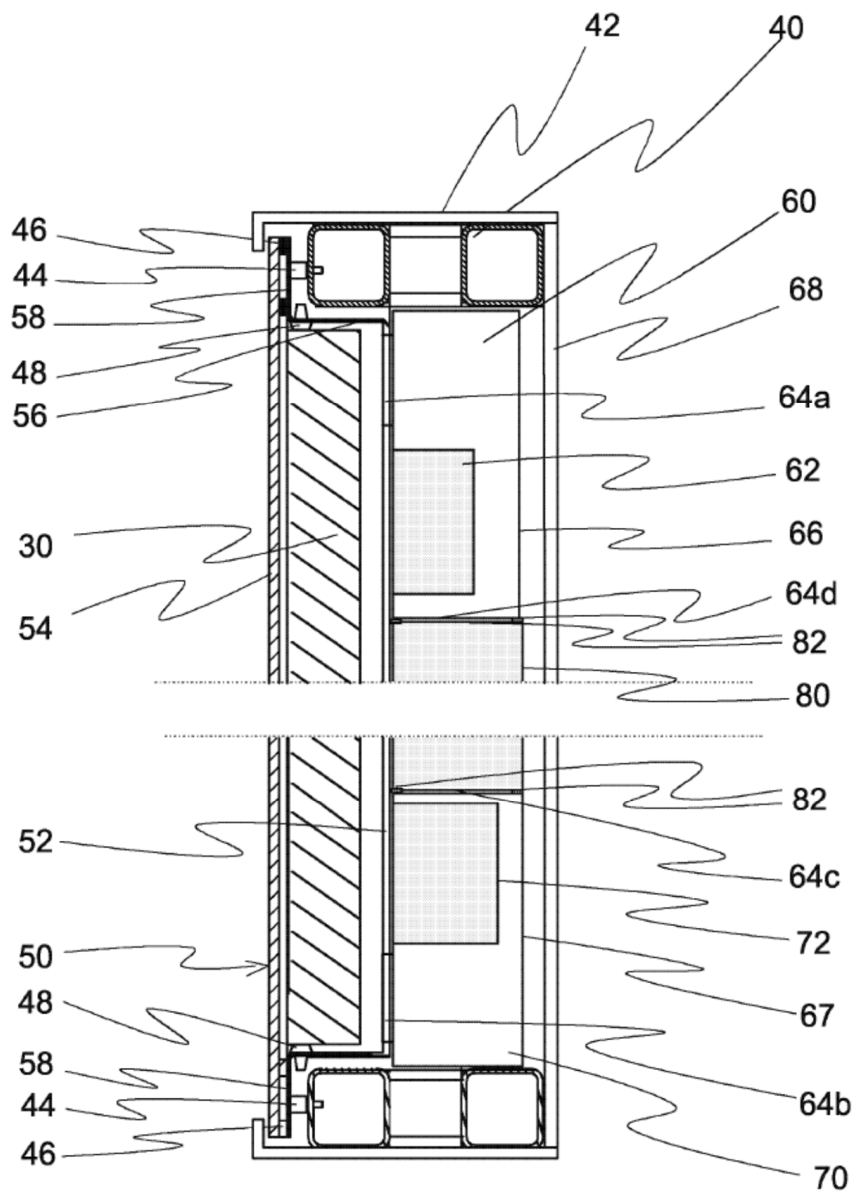
295. Thus, it is my opinion that Nagayama, Gromatzky, and the knowledge of a POSITA make claim 13g obvious for at least the same reason as claims 1e.

XII. '311 Patent – Karppanen Grounds

A. Claims 1-7 and 9-13

1. Claim 1, Preamble – “A liquid crystal display device, comprising:”

296. I understand that claim preambles are not ordinarily a limitation on a patent claim, but even if the preamble of claim 1 is limiting, Karppanen discloses display devices. Ex. 1008, Abstract, 1:1-3, 1:13-28. For example, Karppanen shows a display device, referred to as an “electronic information board,” that includes a “display element” 30, such as a thin-film transistor (“TFT”) LCD (liquid crystal display). Ex. 1008, Fig. 1, 6:23-30.

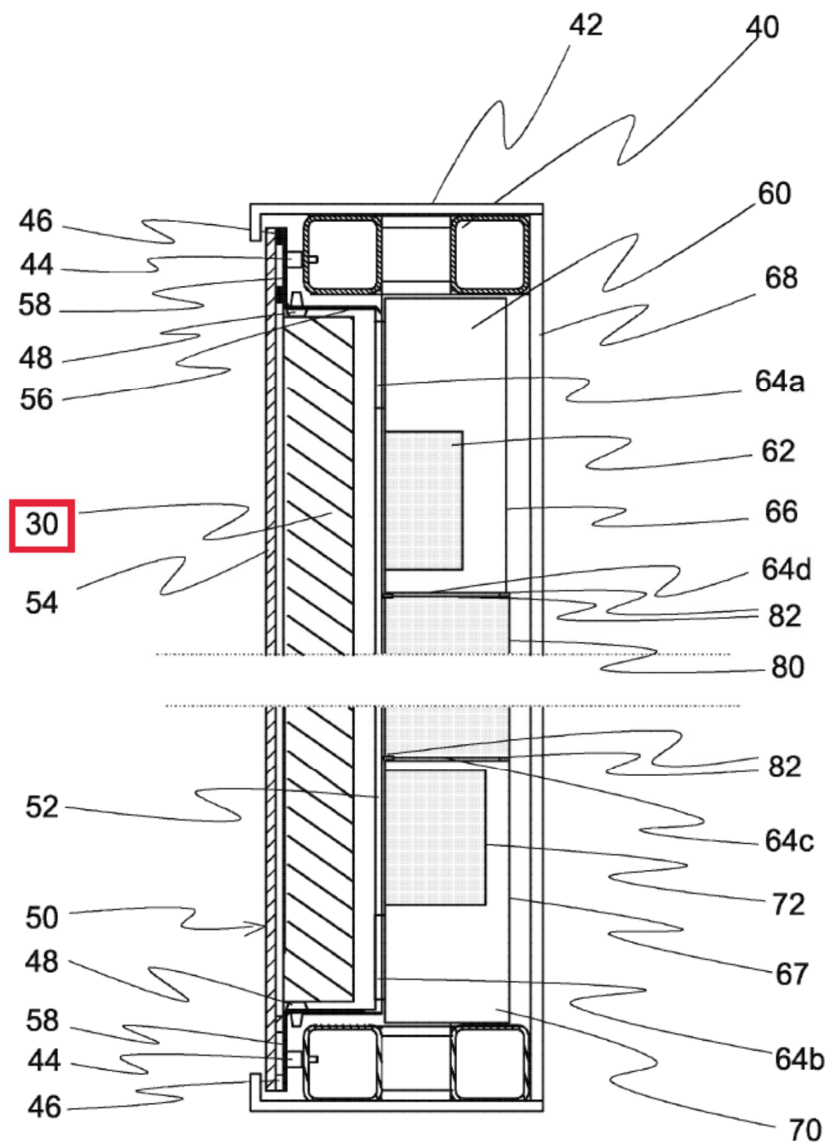


297. Because Karppanen incorporates an LCD into its electronic information board, Karppanen discloses a liquid crystal display device.

298. Thus, it is my opinion that Karppanen discloses the preamble of claim 1.

(a) Claim 1a – “a liquid crystal panel;”

299. As I discussed above with respect to the preamble to claim 1, Karppanen discloses that its electronic information board includes a display element 30. For example, Karppanen discloses that the display element “is preferably a TFT LCD display.” Ex. 1008, 6:26-30. The display element is depicted in Figure 1:



300. It was well-known to a POSITA that an “LCD” is a liquid crystal display and that LCDs include liquid crystal panels.

301. Therefore, it is my opinion that Karppanen and the knowledge of a POSITA discloses or makes obvious claim 1b.

(b) Claim 1b – “a protection panel separated from the liquid crystal panel by a channel;”

302. Karppanen discloses that its electronic information board includes a “transparent front plate 54” that “is preferably made of shock-resistant glass,” which “forms the front surface of the information board.” Ex. 1008, 6:5-22. The transparent front plate is fastened “so that the edge parts of the front plate and the back wall form a closed display casing.” Ex. 1008, 6:13-16. In addition, Karppanen explains that the display element 30 is inside of this display casing and that the display element is positioned “in such a way that there remains a gap enabling the circulation of air between the walls of the display casing and the outer surface of the display element.” Ex. 1008, 6:23-30, *see also* Ex. 1008, 3:32-4:2 (“The display element has been supported to the display casing by preferably flexible support elements so that between the front surface of the display element and the front plate as well as the back surface of the display element and the back wall there is a gap enabling circulation of air.”), 11:9-14 (claim 2), Figure 1 (visible gap between display element 30 and front plate 54). And as I noted above with respect to claim 1b, the display element 30 “is preferably a TFT LCD display.” Ex. 1008, 6:26-28.

303. Based on this arrangement, it is my opinion that the transparent front plate is a protection panel for the display element 30. In addition, the gap between the front plate 54 and the display element 30 described by Karppanen corresponds to the claimed “channel.”

304. Similar to Karppanen, Gromatzky describes an LCD display 10 that comprises an “environmentally-sealed enclosure 12 that has a front portion 14 and a rear portion 16” and that the “environmentally-sealed enclosure 12 protects the internal components of the LCD display 10 from external elements that may affect the proper operation, such as water, dust, etc.” Ex. 1007, 2:63-3:2. At the front portion 14 is a transparent lens 18 that “protects the internal components of the LCD display 10 and also allows the LCD module 26 to be viewed from outside of the enclosure 12.” Ex. 1007, 3:12-14. Thus, Gromatzky’s transparent lens 18 constitutes a “protection panel.”

305. In addition, Gromatzky describes that the LCD module 26, which I identified as the liquid crystal panel in claim 1a, “is placed approximately 9.4 millimeters from the lens 18” and that this “[s]pacing between the lens 18 and the LCD module 26 also allows air to be routed across the LCD module 26 for thermal management.” Ex. 1007, 4:39-44, Fig. 1; *see also* Ex. 1007, 4:32-36. Thus, Gromatzky also discloses a “protection panel separated from the liquid crystal panel by a channel.”

306. Therefore, it is my opinion that Karppanen discloses claim 1b.

(c) Claim 1c – “a flow control device to impart turbulence to an air flow in the channel, the flow control device comprising:”

307. Karppanen discloses that its electronic information board includes a cooling system that has “at least one circulating fan for forming an air flow through the display casing and the device casing.” Ex. 1008, 4:3-5. It states that the “air flowing through the display and device casing ‘rinses’ the surfaces of the electronic devices and the display element, whereupon heat transfers effectively from these devices into the air flowing by.” Ex. 1008, 4:6-8. And Karppanen specifically credits the gaps on the front and back sides of the display, which allows the air to flow past both sides, as a part of the effectiveness of its cooling system. Ex. 1008, 4:9-10, 9:9-21; *see also* Ex. 1008, claim 2.

308. Figure 1 shows the structure of a “fan casing” 70, which includes one or more circulating fans 70. Ex. 1008, Fig. 1, 7:11-12. Karppanen describes that the fan casing 70 is attached to the rear of the device casing 50, and that an opening is provided in the back wall 52 of the device casing 50 to allow air flow from the circulating fans 70 to flow into the device casing 50 and around the display element 30. Ex. 1008, 7:11-21, 8:4-9. Thus, Karppanen’s device uses the circulating fans 72 in the fan casing to create an air flow into the device casing 50, which guides the air flow around the front and back sides of the display element

30, as I discussed above. Thus, it is my opinion that Karppanen discloses “a flow control device to impart ... an air flow in the channel.” However, Karppanen does not explicitly discuss turbulent air flows.

309. But, like Karppanen, Gromatzky discloses that a channel is formed between its LCD module 26 and transparent lens 18, through which air may be blown. Ex. 1007, 4:39-44. Gromatzky discloses that a fan 32 is used to circulate air through the channel to cool the LCD module 26. Ex. 1007, 4:52-56. In addition, Gromatzky describes that one embodiment of its device provides a laminar flow by using a laminar flow fan. 4:64-67. However, Gromatzky is explicit that “[t]he fan 32 may be any type of air movement device that can create the airflow path 30” and that fans “that generate turbulent air” may be used as well.” Ex. 1007, 4:64-65, 5:17-20.

310. A POSITA selecting types of fans to use within the Karppanen device to generate an air flow the gap between the display element 30 and the transparent front plate 54 would know from Gromatzky that any type of fan could be used, including fans that generate turbulent air. Because the POSITA only has a limited number of options regarding air flow—laminar and turbulent—it would have been obvious to try a fan that generates turbulent air.

311. Thus, it is my opinion that Karppanen, Gromatzky, and the knowledge of a POSITA make claim 1c obvious.

(d) Claim 1d – “a temperature sensor to measure the temperature of air discharged from the channel; and”

312. Karppanen discloses the use of temperature sensors to measure the temperature within the display casing, where the display element 30 is positioned. Specifically, Karppanen explains that it maintains the temperature of the display casing 50 within “desired limits.” Ex. 1008, 9:9-11. To do so, it uses temperature transducers, which are “connected to the control unit in the device casing” and that the “control unit controls the operation of the circulating fans 72 based on the measured temperatures in accordance with a predetermined control logic.” Ex. 1008, 9:13-21. Therefore, the circulation fans are controlled by the control unit based on the sensed temperatures from the transducers.

313. My understanding is that prior to the priority date of the '253 Patent, it was known to position temperature sensors at different locations within a display device. For example, I reviewed the Burke reference which explained that it was known to position one or more temperature sensors within the housing of the device or within an electronics chamber of the device. Ex. 1011, 6:24-33. Similarly, the Hannemann reference explains that the number and position of temperature sensors may be varied as needed to allow for thermal regulation. Ex. 1013, ¶ 19. Utilizing one or more temperature sensors and the decision of where and how many temperature sensors to utilize are simply a design choice based on

the anticipated use case for the device, such as will it be utilized indoors or outdoors.

314. In the case of Karppanen, one option would be to affix a transducer to the display element itself 30; however, because the display element may be obtained from a supplier as a self-contained unit, useful attachment points for a temperature sensor may be limited. For example, affixing the temperature sensor to the front of the display element 30 may partially obscure a portion of the display element, making the sensor visible to the viewer and degrading the quality of the picture. Thus, an alternative option would be to locate the temperature sensor in a region of air flow immediately downstream from the display element, after air has flown past the display. In such a configuration, the temperature of the air flow at that point would provide a good indication of the temperature of the display element itself. This is because air is blown through gap between the display element and the front plate to cool the LCD panel, the temperature of the air exiting the channel would provide an accurate indication of the temperature of the LCD panel because the air would have passed over a larger portion of the panel. Further, such a placement aligns with Karppanen's express description "control[ing] the operation of the circulating fans 72 based on the measured temperatures" as determined by the transducers. Ex. 1008, 9:14-17. Thus, a POSITA would be aware that positioning a temperature sensor at the exit of this

channel would have likely provided accurate information about the temperature of the whole LCD panel. Therefore, as one of a few available locations to position temperature sensor, it would have been obvious to a POSITA to position Karppanen's transducer "to measure a temperature of the air having passed through the front channel."

315. For at least these reasons, claim 1d would have been obvious based on Karppanen and the knowledge of a POSITA.

(e) Claim 1e – “a flow rate controller to control air flow through the channel according to the measured temperature.”

316. As I discussed above with respect to claims 1c and 1d, Karppanen discloses using one or more fans to blow air through the gap formed between the display element 30 and the transparent plate 54, i.e., the claimed channel, based on signals received by a control board from a temperature sensor. Ex. 1008, 4:3-10, 9:9-21. While Karppanen does not explicitly state that its control board controls the air flow, the control board controls the circulating fans, which would control the air flow through the channel. Ex. 1008, 9:14-21. A POSITA would understand that Karppanen teaches adjusting fan speed, and therefore air flow through the Karppanen device, including the claimed channel, based on the received temperature information.

317. For at least these reasons, claim 1e would have been obvious based on Karppanen and the knowledge of a POSITA.

2. Claim 2 – “The liquid crystal display device according to claim 1, wherein the channel comprises: an air inlet to guide air into the channel; and an air outlet to discharge air from the channel.”

318. As I discussed above with respect to claims 1b and 1c, Karppanen uses a circulating fan to blow air into the display casing, where the air “rinses” the display element 30, after which the air exits the display casing to be recirculated. In addition, Karppanen describes the specific airflow path as proceeding from the circulating fans 72 through the cross-flow cell 80, through “first flow hole” 64a into the display casing 50, down through the display casing and over the front side of the display element 30, and out of the display casing via second flow hole 64b to begin a new circuit. Ex. 1008, 8:3-21. Each of these flow holes is positioned to guide into or out of the front channel. Thus, it is my opinion that the front channel “comprises” these two flow holes. And in the configuration explicitly described in Karppanen, first flow hole 64a constitutes “an air inlet to guide air into the channel” and second flow hold 64b constitutes “an air outlet to discharge air from the channel.” However, a POSITA would recognize that the direction of the air flow is arbitrary in the Karppanen device.

319. Thus, it is my opinion that Karppanen and the knowledge of a POSITA makes obvious the additional features of claim 2.

3. Claim 3 – “The liquid crystal display device according to claim 2, wherein the flow control device further comprises a fan to force air through the channel, wherein the flow rate controller controls the fan according to the detected temperature.”

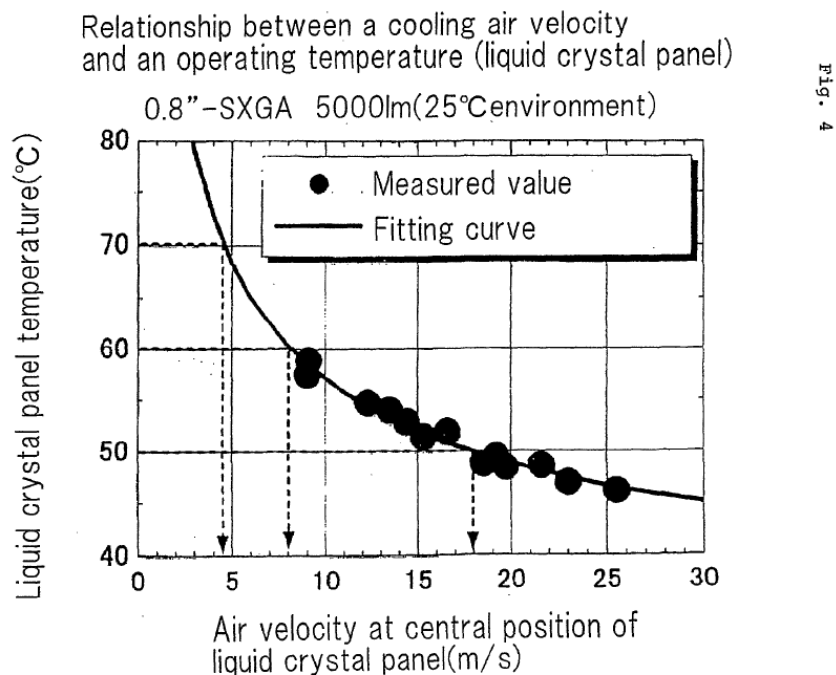
320. As I discussed above with respect to claim 1c, Karppanen discloses the use of circulating fans 72 to circulate air through the channel formed between the display element 30 and the transparent front plate 54. Ex. 1008, 4:3-10, 9:9-21. Further, as I discussed above with respect to claim 1e, Karppanen discloses using one or more fans to blow air through the gap formed between the display element 30 and the transparent plate 54, i.e., the claimed channel, based on signals received by a control board from a temperature sensor. Ex. 1008, 4:3-10, 9:9-21. Further, the “detected temperature” is the same as the measured temperature discussed above.

321. Thus, it is my opinion that Karppanen discloses the additional features of claim 3.

4. Claim 4 – “The liquid crystal display device according to claim 3, wherein: the flow rate controller controls fan such that the air in the channel has a velocity in a range of 4 to 14 m/s.”

322. Karppanen does not specifically discuss the velocity of air flow in the gap formed between the display element 30 and the transparent front plate 54. However, Utsunomiya provides information explaining the need for sufficient air flow velocity to cool an LCD panel. In particular, Utsunomiya’s Figure 4 provides

a plot that illustrates the relationship between cool air velocity and operating temperature of the LCD panel:



323. In describing this plot, Utsunomiya explains that “Fig. 4 is a graph showing the relationship between a panel cooling air velocity and the panel operating temperature in 0.8"-SXGA (5000-lm class, 25°C environment). For reducing the panel operating temperature from 70°C to 60°C ($\Delta T = -10^\circ\text{C}$), the air velocity may be simply increased from 4.5 m/s to 8 m/s ($\Delta V = +3.5$ m/s), whereas for reducing from 60°C to 50°C ($\Delta T = -10^\circ\text{C}$), the air velocity must be increased from 8 m/s to 18 m/s ($\Delta V = +10$ m/s), as can be seen from the graph.” Thus, Utsunomiya explains that to cool a panel temperature of 70 degrees C in a 25 degrees C environment to 60 degrees, the air velocity must increase from 4.5

meters per second to 8 meters per second. Thus, Utsunomiya discloses that a 4.5 meters per second air velocity is required to maintain a 70 degrees C operating temperature. And Karppanen explains that 70 degrees C is a temperature at which “the LCD matrix of TFT LCD display elements becomes inoperative.” Karppanen, 2:29-30.

324. Thus, in designing a cooling system like Karppanen’s, a POSITA would be aware of well-known characteristics relationships between fan speed and temperature, like is shown in Utsunomiya. Further, as I discussed above in the Motivation to Combine section, the relationship between fan speed and cooling effect was well-known prior to the priority dates of the Challenged Patents. See Section VIII. Further, a POSITA seeking to cool a device, such as Karppanen’s, would have sought to set fan speeds in a manner to provide sufficient cooling of the LCD panel, while simultaneously prevent unreasonable power usage for high fan speeds, i.e., high air flowrates, as well as other considerations, such operating noise of cooling fans based on their rotational speed.

325. Thus, a POSITA considering Karppanen, while aware of Utsunomiya, would be motivated to use the air flows disclosed by Utsunomiya as a basis for selecting suitable air flow speeds for use in the Karppanen device and it would have been obvious to try air flows at or above 4.5 meters per second to obtain the desirable cooling effect. Further, to limit power consumption and noise, and noting

the diminishing returns in cooling for ever-increasing air flow velocity, it would have been obvious for a POSITA to select an upper bound for its air flow velocity. Based on the curve shown in Utsunomiya, at 14 meters per second, the incremental increase in cooling effectiveness has already dropped significantly. Thus, a POSITA would have been motivated to select lower and upper bounds for air flow velocity to provide sufficient cooling to keep the panel temperature below 70 degrees, while limiting power consumption by establishing an upper limit on air flow velocity. And it would have been obvious to try a lower bound of 4.5 meters per second and an upper bound of 14 meters per second from a limited set of options for air flow velocity based on cooling effectiveness, power consumption, and operating noise.

326. Therefore, it is my opinion that the additional features of claim 4 are obvious based on Karppanen, Utsunomiya, and the knowledge of a POSITA.

5. Claim 5 – “The liquid crystal display device according to claim 2, further comprising dust filters disposed in the air inlet and the air outlet.”

327. Karppanen discloses the use of air filters within ventilation slots of its electronic information board. Ex. 1008, 10:1-3. Karppanen explains that the air filters are used for their conventional purpose of “prevent[ing] entry of impurities into the cross-flow cell.” However, there are multiple locations where impurities may cause problems for the electronic information board. For example, Karppanen

describes that its display element 30 is positioned within a device casing that is constructed from “a back wall 52, a transparent front plate 54 and an edge part 56 having a flange-like fastening collar 58.” Ex. 1008, 6:9-12. This configuration “form[s] a closed display casing,” which is designed to protect the device from objects striking the display element, e.g., by the “shock-resistant glass” of the front plate. Ex. 1008, 6:12-18. And because the display casing 50 is sealed shut, except for the air inlet and outlet discussed above with respect to claim 2, a POSITA would have understood that the display casing 50 protects the display element from other contaminants from dust or debris.

328. The POSITA would have also recognized that the air inlet and outlet provide opportunities for such material to enter the display casing. And while filters may be placed within the ventilation slots 78 to prevent material from entering the information board from the external environment, any such material already present within the device, such as may be introduced while servicing the information board, could move freely throughout the device by the air circulated by the circulating fans. Thus, to protect the display element 30, a POSITA would have been motivated to position a dust filter at the air inlet into the display casing discussed above with respect to claim 2. Further, because contaminants can enter any opening within the device, the POSITA would have been motivated to position an additional dust filter at the air outlet of the display casing. For example, while

the circulating fans are operating, dust ingress through an outlet may be more difficult, if the fans are not operating, such as because the device is powered down, environmental conditions such as wind can easily pass through the ventilation slots 78 and cause any dust or debris within the information board to enter the display casing via the outlet opening, if a filter is not installed.

329. Thus, it is my opinion that Karppanen and the knowledge of a POSITA make obvious the additional features of claim 5.

6. Claim 6 – “The liquid crystal display device according to claim 1, wherein: the width of the channel is in a range of 5 to 25 mm.”

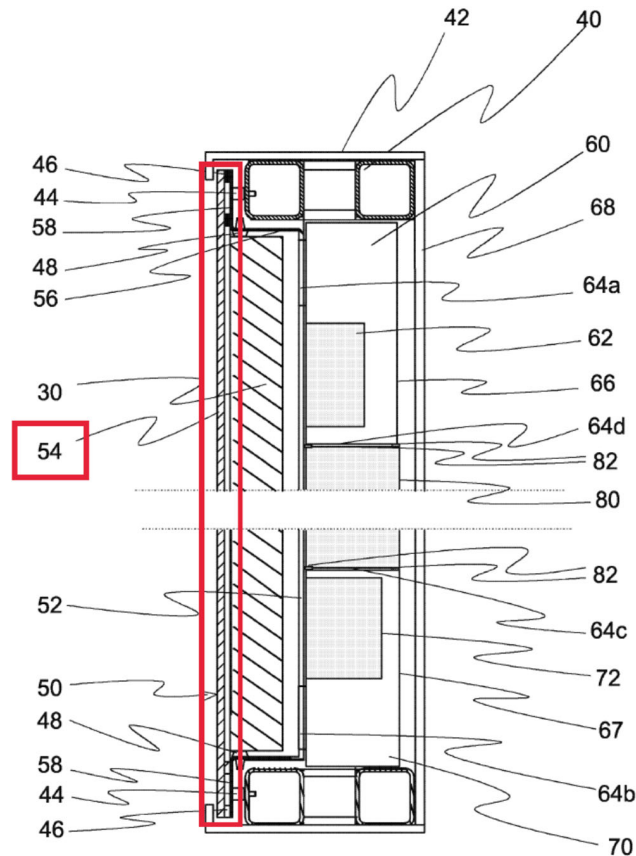
330. As I discussed above with respect to claim 1b, Karppanen and Gromatzky both disclose a display panel positioned within a housing and positioned to create a gap between the front of the display panel and a transparent panel in the housing. While Karppanen does not disclose the size of the gap between its display element 30 and front plate 54, Gromatzky discloses that the channel created between its LCD panel and the transparent lens 18 is 9.4 millimeters. Ex. 1007, 4:39-41. Because both Karppanen and Gromatzky cool their respective LCDs by circulating air through the gap between the display panel and the transparent panel, a POSITA seeking to implement Karppanen and provide a suitable gap would have looked to Gromatzky for guidance and would have been

taught that a gap of 9.4 millimeters, which is within the claimed range of 5 to 25 millimeters, would be sufficient for cooling a liquid crystal display.

331. Thus, it is my opinion that Karppanen, Gromatzky, and the knowledge of a POSITA make obvious the additional features of claim 6.

7. Claim 7 – “The liquid crystal display device according to claim 1, further comprising: a housing enclosing the liquid crystal panel, wherein the protection panel is made of a transparent material and is entirely located at a front side of the housing.”

332. Karppanen describes that its display element 30 is positioned within a device casing that is constructed from “a back wall 52, a transparent front plate 54 and an edge part 56 having a flange-like fastening collar 58.” Ex. 1008, 6:9-12, 6:23-26; *see also* Ex. 1008, claim 3. In addition, as I discussed above with respect to claim 7 in the Nagayama Ground, because “front” and “rear” are relative terms, I note that the ’311 Patent describes the “front” relative to the side of the LCD panel that displays images or video so that they can be seen through its protection panel “provided at the front side of the housing 10.” ’311 Patent, 4:53-64. Similarly, Karppanen shows that its front plate 54 is located entirely at the front side of the housing:



333. Thus, it is my opinion that Karppanen discloses the additional features of claim 7.

8. Claim 9, Preamble – “A liquid crystal display device, comprising:”

334. As I discussed above with respect to the preamble of claim 1, Karppanen discloses a “liquid crystal display device.”

335. Therefore, it is my opinion that Karppanen discloses the preamble of claim 9 for the same reasons given above with respect to the preamble of claim 1.

(a) Claim 9a – “a liquid crystal panel;”

336. As I discussed above with respect to claim 1a, Karppanen discloses a “liquid crystal panel.”

337. Therefore, it is my opinion that Karppanen discloses claim 9a for the same reasons given above with respect to claim 1a.

(b) Claim 9b – “a protection panel arranged a predetermined distance from the liquid crystal panel; and”

338. As I discussed above with respect to claim 1b, Karppanen discloses a “a protection panel separated from the liquid crystal panel by a channel;” however, as discussed with respect to claim 6, Karppanen does not disclose the specific distance between its display element 30 and transparent front plate 54. But as I discussed with respect to claim 6, Gromatzky discloses that its protection panel “is placed approximately 9.4 millimeters from the lens 18,” which I interpret to be a “predetermined distance from the liquid crystal panel” as recited in claim 9b, and that this “[s]pacing between the lens 18 and the LCD module 26 also allows air to be routed across the LCD module 26 for thermal management.” Ex. 1007, 4:39-44, Fig. 1; *see also* Ex. 1007, 4:32-36.

339. Because both Karppanen and Gromatzky cool their respective LCDs by circulating air through the gap between the display panel and the transparent panel, a POSITA seeking to implement Karppanen and provide a suitable gap would have looked to Gromatzky for guidance and would have been taught that a predetermined gap of 9.4 millimeters would be sufficient for cooling a liquid crystal display.

340. Therefore, it is my opinion that Karppanen, Gromatzky, and the knowledge of a POSITA make obvious claim 9b for the reasons given above as well as those given with respect to claims 1b and 6.

(c) Claim 9c – “a flow control device to detect temperature variation caused by heat incident on a front side of the liquid crystal panel, and to control a flow rate of air blowing toward a channel, which is defined between the liquid crystal panel and the protection panel.”

341. As I discussed above with respect to claims 1c, 1d, 1e, and 3, Karppanen discloses that it positions temperature sensors within the device and display casings 50, 60. Ex. 1008, 9:9-21. Karppanen notes that the electronic components themselves are a source of heat, such as the display element 30 within the display casing 50, but also explicitly discusses that ambient environment factors can generate heat as well, such as sunshine. Ex. 1008, 9:4-9. Thus, the temperature sensed by the temperature sensors within the display casing will be based on both the heat generated by the display element 30 itself, but also environmental conditions that include sunshine that passes through the transparent front plate 54 and is incident upon the front side of the display element 30.

342. Thus, any temperature increase within the display casing 50 based on the incident light striking the display element 30 will affect the temperature sensed by the temperature sensor(s) located within the display casing 50. Ex. 1008, 9:4-9, 1:21-26. Further, as I discussed above with respect to claim 1e, Karppanen

discloses using one or more fans to blow air through the gap formed between the display element 30 and the transparent plate 54, i.e., the claimed channel, based on signals received by a control board from a temperature sensor. Ex. 1008, 4:3-10, 9:9-21. Further, as I discussed above with respect to claim 1d, it would have been obvious to locate the temperature sensor in a region of air flow immediately downstream from the display element, after air has flown past the display.

343. Thus, a POSITA would understand that the fans in Karppanen are controlled by its control unit to blow air into the front channel based on the temperature sensed by its temperature sensor(s), which includes any “temperature variation caused by heat incident on a front side of the liquid crystal panel.”

344. Thus, it is my opinion that Karppanen discloses claim 9c.

9. Claim 10 – “The liquid crystal display device according to claim 9, wherein: the flow control device has a flow rate controller to regulate the flow rate of the air such that air in the channel has a flow velocity of not less than 4 m/s when the channel defined between the liquid crystal panel and the protection panel has a spacing distance in a range of 5 to 25 mm.”

345. As I discussed above with respect to claim 4, it would have been obvious, based on Karppanen, Utsunomiya, and the knowledge of a POSITA to maintain an air flow velocity of 4 m/s or greater in the front channel. Further, as I discussed above with respect to claim 6, Gromatzky discloses that the channel created between its LCD panel and the transparent lens 18 is 9.4 millimeters. Ex. 1007, 4:39-41.

346. Thus, it is my opinion that Karppanen, Gromatzky, Utsunomiya, and the knowledge of a POSITA make claim 10 obvious.

10. Claim 11 – “The liquid crystal display device according to claim 10, wherein: the flow control device further includes a temperature sensor to detect a temperature variation of the air having passed through the channel, and the flow rate controller is operated according to a signal transmitted from the temperature sensor.”

347. As discussed above with respect to claims 1d and 1e, Karppanen discloses the use of temperature sensors to measure the temperature within the display casing, where the display element 30 is positioned. Specifically, Karppanen explains that it maintains the temperature of the display casing 50 within “desired limits.” Ex. 1008, 9:9-11. To do so, it uses temperature transducers, which are “connected to the control unit in the device casing” and that the “control unit controls the operation of the circulating fans 72 based on the measured temperatures in accordance with a predetermined control logic.” Ex. 1008, 9:13-21. Therefore, the circulation fans are controlled by the control unit based on the sensed temperatures from the transducers.

348. And while Karppanen discloses that its temperature sensors, i.e., “transducers ... that measure the temperature,” are placed in the device and display casings, it does not explicitly state that the sensors “detect a temperature variation of the air having passed through the channel.” However, as I discussed above with

respect to claim 1b, the gap between the display element 30 and the transparent front plate 54 is created within the display casing 50.

349. A POSITA incorporating instrumentation into an electronic display board, such as Karppanen's, to sense temperature and to control cooling fans based on the temperature would position one or more temperature sensors in locations to sense temperatures that indicate the temperatures of certain electronics. In the case of the display casing, a POSITA would want to position the transducer to obtain temperature information about the display element 30.

350. One option would be to affix a transducer to the display element itself 30; however, because the display element may be obtained from a supplier as a self-contained unit, useful attachment points for a temperature sensor may be limited. For example, affixing the temperature sensor to the front of the display element 30 may partially obscure a portion of the display element, making the sensor visible to the viewer and degrading the quality of the picture. Thus, an alternative option would be to locate the temperature sensor in a region of air flow immediately downstream from the display element, after air has flown past the display. Thus, the temperature of the air flow at that point may provide good indication of the temperature of the display element itself. Therefore, as one of a few available locations to position temperature sensor, it would have been obvious

to a POSITA to position Karppanen's transducer "to detect a temperature variation of the air having passed through the channel."

351. Therefore, it is my opinion that Karppanen and the knowledge of a POSITA make the additional features of claim 11 obvious.

11. Claim 12, preamble – "A display device, comprising:"

352. As I discussed above with respect to the preamble of claim 1, Karppanen discloses a "liquid crystal display device."

353. Therefore, it is my opinion that Karppanen discloses the preamble of claim 12 for the same reasons given above with respect to the preamble of claim 1.

(a) Claim 12a – "a liquid crystal panel to display an image;"

354. As I discussed above with respect to claims 1a and 9a, Karppanen discloses that its display element 30 includes a liquid crystal panel. Ex. 1008, 6:26-30. While Karppanen does not explicitly state that the liquid crystal panel displays images, it states that "[t]he display element is preferably a TFT LCD display which withstands static information significantly better than other display techniques." Ex. 1008, 6:26-28. I interpret this portion of Karppanen as referencing displaying static images using a liquid crystal panel.

355. Thus, it is my opinion that Karppanen discloses claim 12a for at least the same reason as claims 1a and 9a.

(b) Claim 12b – “a protection panel to protect the liquid crystal panel; and”

356. As I discussed above with respect to claims 1b and 9b, Karppanen discloses a transparent front plate 54 that is positioned in front of the display element 30 to protect the display element 30. Karppanen discloses that its electronic information board includes a “transparent front plate 54” that “is preferably made of shock-resistant glass,” which “forms the front surface of the information board.” Ex. 1008, 6:5-22. In my opinion, Karppanen prefers “shock-resistant glass” for its front plate 54 because its front plate 54 is designed to protect the liquid crystal panel, such as from impacts of objects striking the Karppanen information board.

357. Thus, it is my opinion that Karppanen discloses claim 12b for at least the same reason as claims 1b and 9b.

(c) Claim 12c – “a channel formed between the liquid crystal panel and the protection panel to pass air therebetween to remove heat from a front side of the liquid crystal panel,”

358. As I discussed above with respect to claim 1b, Karppanen explains that the display element 30 is inside of this display casing and that the display element is positioned “in such a way that there remains a gap enabling the circulation of air between the walls of the display casing and the outer surface of the display element.” Ex. 1008, 6:23-30, *see also* Ex. 1008, 3:32-4:2 (“The display

element has been supported to the display casing by preferably flexible support elements so that between the front surface of the display element and the front plate as well as the back surface of the display element and the back wall there is a gap enabling circulation of air.”), 11:9-14 (claim 2), Figure 1 (visible gap between display element 30 and front plate 54). And as I noted above with respect to claim 1b, the display element 30 “is preferably a TFT LCD display.” Ex. 1008, 6:26-28.

359. As I discussed above with respect to claim 1c, Karppanen also describes that its electronic information board includes a cooling system that has “at least one circulating fan for forming an air flow through the display casing and the device casing.” Ex. 1008, 4:3-5. It states that the “air flowing through the display and device casing ‘rinses’ the surfaces of the electronic devices and the display element, whereupon heat transfers effectively from these devices into the air flowing by.” Ex. 1008, 4:6-8. And Karppanen specifically credits the gaps on the front and back sides of the display, which allows the air to flow past both sides, as a part of the effectiveness of its cooling system. Ex. 1008, 4:9-10, 9:9-21; *see also* Ex. 1008, claim 2.

360. Based on this arrangement that enables “circulation of air,” it is my opinion that the gap between the front plate 54 and the front of the display element 30 described by Karppanen corresponds to the claimed “channel formed between

the liquid crystal panel and the protection panel to pass air therebetween to remove heat from a front side of the liquid crystal panel.”

361. Thus, it is my opinion that Karppanen discloses claim 12c for at least the same reason as claims 1b and 1c.

(d) Claim 12d – “wherein a distance between the liquid crystal panel and the protection panel is in a range of 5 mm to 25 mm.”

362. As I discussed above with respect to claim 6, Gromatzky discloses that the channel created between its LCD panel and the transparent lens 18 is 9.4 millimeters. Ex. 1007, 4:39-41. Because both Karppanen and Gromatzky cool their respective LCDs by circulating air through the gap between the display panel and the transparent panel, a POSITA who was seeking to implement Karppanen and provide a suitable gap would have looked to Gromatzky for guidance and would have been taught that a gap of 9.4 millimeters, which is within the claimed range of 5 to 25 millimeters, would be sufficient for cooling a liquid crystal display.

363. Thus, it is my opinion that Karppanen and Gromatzky make claim 12d obvious for at least the same reason as claim 6.

12. Claim 13, preamble – “A display device, comprising:”

364. As I discussed above with respect to the preamble of claim 1, Karppanen discloses a “liquid crystal display device.”

365. Therefore, it is my opinion that Karppanen discloses the preamble of claim 12 for the same reasons given above with respect to the preamble of claim 1.

(a) Claim 13a – “a liquid crystal panel to display an image;”

366. As I discussed above with respect to claim 12a, Karppanen discloses “a liquid crystal panel to display an image.”

367. Therefore, it is my opinion that Karppanen discloses claim 13a for the same reasons given above with respect to claim 12a.

(b) Claim 13b – “a protection panel to protect the liquid crystal panel;”

368. As I discussed above with respect to claim 12b, Karppanen discloses “a protection panel to protect the liquid crystal panel.”

369. Therefore, it is my opinion that Karppanen discloses claim 13b for the same reasons given above with respect to claim 12b.

(c) Claim 13c – “a channel formed between the liquid crystal panel and the protection panel; and”

370. As I discussed above with respect to claim 12c, Karppanen discloses “a protection panel to protect the liquid crystal panel.”

371. Therefore, it is my opinion that Karppanen discloses claim 13c for the same reasons given above with respect to claim 12c.

(d) Claim 13d – “a flow control device to control the flow rate of air in the channel to remove heat from a front side of

the liquid crystal panel, the flow control device comprising.”

372. As I discussed above with respect to claims 1c, 1e, and 3, Karppanen discloses that its electronic information board includes a cooling system that has “at least one circulating fan for forming an air flow through the display casing and the device casing.” Ex. 1008, 4:3-5. It states that the “air flowing through the display and device casing ‘rinses’ the surfaces of the electronic devices and the display element, whereupon heat transfers effectively from these devices into the air flowing by.” Ex. 1008, 4:6-8. And Karppanen specifically credits the gaps on the front and back sides of the display, which allows the air to flow past both sides, as a part of the effectiveness of its cooling system. Ex. 1008, 4:9-10, 9:9-21; *see also* Ex. 1008, claim 2. And while Karppanen does not explicitly state that its control board controls the air flow, the control board controls the circulating fans, which would control the air flow through the channel. Ex. 1008, 9:14-21. A POSITA would understand that Karppanen teaches adjusting fan speed, and therefore air flow through the Karppanen device, including the claimed channel, based on the received temperature information.

373. For at least these reasons, claim 13d would have been obvious based on Karppanen and the knowledge of a POSITA.

(e) Claim 13e – “a fan to force air through the channel;”

374. As I discussed above with respect to claim 3, Karppanen discloses “a fan to force air through the channel.”

375. Therefore, Karppanen discloses claim 13e.

(f) Claim 13f – “a temperature sensor to measure the temperature of air discharged from the channel; and”

376. As I discussed above with respect to claim 1d, it would have been obvious based on Karppanen and the knowledge of a POSITA to include “a temperature sensor to measure the temperature of air discharged from the channel.”

377. Therefore, Karppanen discloses claim 13f.

(g) Claim 13g – “a flow rate controller control the fan according to the measured temperature to regulate the flow rate of the air in the channel.”

378. As I discussed above with respect to claim 1e, Karppanen discloses “a flow rate controller to control air flow through the channel according to the measured temperature.” While claim 13g specifically recites that the flow rate controller controls the fan to regulate the flow rate of the air, my analysis of claim 1e relates to the control of Karppanen’s circulating fans. By controlling the circulating fan, the flow rate of the air is regulated. Therefore, the analysis applies equally to claim 13g.

379. For at least these reasons, claim 13g would have been obvious based on Karppanen and the knowledge of a POSITA for the same reasons discussed above with respect to claim 1e.

XIII. Conclusion

380. For the foregoing reasons, it is my opinion that claims 1, 2, 4-12, and 14-20 of the '253 Patent and claims 1-7 and 9-13 of the '311 Patent are invalid.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed this 14th day of July, 2023.

A handwritten signature in black ink, reading "Carl D. Meinhart", is written over a horizontal line.

Dr. Carl D. Meinhart