UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD, and

SAMSUNG ELECTRONICS AMERICA, INC.,

Petitioners,

v.

CELLECT, LLC,

Patent Owner.

Case IPR2020-00474

U.S. Patent No. 6,982,740

DECLARATION OF DEAN P. NEIKIRK, PH.D. IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 6,982,740

TABLE OF CONTENTS

I, Dean P. Neikirk, Ph.D., hereby declare under penalty of perjury:

I. INTRODUCTION

1. I have been retained on behalf of Samsung to provide assistance regarding U.S. Patent No. 6,982,740 ("the '740 patent," Ex. 1001) in connection with Samsung's Petition for *Inter Partes* Review.[1] Specifically, I have been asked to consider the validity of claims 1, 2, and 13 of the '740 patent (the "Challenged Claims"). I have personal knowledge of the facts and opinions set forth in this declaration, and, if called upon to do so, I would testify competently thereto.

2. I am being compensated for my time at my standard rate of $600/hr. My compensation is based solely on the amount of time that I devote to activity related to this case and is in no way contingent on the nature of my findings, the presentation of my findings in testimony, or the outcome of this or any other proceeding. I have no other financial interest in this proceeding. My opinions are based on my years of education, research and experience, as well as my investigation and study of relevant materials, including those cited herein.

3. I may rely upon these materials, my knowledge and experience, and/or additional materials to rebut arguments raised by the Patent Owner. Further, I may

[1] Where appropriate, I refer to exhibits that I understand are filed with the Petition for *Inter Partes* Review of the '740 Patent.

also consider additional documents and information in forming any necessary opinions, including documents that may not yet have been provided to me.

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

II. BACKGROUND AND QUALIFICATIONS

5. All of my opinions stated in this declaration are based on my own personal knowledge and professional judgment. In forming my opinions, I have relied on my knowledge and experience in designing, developing, researching, and teaching image sensor technology.

6. I received a Bachelor of Science degree from Oklahoma State University, in physics and mathematics, in 1979.

7. Following my undergraduate studies, I attended the California Institute of Technology, where I earned a Master's degree and Doctorate degree in Applied Physics, in 1981 and 1984, respectively.

8. Each of my academic degrees involved significant studies in sensors, including image sensors; optical systems; solid state physics; semiconductor devices; electrical engineering; electronic systems; electromagnetics; radio frequency

systems; and antennas. For example, courses relating to these fields that I took include two years of study in electromagnetics and optics, one year of study in solid state and semiconductor physics, as well as four years of graduate research in electronic devices, antenna design, antenna fabrication, and optical systems.

9. My Ph.D. thesis was on the design and fabrication of high frequency electromagnetic detectors and quasi-optical imaging antenna arrays, including research on integrated-circuit fabrication, semiconductor devices, integrated circuits, antennas, sensors, and IC packaging. I designed and fabricated the first monolithic integrated-circuit imaging antenna array for use in an electronic camera operating at wavelengths in the far infrared (sometimes referred to as the terahertz) region of the electromagnetic spectrum. For this work on the first high resolution focal plane array for use at wavelengths between 0.1 mm and 1 mm, I was awarded the 1984 Marconi International Fellowship Young Scientist Award "for contributions to the development of millimeter wave integrated circuits especially in the area of detectors and imaging arrays."

A. Research and Teaching Experience

10. My work as a professor began in 1984, when I joined the University of Texas at Austin as an assistant professor. In 1988, I became an associate professor, and in 1992 became a full professor. Today, I continue to be a full professor in the Department of Electrical and Computer Engineering at the University of Texas.

11. Over the years, I have taught a variety of electrical engineering courses at the University of Texas. These include Integrated Circuit Fabrication, VLSI Fabrication Techniques, Ultra Large Scale Integrated Circuit Fabrication Techniques, Integrated Circuit Nanomanufacturing Techniques, Electromagnetics in Packaging, Simulation Methods in CAD/VLSI, Micro-Electromechanical Systems, Electromagnetic Engineering, and Microwave and Radio Frequency Engineering. I have also taught several continuing education courses in these fields.

12. I currently conduct research with students and research scientists in the Microelectromagnetics Research Group in the Microelectronics Research Center at The University of Texas at Austin. My research areas include the fabrication and modeling of electromagnetic micro-machined sensors and actuators. I am also involved in research relating to integrated circuit processing and the high frequency properties of transmission lines. Over the years, I conducted research in the area of wireless sensors for identifying failing bridges and improving the safety of new bridges. I have also conducted research in the areas of electromagnetics, optical devices for use in electronic cameras, manufacturing systems engineering, and solid-state electronics.

13. For over ten years, I served as the Graduate Advisor for the Department of Electrical and Computer Engineering at the University of Texas at Austin, as well as serving for over five years as an Associate Chairman of the Electrical and

Computer Engineering Department. In addition to my current position as a professor in the Electrical and Computer Engineering Department at The University of Texas at Austin, I am also an Associate Dean of Graduate Studies at The University of Texas at Austin.

14. I have also devoted a significant portion of my time at the University to contributing to various technical journals and other publications. My work has been included in 93 referenced archival journal publications, 165 referenced conference proceedings, and 24 published abstracts. I have also contributed to book chapters and technical reports relating to various electrical engineering topics. My publications have addressed technologies such as chemical sensors, integrated circuits for antenna arrays, determining conductor loss in transmission lines, optical and electromagnetic devices for infrared detection, multilayer interconnection lines for high speed digital integrated circuits, RF oscillator circuits, memory-switching double-barrier quantum-well diodes circuits, RF and infrared detection circuits, and other topics related to sensors and optical systems.

15. More information on my research and teaching experience, and my contribution to technical publications, is included in my *curriculum vitae* (Appendix A).

B. Patents Awarded

16. Through my work on sensors and electronic systems, I have been named an inventor on seventeen U.S. patents. These are summarized in my *curriculum vitae* attached as Appendix A.

17. My issued patents include, for example, U.S. Patent No, 5,408,107, titled “Semiconductor Device Apparatus Having Multiple Current-Voltage Curves and Zero-Bias Memory.” This patent is directed to a semiconductor device that can be switched between current-voltage curve settings at higher positive or negative voltages and can be read at lower voltages. As another example, U.S. Patent No. 9,291,586, titled “Passive Wireless Self-Resonant Sensor,” relates to a sensor for detecting materials, including a substrate, a passivation layer formed on the substrate, a high surface area material disposed on the passivation layer, and a self-resonant structure that includes a planar spiral inductor and a plurality of planar interdigitated capacitor electrodes disposed within the passivation layer.

18. Many of my patents are related to sensor arrays used for chemical testing. These include, for example, U.S. Patent 6,589,779: “General signaling protocol for chemical receptors in immobilized matrices,” U.S. Patent 6,602,702: “Detection system based on an analyte reactive particle,” U.S. Patent 7,316,899, ‘Portable sensor array system,” and U.S. Patent 8,105,849, “Integration of fluids and reagents into self-contained cartridges containing sensor elements.” These patents

resulted from research by my group and my collaborators into new sensor arrays with the capability to use optical effects to perform multi-analyte chemical analysis.

19. Two companies have been founded based on technology developed and patented by my research group and collaborators in the area of chemical sensing arrays. In both cases the technology was developed at The University of Texas at Austin and licensed to start-ups. In one case LabNow, Inc. received $14 million in first-round venture investment for its point-of-care diagnostic system from the Soros Group, Austin Ventures and other investors to develop the company's technology and to launch its initial product, CD4Now™, a point-of-care diagnostic tool for HIV/AIDS patients.

C. Other Awards

20. My work as a professor of electrical engineering, and my scholarship in various fields relating to sensors and electronic systems, have been recognized through several awards I have received over the years. As noted in my curriculum vitae (Appendix A), these include the Marconi International Fellowship Young Scientist Award. the Engineering Foundation Faculty Award from the University of Texas at Austin, the General Motors Foundation Centennial Teaching Fellowship, the IBM Corporation Faculty Development Award, the National Science Foundation Presidential Young Investigator, the Lockheed Martin Aeronautics Company Award for Excellence in Engineering Teaching, and various other academic awards.

D. Industry Experience

21. While the majority of my professional experience in electrical engineering has involved research and teaching, I have also provided technical consulting to numerous companies and been involved in academic-industry partnerships. For example, I have provided consulting to Teltech Resource Network, Ardex, Inc., E.P. Hamilton Associates, Burnett Company, Microelectronics and Computer Technology Corporation, and Baker-Hughes. In addition, my work on electro-chemical sensors was selected as a commercialization venture between the University of Texas and LabNow, Inc. Further, my work together with a graduate student relating to actuator stacked microbolometer arrays for multispectral infrared detection was selected for sponsorship by Coventor, Inc., a company that provides software tools for developing microelectromechanical systems, microfluidics, and semiconductor process applications.

E. Professional Society Involvement

22. I have been a Senior Member of the Institute of Electrical and Electronics Engineers ("IEEE") for more than fifteen years. From March 1991 to October 1994, I served as an Associate Editor for the IEEE publication called "IEEE Transactions on Education." I also served as a member of the Editorial Board on the IEEE Transactions on Microwave Theory and Techniques in the 1990-2000 timeframe.

23. A detailed description of my professional qualifications, including a listing of my specialties/expertise and professional activities, are contained in my *curriculum vitae* (Appendix A).

III. BASIS OF MY OPINIONS AND MATERIALS CONSIDERED

24. In reaching the conclusions described in this declaration, I have relied on the documents and materials cited herein as well as those identified in Appendix B attached to this declaration. These materials comprise patents, related documents, and printed publications. Each of these materials is a type of document that experts in my field would have reasonably relied upon when forming their opinions and would have had access to either through the applicable patent offices and/or well-known libraries, conferences, publications, organizations and websites in the field as further discussed herein.

25. My opinions are also based upon my education, training, research, knowledge, and personal and professional experience.

IV. LEGAL STANDARDS

A. Priority Dates and Priority Claims

26. I was informed and understand that for a patent to claim the benefit of the filing date of a prior application, the prior application must comply with the written description requirement of 35 U.S.C. §112. To satisfy the written description requirement, the specification of the prior application must contain a written

description of the invention and the manner and process of making and using it, in such full, clear, concise, and exact terms to enable an ordinarily skilled artisan to practice the invention claimed in the later patent application. Additionally, the priority application must describe the later claimed invention in sufficient detail that a person having ordinary skill in the art can clearly conclude that the inventor invented the claimed invention as of the filing date sought.

B. Obviousness Under 35 U.S.C. §103(a)

27. I understand that a claim may be invalid under 35 U.S.C. §103(a) if the subject matter described by the claim as a whole would have been obvious to a hypothetical person of ordinary skill in the art in view of a prior art reference or in view of a combination of references at the time the claimed invention was made. Therefore, I understand that obviousness is determined from the perspective of a hypothetical person of ordinary skill in the art and that the asserted claims of the patent should be read from the point of view of such a person at the time the claimed invention was made. I further understand that a hypothetical person of ordinary skill in the art is assumed to know and to have all relevant prior art in the field of endeavor covered by the patent in suit.

28. I have also been advised that an analysis of whether a claimed invention would have been obvious should be considered in light of the scope and content of the prior art, the differences (if any) between the prior art and the claimed invention,

and the level of ordinary skill in the pertinent art involved. I understand as well that a prior art reference should be viewed as a whole.

29. I have also been advised that in considering whether an invention for a claimed combination would have been obvious, I may assess whether there are apparent reasons to combine known elements in the prior art in the manner claimed in view of interrelated teachings of multiple prior art references, the effects of demands known to the design community or present in the market place, and/or the background knowledge possessed by a person having ordinary skill in the art. I understand that other principles may be relied on in evaluating whether a claimed invention would have been obvious, and that these principles include the following:

- A combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results;
- When a device or technology is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or in a different one, so that if a person of ordinary skill can implement a predictable variation, the variation is likely obvious;
- If a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill;

- An explicit or implicit teaching, suggestion, or motivation to combine two prior art references to form the claimed combination may demonstrate obviousness, but proof of obviousness does not depend on or require showing a teaching, suggestion, or motivation to combine;
- Market demand, rather than scientific literature, can drive design trends and may show obviousness;
- In determining whether the subject matter of a patent claim would have been obvious, neither the particular motivation nor the avowed purpose of the named inventor controls;
- One of the ways in which a patent's subject can be proved obvious is by noting that there existed at the time of invention a known problem for which there was an obvious solution encompassed by the patent's claims;
- 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;
- "Common sense" teaches that familiar items may have obvious uses beyond their primary purposes, and in many cases a person of ordinary skill will be able to fit the teachings of multiple patents together like pieces of a puzzle;

- A person of ordinary skill in the art is also a person of ordinary creativity, and is not an automaton;
- A patent claim can be proved obvious by showing that the claimed combination of elements was "obvious to try," particularly when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions such that a person of ordinary skill in the art would have had good reason to pursue the known options within his or her technical grasp; and
- One should be cautious of using hindsight in evaluating whether a claimed invention would have been obvious.

30. I further understand that, in making a determination as to whether or not the claimed invention would have been obvious to a person of ordinary skill, the Board may consider certain objective factors if they are present, such as: commercial success of products practicing the claimed invention; long-felt but unsolved need; teaching away; unexpected results; copying; and praise by others in the field. These factors are generally referred to as "secondary considerations" or "objective indicia" of nonobviousness. I understand, however, that for such objective evidence to be relevant to the obviousness of a claim, there must be a causal relationship (called a "nexus") between the claim and the evidence and that this nexus must be based on a novel element of the claim rather than something in the prior art. I also understand

that even when they are present, secondary considerations may be unable to overcome primary evidence of obviousness (such as motivation to combine with predictable results) that is sufficiently strong.

31. I have been asked to consider the validity of the Challenged Claims. I understand that for *inter partes* reviews, invalidity must be shown under a preponderance of the evidence standard. I have concluded that each of the Challenged Claims is invalid at least under 35 U.S.C. §103 based on the references described below and as explained herein.

C. Claim Construction

32. I have been informed that patent claims are construed from the viewpoint of a person of ordinary skill in the art of the patent at the time of the invention. I have been informed that patent claims generally should be interpreted consistent with their plain and ordinary meaning as understood by a person of ordinary skill in the art in the relevant time period (*i.e.*, at the time of the purported invention, or the so called "effective filing date" of the patent application), after reviewing the patent claim language, the specification and the prosecution history (*i.e.*, the intrinsic record).

33. I have further been informed that a person of ordinary skill in the art must read the claim terms in the context of the claim itself, as well as in the context of the entire patent specification. I understand that in the specification and

prosecution history, the patentee may specifically define a claim term in a way that differs from the plain and ordinary meaning. I understand that the prosecution history of the patent is a record of the proceedings before the U.S. Patent and Trademark Office, and may contain explicit representations or definitions made during prosecution that affect the scope of the patent claims. I understand that an applicant may, during the course of prosecuting the patent application, limit the scope of the claims to overcome prior art or to overcome an examiner's rejection, by clearly and unambiguously arguing to overcome or distinguish a prior art reference, or to clearly and unambiguously disavow claim coverage.

34. In interpreting the meaning of the claim language, I understand that a person of ordinary skill in the art may also consider "extrinsic" evidence, including expert testimony, inventor testimony, dictionaries, technical treatises, other patents, and scholarly publications. I understand this evidence is considered to ensure that a claim is construed in a way that is consistent with the understanding of those of ordinary skill in the art at the time of the claimed invention. This can be useful for a technical term whose meaning may differ from its ordinary English meaning. I understand that extrinsic evidence may not be relied on if it contradicts or varies the meaning of claim language provided by the intrinsic evidence, particularly if the applicant has explicitly defined a term in the intrinsic record.

35. I understand that there is a "means-plus-function" type of claim interpretation that may be argued to apply to certain terms, pursuant to 35 U.S.C. §112(6). For these terms, if the term is determined to be a "means-plus-function" term under §112(6), I understand that there must be a corresponding structure disclosed in the specification in a way that a person of ordinary skill in the art would understand what structure would perform the claimed function. I understand the disclosure may be implicit in the specification if it would have been clear to a person of ordinary skill in the art what structure corresponds to the claimed function. With respect to a computer-implemented function, an algorithm must be disclosed in the specification.

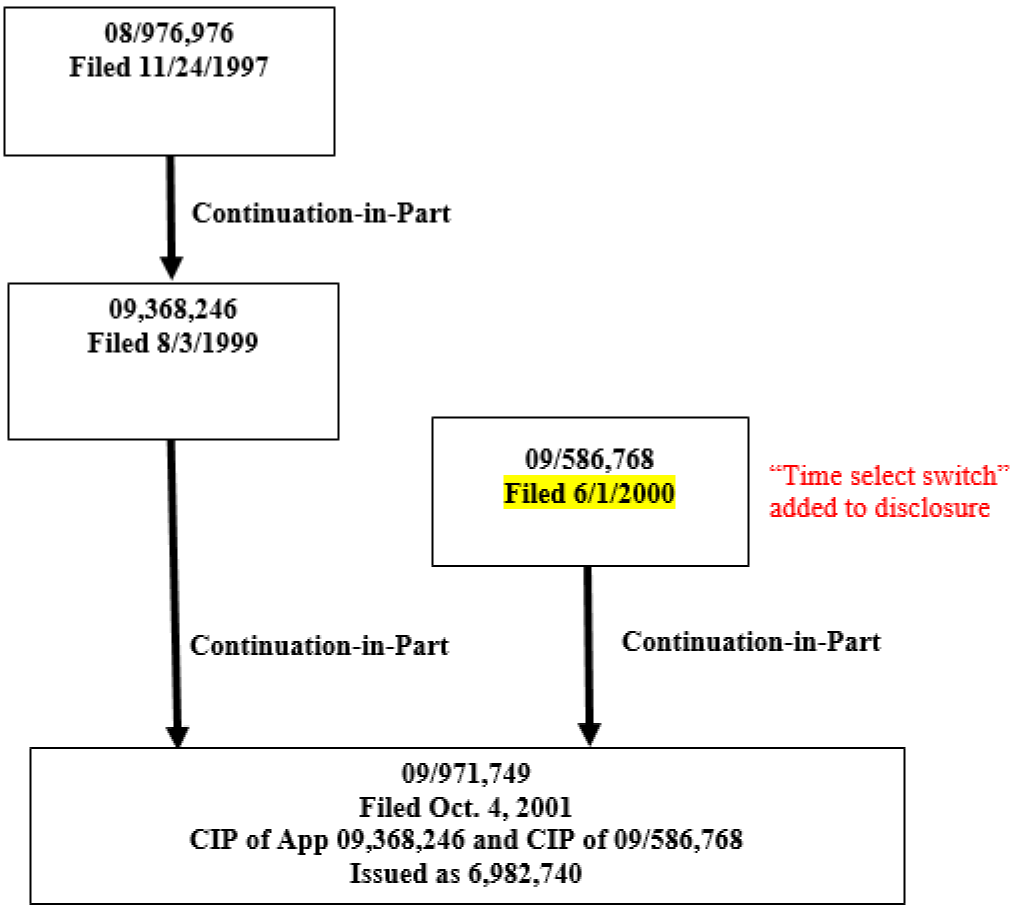
V. PRIORITY DATE AND A PERSON OF ORDINARY SKILL

A. Priority Claims and the Relevant Timeframe of the '740 Patent

36. The '740 patent issued from U.S. Patent Application No. 09/971,749, filed October 4, 2001 (the "'749 Application"), and claims priority to three applications: (1) U.S. Application 09/586,768 (the "'768 Application") (Ex. 1019) which was filed June 1, 2000 and later matured into U.S. Patent No. 6,316,215; (2) U.S. Application 09,368,246 (the "'246 Application") (Ex. 1020) which was filed on August 3, 1999 and later matured into U.S. Patent 6,310,642; and (3) U.S. Application 08/976,976 (the "'976 Application") (Ex. 1022) which was filed on

November 24, 1997 and later matured into U.S. Patent 5,986,693. *See* '740 patent, 1:5-16.

37. The relationship between these different patent applications is illustrated in the chart below:



38. I have carefully reviewed the '740 patent. I have also carefully reviewed the disclosures made in the '976, '246, and '768 Applications, as well as the patents and patent publications incorporated therein by reference.

39. Based on my review of the materials, certain terms and functions in the Challenged Claims are not described in the ’976 or ’244 Applications or any patents or patent publications that it incorporates by reference. As discussed in greater detail below, the ’740 patent claims an image sensor that includes a “time select switch” to control the brightness of the image captured using a digital sensor—similar to the way that you can modify exposure time to control the brightness of the image captured on photographic film. For example, independent claim 1 of the ’740 patent requires “a time select switch … for selectively varying integration periods to produce an image of a desired brightness,” and independent claim 3 of the ’740 patent requires “providing a time select switch” and “adjusting a charge integration period of the imager by manipulating time select switch to maximize desired brightness of the image.” However, there is no mention of a “time select switch” in the ’976 or ’244 Applications, and a person of ordinary skill could not have reasonably concluded that the inventor had possession of the claimed invention at the time that these applications were filed.[2]

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[2] This is true regardless of the time-period chosen for the analysis. At no point in the relevant time range (*i.e.*, as early as 1997 and as late as 2001) would a person of ordinary skill conclude that the inventor had the claimed “time select switch” in his or her possession based on the disclosures in the ’976 or ’244 Applications.

40. By comparison, the ’768 application filed on June 1, 2000 does describe a “time select switch” that can be used to change the integration time of image sensor. *See, e.g.*, U.S. Patent Application No. 09/586,768 (Ex. 1019) 11:2-22 (*“*CMOS imagers, as well as commercially available CID imagers … can be modified to include *an imager integration time switch which allows an operator to preselect a desired integration period* which maximizes observable fluorescence.*”*),[3] 20:12-20 (“An imager integration *time select switch 120 is provided* enabling an operator to manually select the desired integration period.”), Fig. 4.

41. Based on the above, my understanding is that the’768 application filed on June 1, 2000 is the first (and only) priority document that could satisfy the written description requirement for the “time select switch” limitations recited by the Challenged Claims of the ’740 patent. Therefore, the Challenged Claims are not entitled to the benefit of a priority date before June 1, 2000.

B. The Person of Ordinary Skill in the Relevant Timeframe

42. In rendering the opinions set forth in this declaration, I was asked to consider the patent claims and the prior art through the eyes of a person of ordinary skill in the art at the time of the alleged invention. For the reasons discussed above,

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[3] All emphasis and annotations herein are added unless otherwise noted. My annotations generally apply the language of the Challenged Claims.

I understand the priority date of the Challenged Claims is June 1, 2000. I understand that Patent Owner may argue that the Challenged Claims should be entitled to a filing date as early as October 6, 1997. Accordingly, for Ground 1 (Adair in view of Tomoyasu), I apply a priority date of June 1, 2000, and for Ground 2 (Swift in view of Ackland and Tomoyasu) and Ground 3 (Swift in view of Ackland, Tomoyasu, and Tanaka) I apply a priority date of October 6, 1997.

43. I understand that the factors considered in determining the ordinary level of skill in a field of art include the level of education and experience of persons working in the field; the types of problems encountered in the field, the teachings of the prior art, and the sophistication of the technology at the time of the alleged invention. I understand that a person of ordinary skill in the art is not a specific real individual, but rather is a hypothetical individual having the qualities reflected by the factors above. I understand that a person of ordinary skill in the art would also have knowledge from the teachings of the prior art, including the art cited below.

44. Taking these factors into consideration, in my opinion, on or before June 1, 2000, a person of ordinary skill in the art relating to the technology of the '740 patent would have had a minimum of a Bachelor's degree in Electrical Engineering, Physics, or a related field, and approximately two years of professional experience in the field of imaging devices. Additional graduate education could

substitute for professional experience, or significant experience in the field could substitute for formal education.

45. Well before June 1, 2000, my level of skill in the art was at least that of a person of ordinary skill. I am qualified to provide opinions concerning what a person of ordinary skill in the art would have known and understood at that time, and my analysis and conclusions herein with respect to Ground 1 are from the perspective of a person of ordinary skill as of June 1, 2000.

46. Even if the claims are entitled to a priority date as early as October 6, 1997 as I understand Patent Owner claims, my analysis would not change. On or before October 6, 1997, a person of ordinary skill in the art would still have had a minimum of a Bachelor's degree in Electrical Engineering, Physics, or a related field, and approximately two years of professional experience in the field of imaging devices. Additional graduate education could substitute for professional experience, or significant experience in the field could substitute for formal education.

47. Well before October 6, 1997, my level of skill in the art was at least that of a person of ordinary skill. I am qualified to provide opinions concerning what a person of ordinary skill would have known and understood at that time, and my analysis and conclusions herein with respect to Grounds 2 and 3 are from the perspective of a person of ordinary skill as of June 1, 2000.

VI. BACKGROUND ON THE STATE OF THE ART

48. As discussed in Section VII, the ’740 patent is generally directed to a particular configuration of a CMOS-based imager with separate processing circuity, and a “time select switch” for changing the integration time of the device. As discussed in the subsequent sections, each of these components was well-known in the prior art, and the claims of the ’740 patent are generally directed to simple combinations of these prior art elements.

49. As further discussed in the sections below, various arrangements of imager components was known in the prior art. For example, the prior art discusses examples of: (1) an imager array grouped with the timing and control circuitry and separate from the processing circuitry (Ackland (Ex. 1006), Fig. 6 (*e.g.*, depicting an array and timing and control circuitry separate from the processing circuitry)); (2) timing and control circuitry grouped with the processing circuitry but separate from the array (Hurwitz (Exs. 1042, 1046, 1047), 120, Fig. 1 (*e.g.*, depicting a single ASIC for the timing and control and processing circuitry); Ricquier (Exs. 1038, 1033), 2-3 (*e.g.*, discussing “off-chip” timing and control relative to the pixel array)); or (3) the array, timing and control circuitry, and processing circuitry each being separate from one another (Ricquier, 2-3 (*e.g.*, discussing “off-chip” timing and control); Stam (Ex. 1043), 6:25-28, Fig. 5 (*e.g.*, illustrating “Timing and Control” 203 “Image Array Sensor” chip 106 and “Microprocessor” 204 as three separate structures)). All

of these various combinations were known in the art, and a person of ordinary skill would have known that components could be placed apart from each other or placed in different locations based on the design needs and intended applications of a given device.

50. Similarly, the prior art discloses various physical arrangements of an image sensor relative to the other components. For example, the prior art discloses: (1) an imager that is positioned parallel or perpendicular to a circuit board on which the processing circuitry is mounted (Swift (Ex. 1005), 8:33-9:21, Fig. 2 (*e.g.*, depicting image sensor 51 and circuit board 52 and 53)); (2) three stacked circuit boards or chips that can contain the various components (Suzuki (Ex. 1015), 2:51-55, 3:15-19, Fig. 2 (*e.g.*, depicting "chip-connecting board 226," "circuit board 227," and "connector board 228" arranged in a stacked configuration), Fig. 3c; Chamberlain (Ex. 1044), 5:47-50, 6:21-35, Fig. 2, Fig. 17 (*e.g.*, depicting "driver board 13," "logic board 16," and "option boards 19" arranged in a stacked configuration)); (3) an image sensor stacked on a circuit board, which is offset from another circuit board (Wakabayashi (Ex. 1027), Fig. 3, Fig. 7 (*e.g.*, depicting "circuit board 39" offset from the "imager device 27" stacked on "circuit board 29")); or (4) a circuit board with processing circuitry that is placed in a control box remote from the image sensor (Monroe (Ex. 1007), 3:57-62, 8:8-11, Fig. 3 (*e.g.*, depicting "power supply and lighting unit 14," having "video processing circuitry," remote from

"video otoscope 12" having "solid state imager 36")). All of these various combinations were known in the art, and a person of ordinary skill would have known that components could be placed on a number of circuit boards and arranged in any number of different "planes" based on the design needs and intended applications of a given device.

51. Further, it was well-known that "[f]itting of the components into the available space" while maintaining "orientation of the components relative to one another," including "placement" of circuitry on "various layers" arranged "stackwise," is a common design consideration for portable devices. Ex. 1045 (Textbook on PCB Design, 1984), 15, 20.

A. CMOS Imager Arrays

52. As set forth in the "Background Art" section of the '740 patent, solid state imaging technology typically employs one of three types of sensors including charged coupled devices (CCD), charge injection devices (CID), and photo diode arrays (PDA). '740 patent, 1:39-52. The '740 patent further admits that "[i]n the mid-1980s, complementary metal oxide semiconductors (CMOS) were developed for industrial use." '740 patent, 1:47-50.

53. In general, each pixel in a solid-state imager (including CMOS based imagers) will convert the light it receives into an electrical charge proportional to the amount of light that it receives. After a certain amount of time has elapsed, the

signal produced by the charge accumulated by the pixel is measured, and this measured information from all the pixels is combined together and processed to create a single digital image. This process (i.e., measuring the signal produced by charge on each of the pixels over time) is traditionally controlled by "timing and control" circuitry connected to the pixel array, and the output from the pixel array is communicated to the rest of the device through "read out circuitry" where it can be processed into a convenient data format.

54. As explained by the '740 patent, "active pixel-type CMOS imagers" and "passive pixel-type CMOS imagers" were already well known in the art. *See, e.g.*, '740 patent, 1:53-55, 2:7-9. These types of CMOS based imagers had various advantages over other types of solid-state imagers. For example, the '740 patent states that it was well known that "[o]ne advantage of active pixel-type imagers is that the amplifier placement results in lower noise levels than CCDs or other solid state imagers." *See, e.g.*, '740 patent, 1:56-58. It was also known, as recognized in the '740 patent, that "[a]nother major advantage is that these CMOS imagers can be mass produced on standard semiconductor production lines." *See, e.g.*, '740 patent, 1:58-60. In addition, it was known that CMOS imagers "can incorporate a number of other electronic controls that are usually found on multiple circuit boards of much larger size"—"[f]or example, timing circuits, and special functions such as zoom and anti-jitter controls can be placed on the same circuit board containing the CMOS

pixel array without significantly increasing the overall size of the host circuit board." *See, e.g.*, '740 patent, 1:63-2:3. Further, it was known in the art that CMOS imagers require significantly less power (*e.g.*, 100 times less power) than a CCD-type imager. *See, e.g.*, '740 patent, 2:3-6.

55. The '740 patent itself is replete with examples of prior art systems that make use of CMOS pixel arrays and the accompanying timing, control, and readout circuity required to operate the array. *See, e.g.*, '740 1:60-2:6 (discussing that "the CMOS imager described in U.S. Pat. No. 5,471,515 to Fossum, et al. … can incorporate a number of other different electronic controls that are usually found on multiple circuit boards"); 2:12-17 ("One example of a manufacturer who has developed a passive pixel array with performance nearly equal to known active pixel devices and being compatible with the read out circuitry disclosed in the U.S. Pat. No. 5,471,515 is VLSI Vision, Ltd., 1190 Saratoga Avenue, Suite 180, San Jose, Calif. 95129"); 2:22-24 ("In addition to the active pixel-type CMOS imager which is disclosed in U.S. Pat. No. 5,471,515, there have been developments in the industry for other solid state imagers which have resulted in the ability to have a "camera on a chip." For example, Suni Microsystems, Inc. of Mountain View, Calif., has developed a CCD/CMOS hybrid which combines the high quality image processing of CCDs with standard CMOS circuitry construction"); 14:28-34 ("A further discussion of the timing and control circuitry which may be used in conjunction with

an active pixel array is disclosed in U.S. Pat. No. 5,471,515 and is also described in an article entitled 'Active Pixel Image Sensor Integrated With Readout Circuits' appearing in NASA Tech Briefs, October 1996, pp. 38 and 39.").

B. Image Processing Circuitry

56. The data produced by an imager/image sensor will generally need to be processed further in order to convert the data into a standard video format. In the context of the '740 patent, this is described as converting the "pre-video" signal produced by the imager into a "post-video" signal that is suitable for a standard video device. *See, e.g.*, '740 patent, 9:64-10:8 ("Once the pre-video signal has been transmitted from the image sensor … [v]ideo processing board 50 then caries out all the necessary conditioning.... The signal produced by the video processing board 50 can be further defined as a post-video signal which can be accepted by a standard video device").

57. These video processing circuits (*e.g.*, for doing white balancing and/or converting the single into a standard format) were well known prior to the '740 patent. For example, as discussed in greater detail in Section VIII.C, U.S. 4,700,219 (Ex. 1009, "Tanaka") was published in October of 1987 and discloses a functionally identical circuit as the preferred embodiment of the "video processing circuitry" disclosed in the '740 patent. The '740 patent itself also concedes that video processing circuity was already known in the art, stating that the detailed "example

of circuitry which may be used in the video processing board … is very similar to the circuitry which is found in a miniature quarter-inch Panasonic camera, Model KS-162." '740 patent, 15:50-61.

C. Time Select Switch

58. As discussed above, each pixel in a solid-state imager generates a signal produced by the charge accumulated by the pixel that is proportional to the amount of light that it receives, and the "image" produced is based on the amount of charge accumulated by each pixel over time. The amount of time of a measurement is normally referred to as an "integration period" or an "integration time." The longer the integration time, the more light that the pixels will receive. This can result in a "brighter" overall image. One objective of the '740 patent is to provide a "time select switch" that can be used to manually set the integration time used when capturing an image. *See, e.g.*, '740 patent, 1:20-23.

59. The idea of using a switch, or some equivalent mechanism, to manually set the integration time was known in the art. For example, as discussed in greater detail in Section VIII.A.2, JPH07275198 (Ex. 1021, "Tomoyasu") describes a method of manually changing the integration time used in a device. Other examples of manually changing an integration time (as opposed to the device determining it automatically) are disclosed in U.S. Patent 4,377,742 (Ex. 1024, "Kawabata") and U.S. Patent 6,005,613 (Ex. 1025, "Endsley"). Kawabata, 2:65-3:16, 35:7-28;

Endsley, 5:3-10, 5:34-35, 5:66-6:2. The ’740 patent itself also states that “commercially available CMOS-CID imagers such as those manufactured by CIDTEC of Liverpool, NY can be modified to include an imager integration time select switch which allows an operator to preselect a desired integration period which maximizes observable fluorescence.” ’740 patent, 6:6-12.

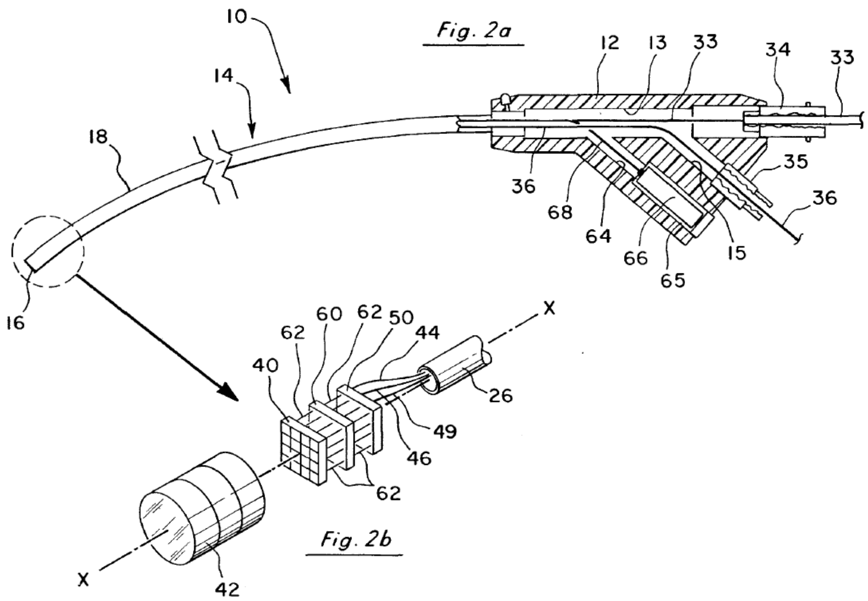
VII. ANALYSIS OF THE ’740 PATENT

A. Overview of the ’740 Patent

60. The ’740 patent describes endoscopic instruments utilizing solid state imaging technology that allows for the imaging sensor to be placed at the distal end of an endoscope. ’740 patent, 1:39-44. The ’740 patent acknowledges that different types of solid state image sensors including charged coupled devices (CCD) and complementary metal oxide semiconductors (CMOS) were known. ’740 patent, 1:44-2:22. The ’740 also acknowledges that it was known for a CMOS imager utilizing active pixels to incorporate a number of other different electronic controls (*e.g.*, timing circuits) that are usually found on multiple circuit boards of much larger size. ’740 patent, 1:60-2:4. Such a CMOS imager is referred to as a “camera on a chip.” ’740 patent, 2:4-6.

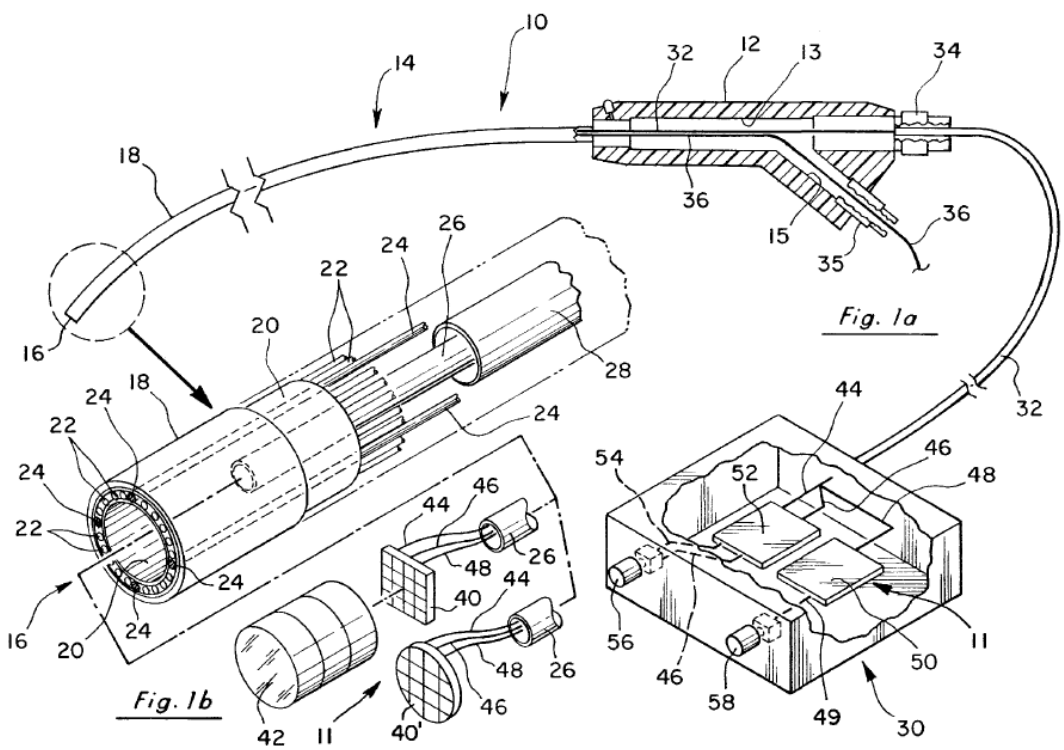
61. The ’740 patent allegedly improves on these “camera on a chip” concepts by “rearrang[ing] the circuitry [into] a stacked relationship so that there is a minimum profile presented when used within a surgical instrument or other

investigative device." '740 patent, 3:20-25. An example of such a device is the endoscope depicted in Figures. 2a and 2b reproduced below.



62. In the endoscope 10 depicted above, an image sensor 40 is connected to boards 50 and 60 that are "longitudinally aligned with image sensor 40 along axis XX" in a stacked relationship. '740 patent, 10:42-46. The image is focused onto the image sensor by a lens group or system 42. '740 patent, 9:46-51. The boards 50 and 60 contain processing circuitry that conditions the pre-video signal to place the signal in a form that can be viewed directly on a standard video device. '740 patent, 10:2-8, 10:36-40; *see also* '740 patent, 10:29-57, 12:39-62, Fig. 2b. Timing and control circuitry for controlling the timing of operation of the image sensor can be on board 50 or on the image sensor 40 itself. '740 patent, 12:18-38. A battery 66 provides power for the camera system. '740 patent, 10:24-28.

63. In another embodiment, shown in Figures 1a and 1b (reproduced below), the video processing board 50 is removed from the distal end of the endoscope tube and placed in a control box 30, which also provides power to the endoscope. ’740 patent, 9:41-60. As discussed in the ’740 patent, in the embodiment of Figure 1a “control box 30 may be placed remote from the endoscope 10,” and contain “some of the processing circuitry which is used to process the image signal” produced by the image sensor. ’740 patent, 9:26-32.



64. The ’740 patent discloses specific structures for converting a pre-video signal to a post-video signal in its discussion of Figures 4b and 5a-e. ’740 patent, 14:35-67, 15:50-53. For example, as shown in Figure 4b (reproduced below) the

"pre-video signal" is passed through a series of filters and mixers to perform white balancing before being fed to a "NTSC/PAL encoder 134" that will "produce the post-video signal which may be accepted by a television." *See, e.g.*, '740 patent, 14:35-67.

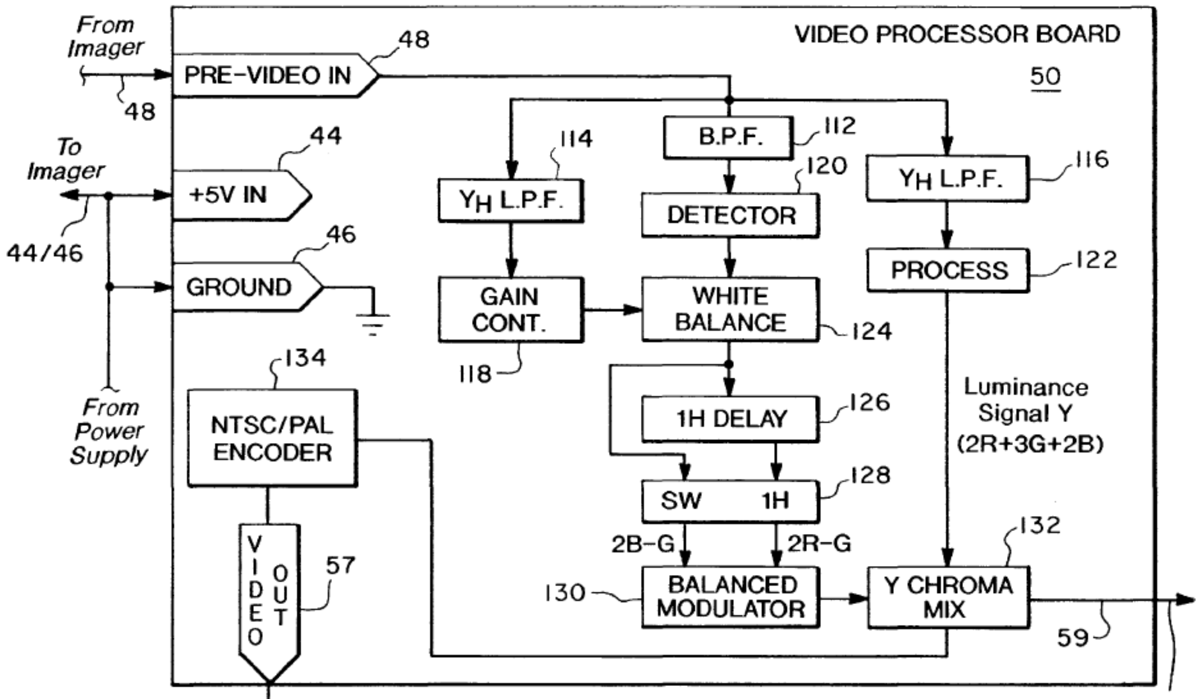
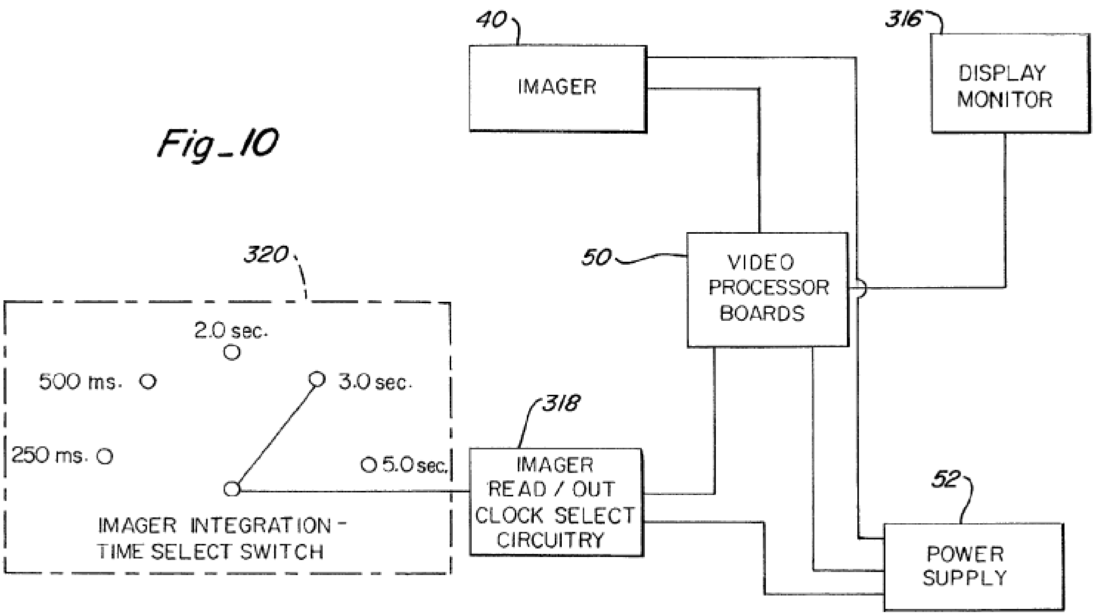


Fig. 4b

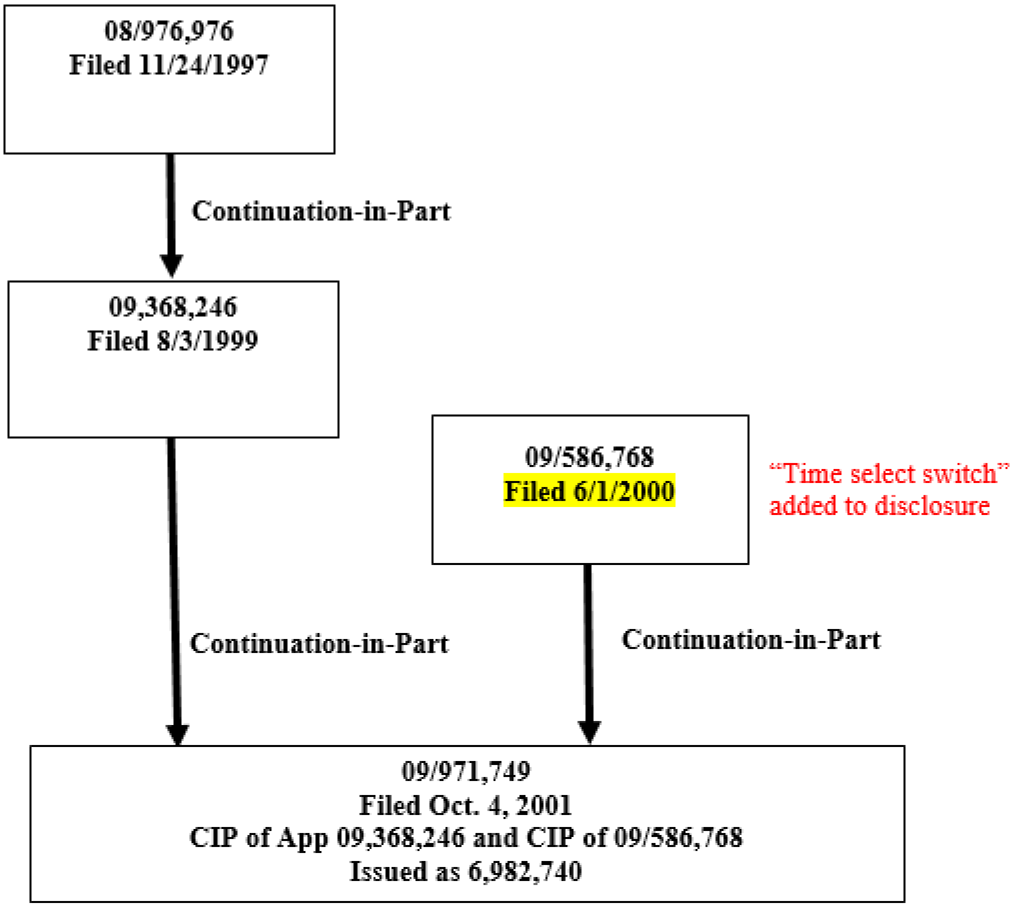
65. The '740 patent also discloses methods for modifying the charge integration period used to capture images with the image sensor. *See* '740 patent, Abstract. Changing the charge integration period for a digital imager is analogous to changing the exposure time used in a conventional camera, and a longer integration period will typically result in a "brighter" image. For example, in the embodiment of Figure 10 (reproduced below) the '740 patent discloses a time select

switch 320 that allows the user to "manually select" an integration period for the imager and change the brightness of the produced image. '740 patent, 5:66-6:25, 19:37-58. As described in the '740 patent, "the imager will accumulate charge based upon the selected integration period," enabling an operator to "adjust the charge integration period to obtain the most desirable image of the area being viewed." '740 patent, 19:50-57.



B. Prosecution History

66. The '740 patent issued from U.S. Patent Application No. 09/971,749, filed October 4, 2001 (the "'749 Application"). As discussed in Section V.A, the '749 application claims priority to a number of prior applications as a "continuation-in-part." For convenience, the chart from Section V.A showing the relationship between these various priority documents is reproduced below:



67. The Examiner issued a Non-Final Office Action on January 5, 2005 rejecting prosecuted claims 1-16 as unpatentable over the prior art of record. '740 patent File History (Ex. 1002), 107-120. The applicant responded by filing an Amendment on April 24, 2005 limiting the claims to devices with a time select switch for manipulating the "desired brightness" of the image located "remote" from the video processing. '740 Patent File History, 130-135.

68. A Notice of Allowance issued on September 16, 2005. The Notice of Allowance stated that the independent claims of '749 Application were distinguished

over the prior art because they included "a time select switch electrically communicating with said first circuit board and remote from said first circuit board for selectively varying integration periods to produce an image of a desired brightness, said switch having a plurality of settings enabling selective control to produce the image of desired brightness." '740 Patent File History, 148. Although the statement suggests that this limitation appears in all of the independent claims, a slightly different version of the limitation appears in independent claim 13. A table comparing the different "time select switch" limitations in claim 1 and claim 13 is shown below:

Claim 1	**Claim 13**
a time select switch electrically communicating with said first circuit board and remote from said first circuit board for selectively varying integration periods to produce an image of a desired brightness, said switch having a plurality of settings enabling selective control to produce the image of a desired brightness.	providing a time select switch remote from the image sensor and circuitry means; and adjusting a charge integration period of the imager by manipulating time select switch to maximize desired brightness of the image.

C. Claim Construction

69. I understand that for purposes of this *Inter Partes* Review, the standard for claim construction is the same as the standard used in federal district court litigation: claim terms should generally be given their ordinary and customary

meaning as understood by one of ordinary skill in the art at the time of the invention and after reading the patent and its prosecution history.

70. I understand that Patent Owner has not identified any terms as being subject to "means-plus function" terms in district court. I have been asked to apply Patent Owner's apparent constructions and the plain and ordinary meaning of the terms consistent with the specification. I have been instructed to not consider the issue of indefiniteness, but, where a term may be indefinite, to instead apply all reasonable interpretations of the term. With respect to the terms listed below, to the extent that these terms are interpreted under 35 U.S.C. §112(6), I have been asked to apply the following constructions:

"[C]ircuitry means … for timing and control of said array of pixels" (Claim 1)/"circuitry means … for timing and control of said pixels" (Claim 13):

71. To the extent it is found that §112(6), I have been asked to apply the following construction. The function is timing and control of the array of pixels, and the structure of the '740 patent specification linked to this function is the "Timing and Control Circuits" box 92 shown in Figure 4a. *See, e.g.,*'740 patent, 4:61-64, 12:63-65, 13:36-38 ("The *timing and control circuits 92* are *used to control the release of the image information or image signal stored in the pixel array.*"), Fig. 4a. I note that when discussing the timing and control circuitry, the '740 patent "incorporated by reference" U.S. Patent 5,471,515 and *NASA Tech Briefs,* October

1996, pp. 38-39 ('740 patent, 14:27-34). I am informed that any structures in these documents cannot be relied upon as being the corresponding structure.

"[C]ircuitry means for converting said pre-video signal to a post-video signal for reception by a standard video device" (Claim 1)/"circuitry means for receiving said pre-video signal from said image sensor and for converting said pre-video signal to a post-video signal which may be received by a standard video device" (Claim 13)

72. To the extent it is found that §112(6) applies, I have been asked to apply the following construction. The function is "converting said pre-video signal to a post-video signal for reception by a standard video device" for the claim 1 term and "receiving said pre-video signal from said image sensor and for converting said pre-video signal to a post-video signal which may be received by a standard video device" for the claim 13 term. The corresponding structure of the specification linked to these functions is the "processing circuitry which … converts the pre-video signal to a post-video signal which may be accepted by a standard video device," as shown in Figure 4b. *See, e.g.*, '740 patent, 4:39-43, 4:57-61 ("'*processing circuitry'* as used herein refers to the *electronic components within the imaging device which receive the image signal from the image sensor and ultimately place the image signal in a usable format*."), 7:65-8:3 ("FIG. 4b is an enlarged schematic diagram of a video processing board having placed thereon the *processing circuitry* which *processes the pre-video signal generated by the array of pixels and which converts the pre-video*

signal to a post-video signal which may be accepted by a standard video device.”), 10:2-8, 14:35-67, 15:50-61, Fig. 4b.

VIII. THE CHALLENGED CLAIMS ARE INVALID

73. It is my opinion that the Challenged Claims of the ’740 patent are unpatentable as explained below.

Ground	References	Basis	Claims
1	Adair in view of Tomoyasu	§103	1, 2, 13
2	Swift in view of Ackland and Tomoyasu		
3	Swift in view of Ackland, Tomoyasu and Tanaka		

A. Claims 1, 2, and 13 Are Obvious Under §103 over Adair in view of Tomoyasu (Ground 1)

1. Overview of WO 99/18613 (“Adair”) (Ex. 1018)

74. Adair (Ex. 1018) was published on April 15, 1999, and I understand, is prior art to the ’740 patent based on the ’740 patent’s priority date of June 1, 2000. *See, e.g.*, Section V.

75. Similar to the ’740 patent, Adair describes endoscopic instruments using solid state imaging technology, and a type of “stacked” configuration that allows the image sensor to be placed at the distal end of an endoscope. *See, e.g.*,, Adair, 1:21-25 (“The rod lens endoscope … is being increasingly replaced by solid state imaging technology which *enables the image sensor to be placed at the distal tip of the investigating device*”). Adair names the same inventors as the ’740 patent

(*i.e.*, Edwin Adair, Jeffrey Adair, and Randall Adair), and Adair and the '740 patent have substantial amounts of overlapping disclosure. I ran a redline of the specification and claims of the '740 patent against the specification and claims of Adair, which shows the substantially overlapping disclosure. Ex. 1023.

76. For example, as shown in the annotated version of Figure 2b reproduced below, in a first embodiment Adair teaches a reduced area imaging device with an "image sensor 40" lying in a first plane, and a first circuit board (*i.e.*, "video processing board 50") lying behind the image sensor in a second plane that contains processing circuitry for converting a pre-video signal to a post-video signal. *See, e.g.*, Adair, 11:6-15 ("Once the pre-video signal has been transmitted from image sensor 40…, it is received by video processing board 50. *Video processing board 50 then carries out all the necessary conditioning of the pre-video signal* and places it in a form so that it may be viewed directly on a standard video device.").

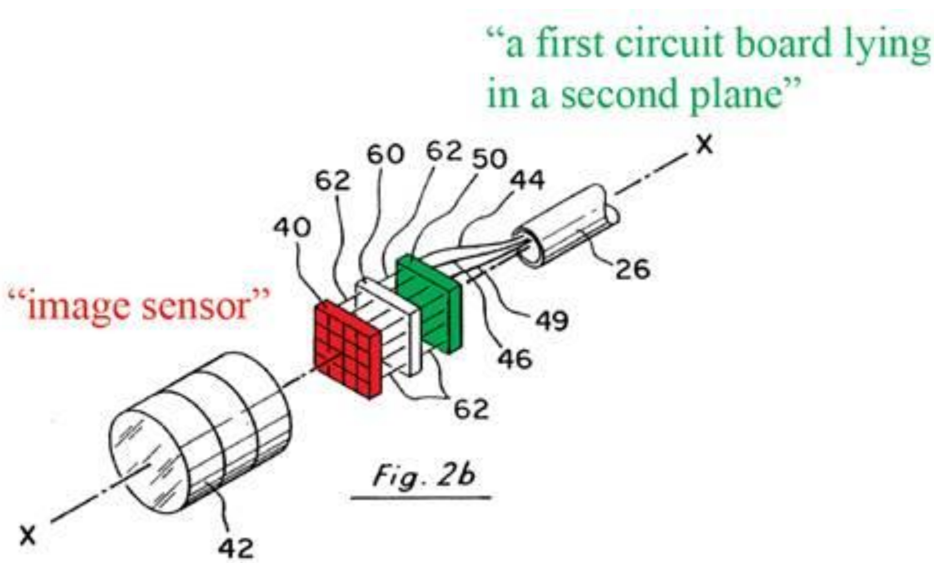


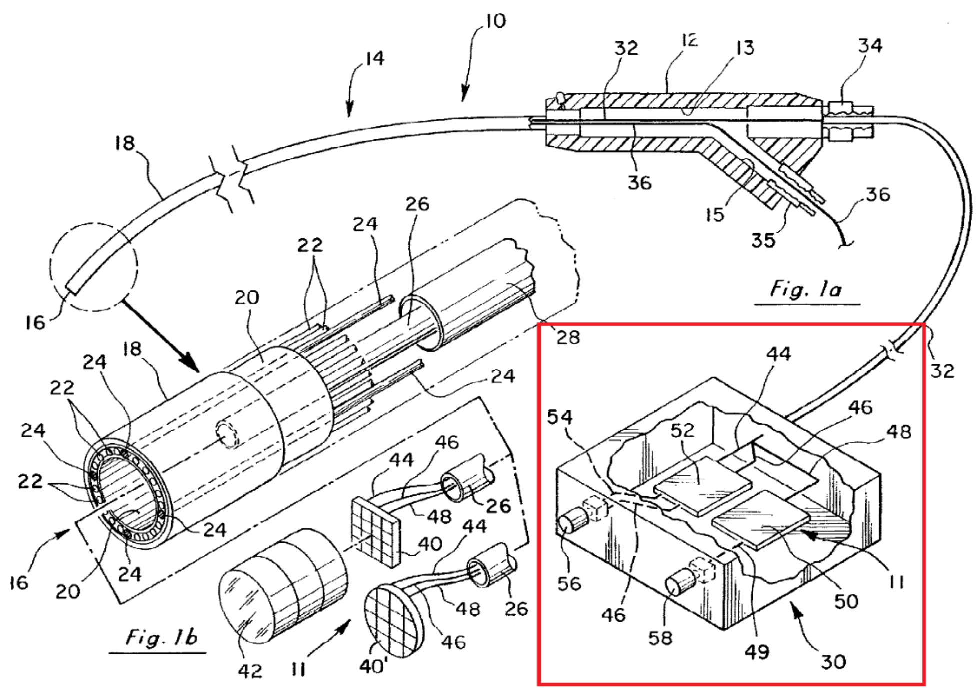
Fig. 2b

77. More generally, Adair discloses a stacked arrangement where an array of CMOS pixels and the accompanying timing and control circuitry is positioned on a first plane, and the video processing circuitry is placed in a second plane in a similar fashion as the '740 patent. *See, e.g.,* Adair 4:19-21 ("The term "image sensor" as used herein describes *the CMOS pixel array which captures images and stores them* within the structure of each of the pixels in the array"), 4:22-25 ("the *timing and control circuits can either be placed on the same planar substrate as the pixel array* and the image sensor can therefore also be defined as an integrated circuit, or the timing and control circuits can be placed remote from the pixel array"); 5:14-22 ("the image sensor and the processing circuitry may *all be placed in a stacked arrangement* of circuit boards.").

78. Adair also discloses a "pre-video conductor" communicating between the first circuit board and the image sensor, specific "video processing" circuitry for converting the image sensor output into a standard format, and a "power supply" that enables the entire device to operate. *See, e.g.,* Adair, 11:7-9 ("*Once the pre-video signal has been transmitted from image sensor 40 by means of conductor 48*, it is received by video processing board 50."), 11:9-12 ("*Video processing board 50* then carries out all the necessary conditioning of the pre-video signal and *places it in a form so that it may be viewed directly on a standard video device*."), 15:9-17

("Power is supplied to sensor 40 by *power supply board 52*.... Power and ground also are supplied to video processing board 50.").

79. In a second embodiment, Adair teaches that "a control box can be provided which communicates with the image sensor and is placed remotely." *See, e.g.*, Adair, Abstract. For example, the annotated version of Figure 1 reproduced below illustrates a "control box 30" that contains some of the necessary circuitry to operate the imaging device:



80. Similar to the control box described in the '740 patent, the control box 30 of Adair "contains some of the processing circuitry which is used to process the image signal produced by image sensor 40" and "communicates with image sensor 40 by means of a cable 32." Adair, 10:1-12.

81. As described below in Section VIII.A.4, Adair describes all of the features of claims 1, 2, and 13 of the ’740 patent except for a “time select switch.” However, a control box containing a “time select switch” (*e.g.*, as taught by Tomoyasu) that is “remote” from the circuitry contained in the endoscope end (*e.g.*, the components shown in Figure 2b of Adair) would have been an obvious addition (*e.g.*, as an additional mechanism for controlling the imager shown in Figure 2b of Adair).

2. Overview of JPH07275198 (“Tomoyasu”) (Ex. 1021)

82. Tomoyasu (Ex. 1021) was published on October 24, 1995, and as I understand, is prior art to the ’740 patent.

83. Tomoyasu describes a camera controlling unit (“CCU”) for adjusting the sensitivity of an imager (*e.g.*, a camera used in an endoscope). *See, e.g.*, Tomoyasu, Abstract (“A CCU 4 comprises a signal processing system wherein *the gain of an AGC circuit 27, and an image integration level through a change in the exposure time, are both settable by sensitivity adjusting means 25*”), [0008], Figs. 1-3. Increasing the “sensitivity” of a camera generally increases the overall brightness of the image produced.

84. Tomoyasu discusses two primary ways of increasing the “sensitivity” of a digital image sensor and change the brightness of the resulting image: (1) controlling “exposure integration, which controls the integration time of the image

sensor," or (2) controlling the "gain control of the electrical signal." *See, e.g.*, Tomoyasu, [0002] ("A *conventional example* of a device that uses an image sensor … *controls exposure integration, which controls the integration time of the image sensor, and the gain control of the electric signal, depending on the brightness of the imaging subject*"), [0003]-[0005], [0018] ("the knob for adjusting the gain of the AGC, and the knob for *adjusting the image integration*, which were each provided independently in the conventional example, are combined together so as to enable operation through a single gain controlling knob 23, and even when combined into one, an *image integration priority switch 24 is provided as priority function setting means to enable adjustments with priority on either of the two types of sensitivity adjusting functions, to thereby improve ease of operation*."), [0045] ("when one wishes the priority to be on the function for *video*, it is possible to set the state of gain through operating only the gain controlling knob 23, in a state wherein the integration priority switch 24 is set to OFF, and *if the brightness is inadequate despite the AGC gain at MAX, that, in a state wherein the AGC gain is at maximum, the amount of deficiency can be covered by the integrating function*. Consequently, it is possible to *increase the sensitivity* through a simple operation in a state wherein the motion is that which is important."), [0046].

85. Changing the integration time increases the amount of light that the sensor receives, which results in larger signals naturally being produced by the

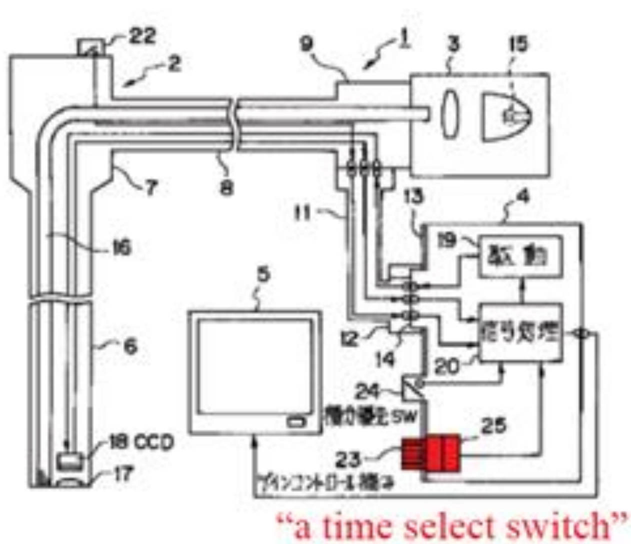
imager. Generally speaking, the "brightness" of the overall image is roughly proportional to the size of signals generated by the imaging device—meaning that a longer integration time will result in a brighter overall image (similar to the way that increasing the exposure time increases the "brightness" of the image captured using a conventional film-based camera). By comparison, the "gain" refers to a fixed amount by which the electrical signals are multiplied. This can be done before the signals are processed into a standard format, or it can be done as part of the processing. In either case, using a large "gain" can artificially change a "smaller" signal produced by the imager into a "larger" signal overall.

86. Each of the two mechanisms (*i.e.*, changing the gain, and changing the integration time) increase the "brightness" of the captured image, and each one has associated costs and benefits. For example, "extending the integration time of the image sensor" has "little negative effect on the S/N [signal to noise ratio] of the image, but because the exposure time will be longer, this will produce blurring in a moving image." *See, e.g.*, Tomoyasu, [0003]. By comparison, increasing the sensitivity of the camera through the "gain control of the electronic signal" avoids the blurring problem, but results in a "negative effect on the S/N of an image." *See, e.g.*, Tomoyasu, [0004]. As a result, it is generally preferable to increase sensitivity using a longer integration time when recording still images, and it may be preferable to increase sensitivity using an increased gain when recording fast moving images

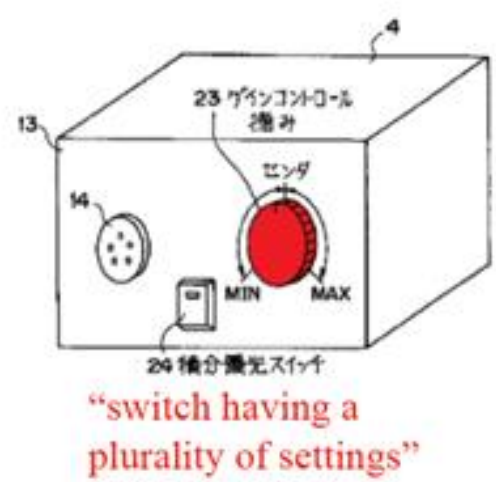
(*e.g.*, when recording video). In practice, however, as Tomoyasu recognizes, capturing the best image might require a combination of these two mechanisms to be used simultaneously. In particular, for video, Tomoyasu discloses that if the "brightness is inadequate despite the AGC gain at MAX … *the amount of deficiency can be covered by the integrating function*." *See, e.g.*, Tomoyasu, [0045].

87. Tomoyasu teaches that in a conventional system, two separate knobs could be provided for adjusting the integration time and the gain of the imaging device. *See, e.g.*, Tomoyasu, [0018] ("the knob for adjusting the gain of the AGC, and the knob for adjusting the image integration … *were each provided independently* in the conventional example"). By comparison, Tomoyasu discloses a system for modifying the "integration time" and the "gain" used by the imager using a "gain controlling knob 23" as shown in Figures 1 and 2:

【図1】

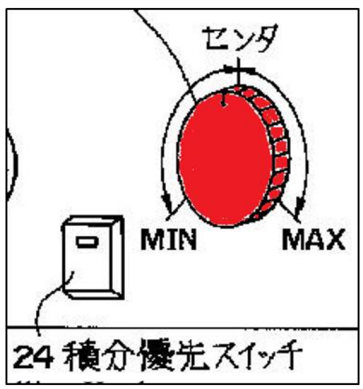


【図2】



Tomoyasu, Figs. 1-2 (color annotations added).

88. As shown in Figures 1-2 of Tomoyasu, the knob is located on the exterior of the "camera controlling unit 4," which is positioned remote from the solid state image sensor ("imaging means") located at the end of an endoscope (*i.e.*, "CCD 18" positioned at the end of "electronic endoscope 2"). *See*, *e.g.*, Tomoyasu, [0010], [0013]. Additionally, as shown in the enlarged segment of Figure 2 shown below, the knob can be turned between a "MIN" position, a "MAX" position, a "Center" position, and all of the intermediate values in-between.



Tomoyasu, Figure 2 (color annotation added).

89. Tomoyasu teaches a user manipulating the "gain controlling knob 23" to modify (1) the gain of the device, and (2) an "integrating function … which changes the sensitivity by changing the time over which the image is integrated, through changing the electronic charge accumulating time (the exposure time)." Tomoyasu, [0017]. Tomoyasu teaches that each of the two variables are changed independently. Only the first variable is changed as the knob is moved between the

"MIN" position and the "Center" position, while only the second variable is changed as the knob is moved between the "Center" position and the "MAX" position. The variable that changes first is changed using the "integration priority switch 24." *See, e.g.*, Tomoyasu, [0017]-[0018] ("The gain controlling knob 23 is attached to the shafts of variable resistors … *to perform linked adjustment of the gain ... [and] the time over which the image is integrated*, through changing the electronic charge accumulating time (the exposure time), where *the integration priority switch 24 is a switch for causing the integrating function through the integrating means to have priority*.").

90. For example, when the "integration priority switch 24" is pressed, "Min to the center of the gain control knob 23 will be the range for varying the integration, and from center to MAX will be the range for varying the AGC gain." Tomoyasu, [0040]. This means that as the gain controlling knob is moved from the MIN position to the center position, the integration time is changed while the gain is held constant at a "minimum level." *See, e.g.*, Tomoyasu, [0041]. Specifically, when "integration priority switch 24 is pressed," turning "the gain control knob 23 from MIN to center" changes the voltage across a variable resistor, and "integration controlling circuit 31 will carry out integration control depending on the value of the voltage." *See, e.g.*, Tomoyasu, [0040]-[0041].

91. Alternately, when the "integration priority switch" is turned off, the "gain" variable is given priority, and the system will change the gain first. *See, e.g.*, Tomoyasu, [0031]-[0032]. In this case, once the gain has reached a "maximum value" (*i.e.*, as a result of moving the "gain control knob 23" up to the "center" position), moving the knob further "gradually increases" the integration time. *See, e.g.*, Tomoyasu, [0031]-[0032] ("When the position of the center tap Rc has been passed, … *the gain of the AGC circuit 27 will be unchanging, at the maximum state; however, when the center tap Rc is passed, the integration controlling voltage of the variable resistor VR2 gradually increases from zero, to increase the integrating function in accordance with the integration controlling voltage value*."). In the later case, this means that "if the brightness is inadequate despite the AGC gain … [being] at maximum, the amount of deficiency can be covered by the integrating function." *See, e.g.*, Tomoyasu, [0045]. In other words, if the image is too dark despite the gain being set at some maximum value, increasing the integration time can be used to further increase the sensitivity of the camera and produce a brighter overall image.

92. Therefore, regardless of whether the "integration priority switch" is turned on or off, the gain control knob independently changes the length of the integration time. When the priority switch is turned on, the integration time is varied by moving the gain control knob between the "MIN" position and the "Center" position; and when the priority switch is turned off, the integration time is varied by

moving the gain control knob between the "Center" position and the "MAX" position. In either case, the user is able to modify the sensitivity of the device by selectively controlling the integration period, and producing an image of the desired brightness.

3. Motivation to Combine Adair and Tomoyasu

93. A person of ordinary skill in the art would have been motivated and found it obvious and straightforward to apply Tomoyasu's explicit teachings of a "gain control" that changes the integration time of the device and varies the brightness of the resulting image in implementing Adair's imaging devices to advantageously control the overall sensitivity of the camera by manipulating the integration time of the imager.

94. Adair and Tomoyasu are in the same field of art, and are analogous art to the '740 patent as they all relate to methods of controlling and using solid state sensors. *See, e.g.*, '740 patent, Abstract, 1:20-21 ("This invention relates to *solid state image sensors* and associated electronics."); Adair, Abstract, 1:4-9 ("This invention relates … *complementary metal oxide, semiconductor integrated circuit sensors* including active pixel arrays and accompanying processing circuitry"); Tomoyasu, [0110] (describing "[a]n imaging device wherein a gain level of an image signal and *an integration level for adjusting sensitivity through extended exposure*

<u>time of a solid-state imaging element or through adding images together can be set variably</u>”).

95. Moreover, Adair, Tomoyasu, and the ’740 patent are directed to the same same “sub-field” of controlling solid state image sensors in the context of an endoscopic system. *See, e.g.*, ’740 patent, 4:65-5:3 (“In a first embodiment, *<u>the image sensor, with or without the timing and control circuitry, may be placed at the distal tip of the endoscopic instrument</u>* while the remaining processing circuitry may be found in a small remote control box.”), 8:39-42; Adair, 5:9-13 (“In a first embodiment, *<u>the image sensor, with or without the timing and control circuitry, may be placed at the distal tip of the endoscopic instrument</u>* while the remaining processing circuitry may be found in a small remote control box.”), 1:21-2:2, 8:7-9; Tomoyasu, [0009] (“the present invention, as depicted in FIG. 1, comprises: … a *<u>camera controlling unit (hereinafter abbreviated "CCU") 4, for driving the imaging means of the electronic endoscope 2 and for carrying out signal processing</u>* on the output signal of the imaging means.”).

96. Additionally, both Adair and Tomoyasu are reasonably pertinent to the various problems identified in the ’740 patent, including the need to arrange the circuitry of a CMOS image sensor to minimize the size of the device; producing a device that is “low cost,” producing devices that may “be used in conjunction with a standard endoscope,” and providing an “imaging device which utilizes selected

charge integration periods in order to enhance the image in terms of a desired brightness or intensity." *See, e.g.*, '740 patent, 3:19-36 ("It is one object of this invention to *provide reduced area imaging devices which take advantage of "camera on a chip" technology, but rearrange the circuitry in a stacked relationship so that there is a minimum profile* … [and] *to provide low cost imaging devices which may be 'disposable*.' … [and] *to provide reduced area imaging devices which may be used in conjunction with standard endoscopes.*"), 3:36-40 ("…to provide a reduced area imaging device which *utilizes selected charge integration periods in order to enhance the image in terms of a desired brightness or intensity*."); Adair, 3:7-21 ("It is one object of this invention to *provide reduced area imaging devices which take advantage of "camera on a chip" technology, but rearrange the circuitry in a stacked relationship so that there is a minimum profile* … [and] *to provide low cost imaging devices which may be 'disposable*.' … [and] *to provide reduced area imaging devices which may be used in conjunction with standard endoscopes.*"); Tomoyasu, Abstract ("A CCU 4 comprises a signal processing system wherein *the gain of an AGC circuit 27, and an image integration level through a change in the exposure time, are both settable* by sensitivity adjusting means 25"), [0045] ("*if the brightness is inadequate* despite the AGC gain at MAX … *the amount of deficiency can be covered by the integrating function*"), [0110] (describing "[a]n imaging device wherein a gain level of an image signal and *an integration level for adjusting* *sensitivity through extended exposure time of a solid-state imaging element or through adding images together can be set variably*”), [0045].

97. A person of ordinary skill in the art would have been motivated to apply Tomoyasu’s known teachings of a control for selectively varying the integration period to produce images of a given level of brightness in implementing Adair’s imaging devices. *See, e.g.*, Tomoyasu, [0045] (“*if the brightness is inadequate* despite the AGC gain at MAX, … *the amount of deficiency can be covered by the integrating function*”). A person of ordinary skill in the art would have been further motivated to apply Tomoyasu’s known teachings of a control placed on a control box/unit remote from the imager in implementing Adair’s imaging system because it would allow a user to easily change the sensitivity level of the imager and generate images with a desired level of brightness. *See, e.g.*, Tomoyasu, Abstract. For example, providing these controls remote from the imager allows a doctor to change the settings for Adair’s endoscope during an ongoing procedure as needed to better analyze the images (*i.e.*, because the actual imager located at the tip of the endoscope will not be readily accessible when the device is being used on a patient). *See, e.g.*, Tomoyasu, Abstract. [0009], Fig. 1 (showing gain control knob 23 located remote from the imager).

98. It was well-known prior to the earliest alleged priority date of the ’740 patent that it was advantageous to provide some mechanism for allowing the user to

manually adjust the integration period of an image sensor based on the desired level of brightness of the image (*i.e.*, adjusting the sensitivity of the imaging device). For example, Kawabata (U.S. 4,377,742; Ex. 1024) was published March 22, 1983 and explicitly teaches that "the upper limit of the integration period range" can be controlled "manually by the user, or automatically." *See* Kawabata, 35:7-28. As explained in Kawabata, allowing a user to set the integration time of an imaging device would allow it to work under a wider range of light conditions. *See, e.g.*, Kawabata, 2:65-3:9 ("…to operate over a relatively wide range of brightness, therefore, *a provision for adjusting the integration period … remarkably extend the apparent dynamic range of the image sensor*"); 3:10-16 ("…when used… over a wide range of brightness, *a great advantage can be expected from the adjustment of the integration period*").

99. Similarly, Endsley (U.S. 6,005,613; Ex. 1025) was filed September 12, 1996, and describes that allowing a camera to operate using different "configuration parameters" makes it more versatile. *See, e.g.*, Endsley, 2:22-27 ("By providing *two or more configurations that are immediately accessible to the camera, and which can be set from the host computer*, the flexibility of the camera is increased. For example, the camera may … *used for different purposes in the different configurations*"). These parameters include an "integration time [of] 1 msec to 100 msec" and an "analog gain [of] 1-7 unit adjustments" (*i.e.*, the same parameters

which may be manipulated using the gain control knob of Tomoyasu), which collectively determine the "exposure of each image." *See, e.g.*, Endsley, 5:3-10, 5:34-35, 5:66-6:2.

100. Accordingly, applying Tomoyasu's known teachings of a control, remote from the "imaging means" at the end of the endoscope, for selectively varying the integration period to produce images of a given level of brightness in implementing Adair's imaging devices would have advantageously allowed a user to have greater control over the camera by adjusting the overall level of sensitivity. *See, e.g.*, Tomoyasu, Abstract; Kawabata, 2:65-3:16 (explaining that if "image sensors … are required to operate over a relatively wide range of brightness, therefore, *a provision for adjusting the integration period … remarkably extend the apparent dynamic range of the image sensor*."); Endsley, 2:22-28 (*"By providing two or more configurations* that are immediately accessible to the camera, and which can be set from the host computer, *the flexibility of the camera is increased*.").

101. Further, the gain control of Tomoyasu would have been an intuitive design choice for controlling image brightness, and would advantageously make the device more flexible and able to be used for different purposes. *See, e.g.*, Tomoyasu, Abstract (explaining that the purpose of the invention is "*to provide an electronic device with improved ease of operation*.").

102. In light of the above, a person of ordinary skill would have found it routine, straightforward and advantageous to apply Tomoyasu's known teachings of a control for modifying an integration period used by the timing circuitry in Adair's imaging system. A person of ordinary skill in the art would have had a reasonable expectation of success that applying these teachings would predictably work, regardless of whether a digital or analog signal is used to convey the control information, and provide the expected functionality because, for example, for the reasons discussed above, it would have been obvious to include a control signal from a remote switch using a remote "control box" (as disclosed in Adair) to the camera to provide for manual adjustment of the integration time. Further, Tomoyasu's teachings of a control for modifying an integration period apply equally whether implemented with digital or analog circuitry.

4. Invalidity of Claims 1, 2, and 13 Over Adair in view of Tomoyasu (Ground 1)

103. In addition to the disclosures in Adair referenced below, Adair's published claim 1 is nearly identical to '740 patent claim 1 and, thus, so are the corresponding limitations in method claim 13 directed to using the device of claim 1, with the exception of the limitations directed to the time select switch. *See* Redline Comparison of '740 patent vs. Adair (Ex. 1023 at 23-28 (comparing claims)). Comparing claim 1 of Adair and the Challenged Claims, a person of ordinary skill

in the art would have understood that the "first circuit board" referenced in the Adair claim 1 corresponds to the image sensor recited in the Challenged Claims and thus Adair's second circuit board also corresponds to the "first circuit board" recited in the Challenged Claims. Ex. 1023 at 23-24 (comparing claims).

a. Element [1.pre]

104. **Element [1.pre] recites "A reduced area imaging device."** To the extent the preamble is limiting, Adair discloses a reduced area imaging device (*e.g.*, "reduced area imaging device").

105. For example, Adair discloses that "[a] *reduced area imaging device* is provided for use in medical or dental instruments such as an endoscope." Adair, Abstract. Adair further discloses that "*[i]t is one object of this invention to provide surgical instruments with reduced area imaging devices* which take advantage of the CMOS-type imagers of Fossum, et al., or passive pixel-type CMOS imagers, but rearrange the accompanying circuitry in a stacked relationship so that there is a minimum profile presented when used within the surgical instrument." Adair, 3:7-11.

106. Moreover, Adair's claim 1 recites, a "*reduced area imaging device*." *See* Adair, Claim 1.

b. Element [1.a]

107. **Element [1.a] recites "an image sensor lying in a first plane and including an array of pixels for receiving images thereon."** Adair discloses element [1.a]. Adair discloses an image sensor (*e.g.*, "image sensor 40") lying in a first plane (*e.g.*, as shown in Figure 2) and including an array of pixels for receiving images thereon (*e.g.*, the "array of pixels making up the image sensor captures images").

108. For example, Adair discloses that an image sensor includes an array of pixels for receiving images, stating that "*[t]he array of pixels making up the image sensor captures images* and stores them in the form of electrical energy by conversion of light photons to electrons." *See* Adair, 8:7-14. This is referred to in the various embodiments of Adair as "image sensor 40." *See* Adair, 9:17-20 ("An *image sensor 40* may be placed within the central channel defined by inner tube 20"), 4:19-21, 12:6-12. In Figure 2b, Adair discloses an "image sensor 40" lying in a first plane while other device components are positioned behind the sensor in other planes. An annotated copy of Figure 2b is reproduced below:

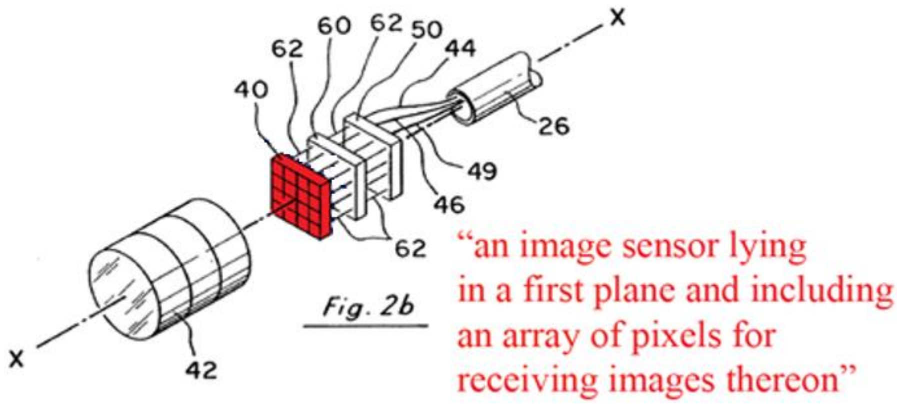


Fig. 2b

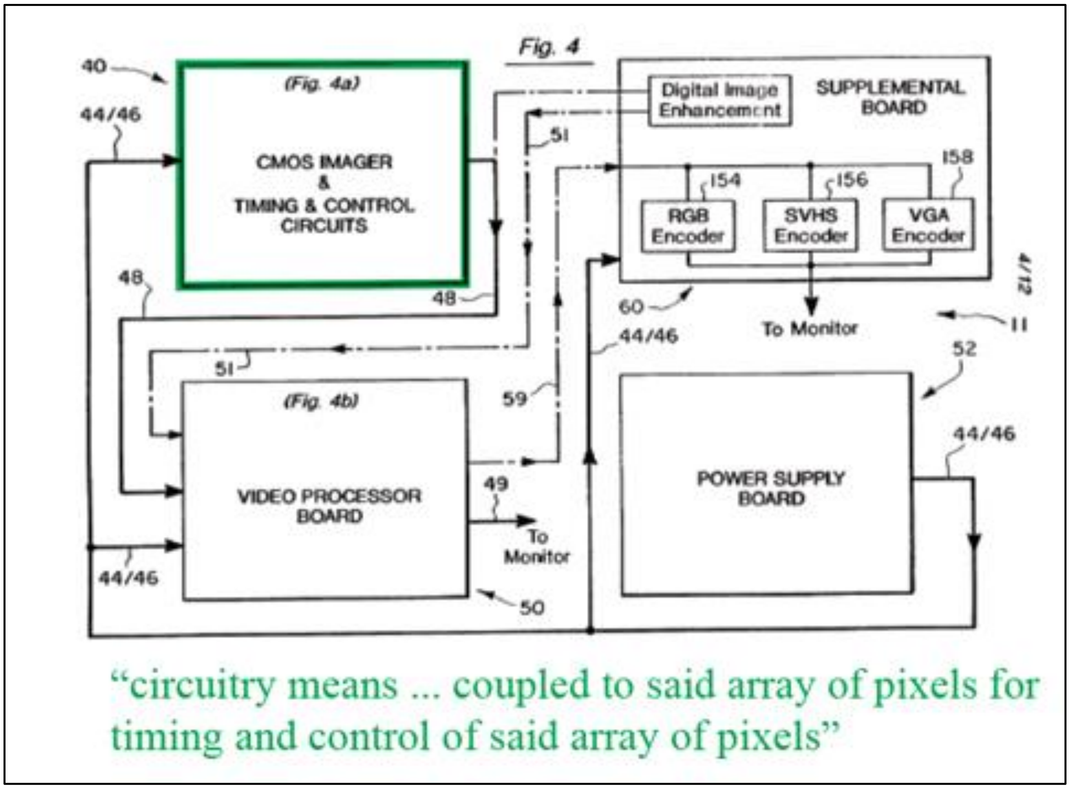
109. Moreover, Adair's claim 1 recites, "[a] reduced area imaging device comprising: *a first circuit board defining a profile area and lying in a first plane, said first circuit board including an array of CMOS pixels on said first plane for receiving images thereon*." Adair, Claim 1.

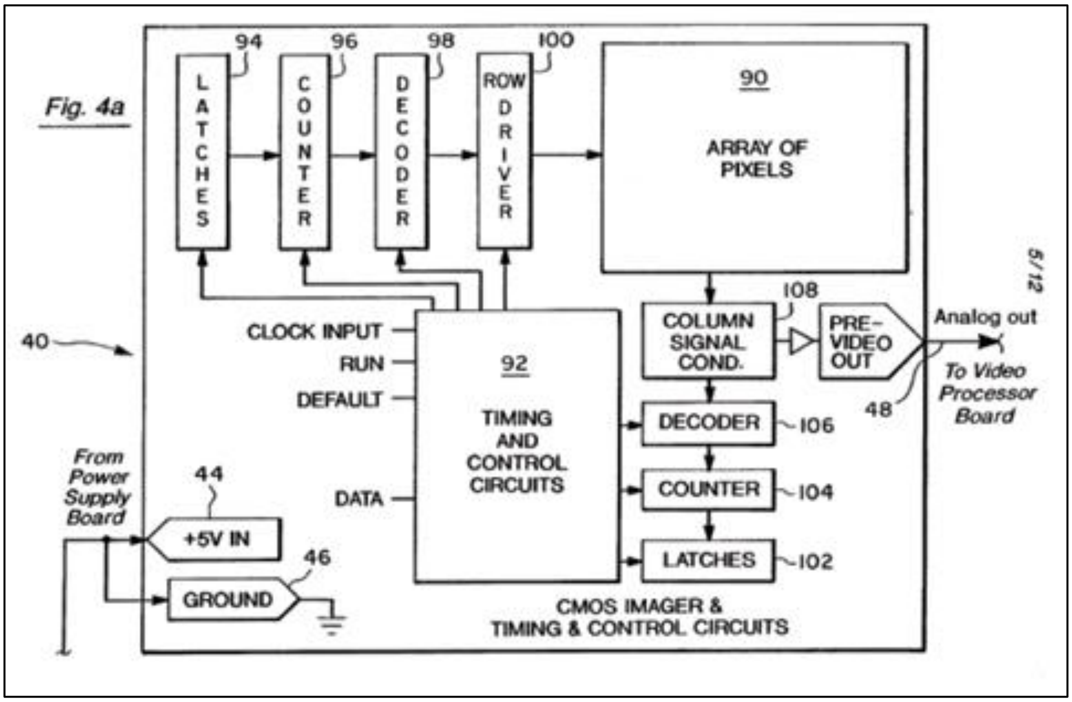
c. **Element [1.b]**

110. **Element [1.b] recites "said image sensor further including circuitry means on said first plane and coupled to said array of pixels for timing and control of said array of pixels."** Adair discloses element [1.b]. Adair discloses said image sensor (*e.g.*, "image sensor 40") further including circuitry means on said first plane and coupled to said array of pixels for timing and control of said array of pixels (*e.g.,* "the CMOS image sensor 40 may include the timing and control circuits on the same planar structure," as shown in Figure 4a).

111. For example, Adair discloses, "*CMOS image sensor 40 may include the timing and control circuits on the same planar structure*." Adair, 15:7-9, 3:6-7. Additionally, as shown in Figure 4 of Adair (specifically, as shown in the details of

Figure 4a illustrating the CMOS imager and accompanying timing and control circuits), the "timing and control" circuitry is coupled to the array of pixels. An annotated copy of Figure 4 and Figure 4A is shown below:



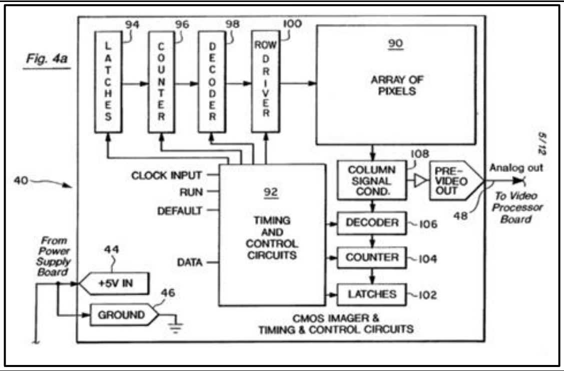


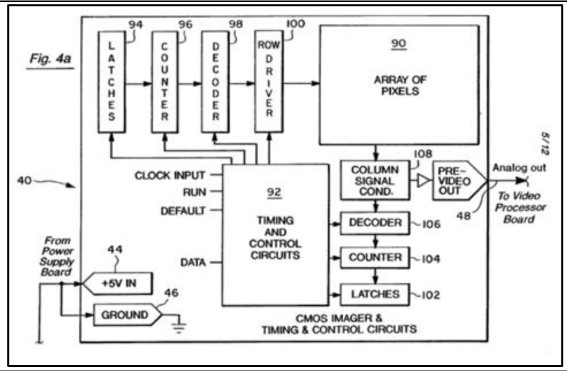
112. Moreover, Adair's claim 1 recites, "[a] reduced area imaging device comprising: <u>*a first circuit board defining a profile area and lying in a first plane, said first circuit board including an array of CMOS pixels on said first plane for receiving images*</u> thereon and wherein individual CMOS pixels within said array of CMOS pixels each include an amplifier, <u>*said first circuit board further including circuitry means on said first plane and coupled to said array of CMOS pixels for timing and control of said array of CMOS pixels*</u>, said first circuit board producing an analog pre-video signal." Adair, Claim 1.

113. Furthermore, to the extent that "circuitry means … for timing and control of said array of pixels" is construed under §112(6) (*see* Section VII.C), as discussed above, Adair's "timing and control circuits" performs the same function

of timing and control of the array of pixels and has the same structure as "timing and control circuits 92," which control the release of the image signal from the pixel array, disclosed in the '740 patent. A table showing a comparison between the disclosure in the '740 patent and equivalent disclosure in Adair is shown below (*see also generally* Ex. 1023):

'740 Patent	**Adair**
"The terms "timing and control circuits" or "circuitry as used herein refer to the electronic components which control the release of the image signal from the pixel array." 4:61-64	"The terms "timing and control circuits" or "circuitry as used herein refer to the electronic components which control the release of the image signal from the pixel array." 5:6-8
"FIG. 4a is a more detailed schematic diagram of image sensor 40 which contains an array of pixels 90 and the timing and control circuits 92" 12:63-65	"FIG. 4a is a more detailed schematic diagram of image sensor 40 which contains an array of pixels 90 and the timing and control circuits 92" 17:6-7
"The timing and control circuits 92 are used to control the release of the image information or image signal stored in the pixel array. In the image sensor of Fossum, et al., the pixels are arranged in a plurality of rows and columns.… The whole process is repeated, based upon the timing sequence that is programmed. When the row driver 100 has accounted for each of the rows, the row driver reads out each of the rows at the desired video rate." 13:36-14:3	"The timing and control circuits 92 are used to control the release of the image information or image signal stored in the pixel array. In the preferred image sensor of Fossum, et al., the pixels are arranged in a plurality of rows and columns.… The whole process is repeated, based upon the timing sequence that is programmed. When the row driver 100 has accounted for each of the rows, the row driver reads out each of the rows at the desired video rate." 18:3-19:3
Fig. 4a:	Fig. 4a:





d. Element [1.c]

114. **Element [1.c] recites "said image sensor producing a pre-video signal."** Adair discloses element [1.c]. Adair discloses said image sensor producing a pre-video signal (*e.g.*, "pre-video signal" output by "image sensor 40").

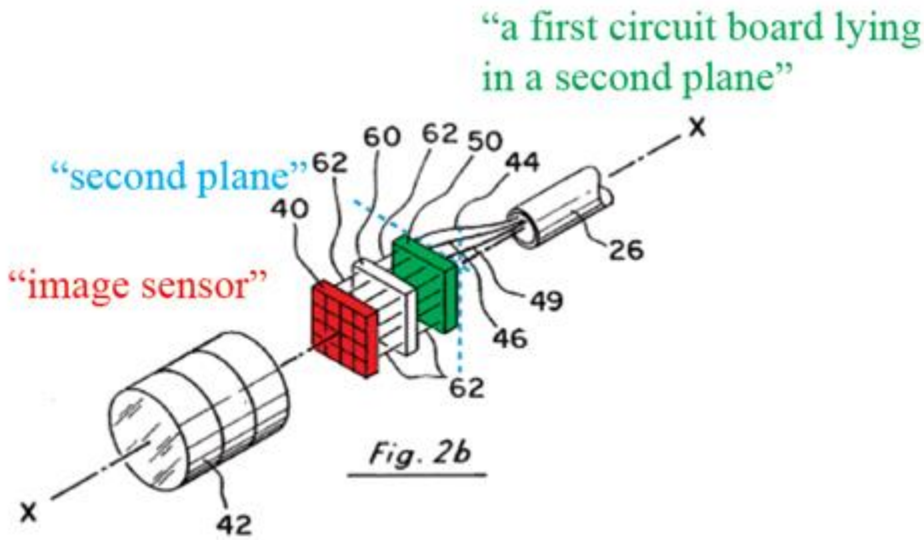
115. For example, Adair discloses that "*output from image sensor 40 in the form of the pre-video signal* is input to video processor board 50 by means of the conductor 48." Adair, 15:12-14; *see also* Adair, 11:6-9 ("*The image signal transmitted from the image sensor through conductor 48 is also herein referred to as a pre-video signal.* Once the pre-video signal has been transmitted from image sensor 40 by means of conductor 48, it is received by video processing board 50."), 20:3-4 ("*Once image sensor 40 has created the pre-video signal*, it is sent to the video processing board 50 for further processing.").

116. Moreover, Adair's claim 1 recites, "first circuit board including an array of CMOS pixels on said first plane for receiving images … *said first circuit board producing an analog pre-video signal*." *See* Adair, Claim 1.

e. Element [1.d]

117. **Element [1.d] recites "a first circuit board lying in a second plane and communicating with said image sensor by at least one pre-video conductor inner-connecting said image sensor and said first circuit board."** Adair discloses element [1.d]. Adair discloses a first circuit board lying in a second plane (*e.g.*, "video processing board 50") and communicating with said image sensor by at least one pre-video conductor inner-connecting said image sensor and said first circuit board (*e.g.* "output from image sensor 40 … is input to video processor board 50 by means of the conductor 48.")

118. For example, Adair discloses, "*output from image sensor 40 in the form of the pre-video signal is input to video processor board 50 by means of the conductor 48*." Adair, 15:12-14, 11:6-15. In Figure 2b, Adair discloses that "image sensor 40" is lying in a first plane, and the "video processing board 50 may be placed *directly behind image sensor 40*" in a second plane. *See, e.g.*, Adair, 12:6-7. An annotated copy of Figure 2b showing the relationship between the image sensor 40 and the video processor board 50 (*i.e.*, a "first circuit board") is reproduced below:



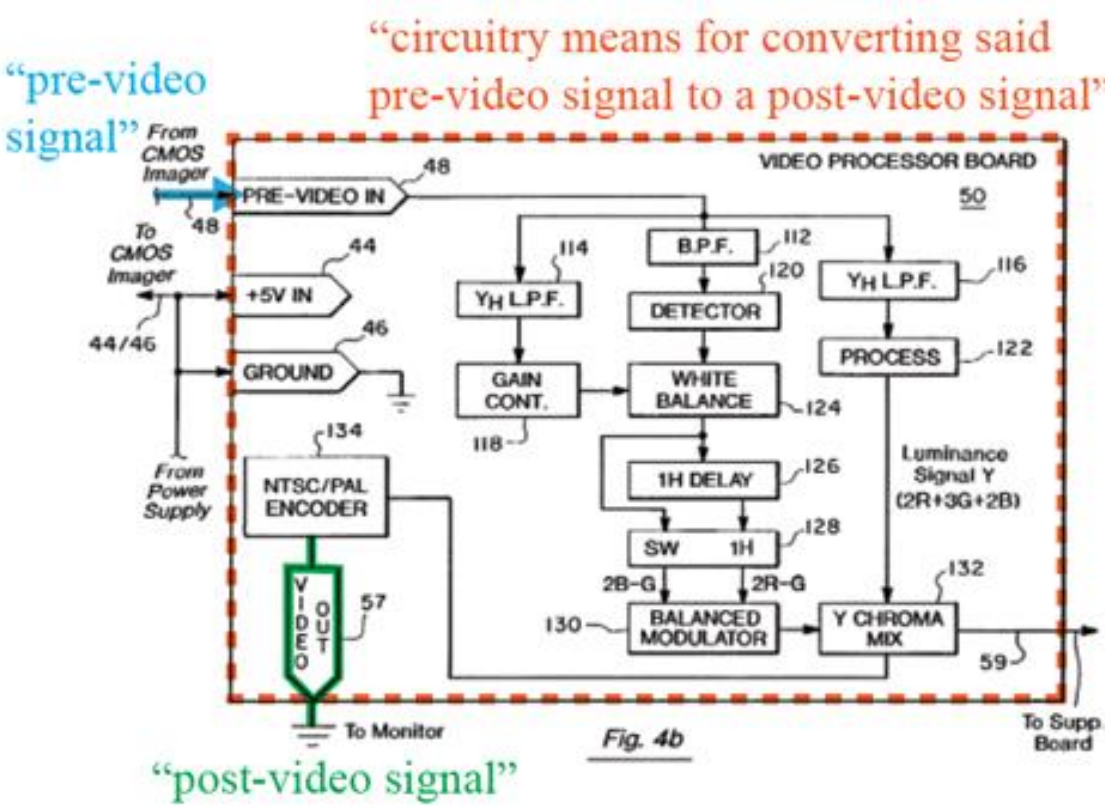
119. Moreover, Adair's claim 1 recites, "said first circuit board including an array of CMOS pixels on said first plane for receiving images … producing an analog pre-video signal," and "a *pre-video conductor for transmitting said pre-video signal*, said conductor having first and second ends, *said first end connected to said first circuit board; a second circuit board lying in a second plane* and longitudinally aligned with said first circuit board, *said second circuit board being connected to said conductor at said second end thereof*." *See* Adair, Claim 1.

f. Element [1.e]

120. **Element [1.e] recites "said first circuit board including circuitry means for converting said pre-video signal to a post-video signal for reception by a standard video device"** Adair discloses element [1.e]. Adair discloses said first circuit board (*e.g.*, "video processing board 50") including circuitry means for converting said pre-video signal to a post-video signal for reception by a standard

video device (*e.g.*, "processing circuitry which … converts the pre-video signal to a post-video signal which may be accepted by a standard video device," as shown in Figure 4b).

121. For example, Adair discloses, "[o]nce image sensor 40 has created the pre-video signal, it is sent to the video processing board 50 for further processing." Adair, 20:3-6. Once the pre-video signal is received, "[v]ideo processing board 50 then *carries out all the necessary conditioning of the pre-video signal and places it in a form so that it may be viewed directly on a standard video device*." Adair, 11:9-12. Additionally, Adair explicitly discloses that "*the signal produced by the video processing board 50 can be further defined as a post-video signal* which can be accepted by a standard video device." Adair, 11:13-15. Adair discloses that, "[t]he term 'processing circuitry' as used herein refers to the *electronic components within the imaging device which receive the image signal from the image sensor and ultimately place the image signal in a usable format*." Adair, 5:3-6. Figure 4b of Adair is also an exemplary "schematic diagram of a *video processing board* having placed thereon the processing circuitry which *processes the pre-video signal generated by the array of pixels and which converts the pre-video signal to a post-video signal which may be accepted by a standard video device.*" Adair, 7:23-27. An annotated Figure 4(b) is reproduced below:



122. Adair teaches that "*[t]he composite frequencies are added to the signal leaving the Y chroma mixer 132 in encoder 134 to produce the post-video signal which may be accepted by a television*." Adair, 20:25-21:2. Adair further discloses that, "Figures 5a-5e illustrate in more detail one example of circuitry which may be used in the video processing board 50 in order *to produce a post-video signal which may be directly accepted by a video device such as a television*." Adair, 22:14-23.

123. Moreover, Adair's claim 1 recites, "circuitry means for converting said pre-video signal to a post-video signal for reception by a standard video device." Adair, Claim 1.

124. To the extent that the "circuitry means for converting said pre-video signal to a post-video signal for reception by a standard video device" limitation is construed under §112(6) (*see* Section VII.C), as discussed above, Adair's processing circuitry that converts the pre-video signal to a post-video signal, which may be received by a standard video device as shown in Figure 4b, performs the same function of receiving said pre-video signal from the image sensor and converting said pre-video signal to a post-video signal for reception by a standard video device and has the same structure as "processing circuitry which converts the pre-video signal to a post-video signal which may be accepted by a standard video device" disclosed in the '740 patent. A table showing a comparison between the disclosure in the '740 patent and equivalent disclosure in Adair is shown below (*see also generally* Ex. 1023):

'740 Patent	**Adair**
"The term 'imaging device' as used herein describes the imaging elements and processing circuitry which is used to produce a video signal which may be accepted by a standard video device…" 4:39-43	"The term 'imaging device' as used herein describes the imaging elements and processing circuitry which is used to produce a video signal which may be accepted by a standard video device…" 4:15-19
"The term "processing circuitry" as used herein refers to the electronic components within the imaging device which receive the image signal from the image sensor and ultimately place the image signal in a usable format." 4:57-61	"The term "processing circuitry" as used herein refers to the electronic components within the imaging device which receive the image signal from the image sensor and ultimately place the image signal in a usable format." 5:3-6.

<table>
<tr>
<td>"FIG. 4b is an enlarged schematic diagram of a video processing board having placed thereon the processing circuitry which processes the pre-video signal generated by the array of pixels and which converts the pre-video signal to a post-video signal which may be accepted by a standard video device"
7:65-8:3</td>
<td>"Figure 4b is an enlarged schematic diagram of a video processing board having placed thereon the processing circuitry which processes the pre- video signal generated by the array of pixels and which converts the pre-video signal to a post-video signal which may be accepted by a standard video device."
7:23-27</td>
</tr>
<tr>
<td>"Once image sensor 40 has created the pre-video signal, it is sent to the video processing board 50 for further processing. At board 50, as shown in FIG. 4 b, the pre-video signal is passed through a series of filters. One common filter arrangement may include two low pass filters 114 and 116, and a band pass filter 112…." 14:35-67</td>
<td>"Once image sensor 40 has created the pre-video signal, it is sent to the video processing board 50 for further processing. At board 50, as shown in Figure 4b, the pre-video signal is passed through a series of filters. One common filter arrangement may include two low pass filters 114 and 116, and a band pass filter 112…." 20:3-19</td>
</tr>
<tr>
<td>"FIGS. 5a–5e illustrate in more detail one example of circuitry which may be used in the video processing board 50 in order to produce a post-video signal which may be directly accepted by a video device such as a television. The circuitry disclosed in FIGS. 5a–5e is very similar to circuitry which is found in a miniature quarter-inch Panasonic camera, Model KS-162…" 15:50-61</td>
<td>"Figures 5a-5e illustrate in more detail one example of circuitry which may be used in the video processing board 50 in order to produce a post-video signal which may be directly accepted by a video device such as a television. The circuitry disclosed in Figures 5a-5e is very similar to circuitry which is found in a miniature quarter-inch Panasonic camera, Model KS-162…." 22:14-23</td>
</tr>
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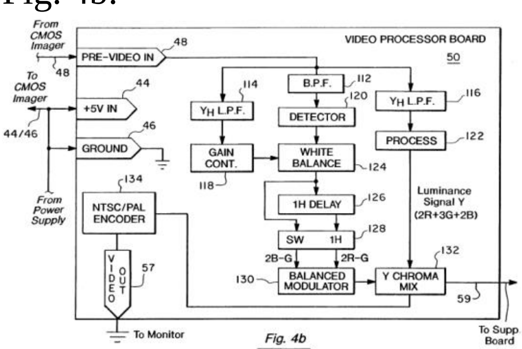
<td>Fig. 4b:

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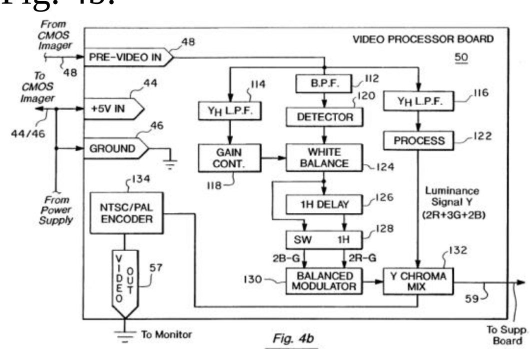
<td>Fig. 4b:

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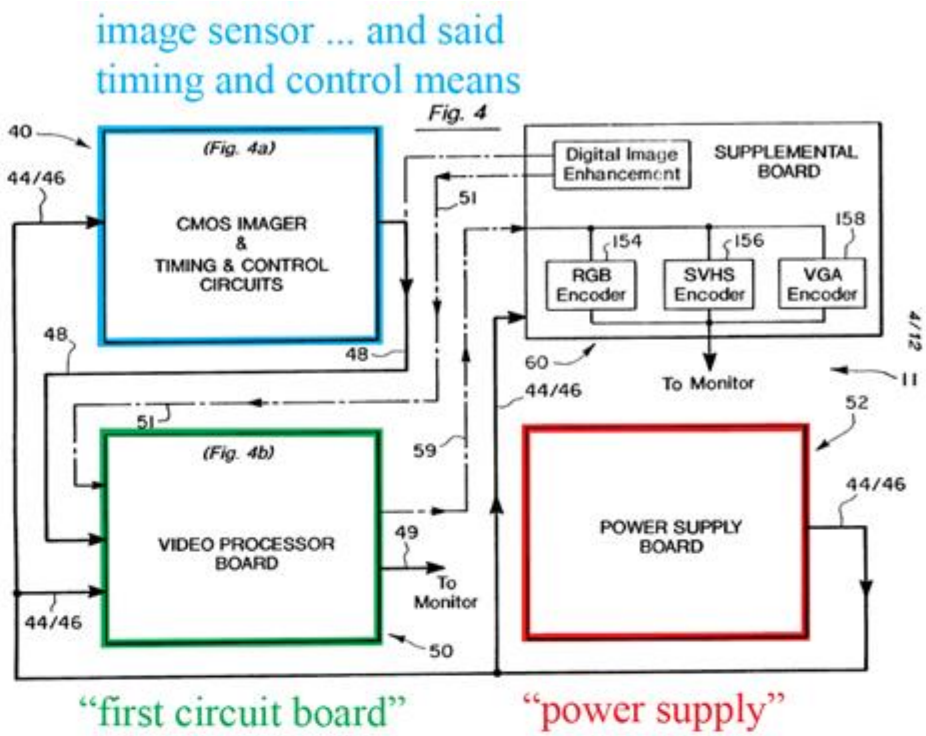
</table>

g. Element [1.f]

125. **Element [1.f] recites "a power supply coupled with said image sensor for driving said array of pixels and said timing and control means, and electrically coupled to said first circuit board for driving said first circuit board."** Adair discloses element [1.f]. Adair discloses a power supply (*e.g.*, "power supply board 52") coupled with said image sensor for driving said array of pixels and said timing and control means (*e.g.*, "[p]ower is supplied to sensor 40 by power supply board 52"; "sensor 40 may include the timing and control circuits"), and electrically coupled to said first circuit board for driving said first circuit board (*e.g.*, "[p]ower and ground are also supplied to video processing board 50").

126. For example, Adair discloses that a "*power supply board 52* may convert incoming power received through power source 54 into the desired voltage." Adair, 11:19-27. Adair also discloses that this power supply board provides power to other components. Adair states that "*power is supplied to sensor 40 by power supply board 52*," (Adair, 15:6-12), "*[p]ower and ground also are supplied to video processing board 50 by conductors 44 and 46 from power supply board 52*," (Adair, 15:14-17), and "[t]he power supply board 52 may also provide power to the supplementary board in the same manner as to sensor 40 and board 50" (Adair, 16:7-11). This is also shown illustrated in Figure 4 by the connections between the power

supply board 52 and the other device components. An annotated Figure 4 is reproduced below:



127. Moreover, Adair's claim 1 recites, "a *power supply electrically* coupled with said first circuit board for driving said array of CMOS pixels, and said timing and control means, and electrically coupled to said second circuit board for driving said second circuit board." *See* Adair, Claim 1.

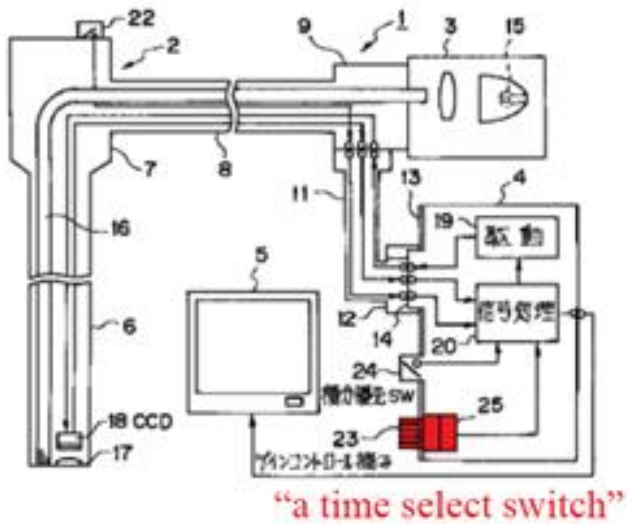
h. Element [1.g]

128. **Element [1.g] recites "a time select switch electrically communicating with said first circuit board and remote from said first circuit board for selectively varying integration periods to produce an image of a desired brightness, said switch having a plurality of settings enabling selective**

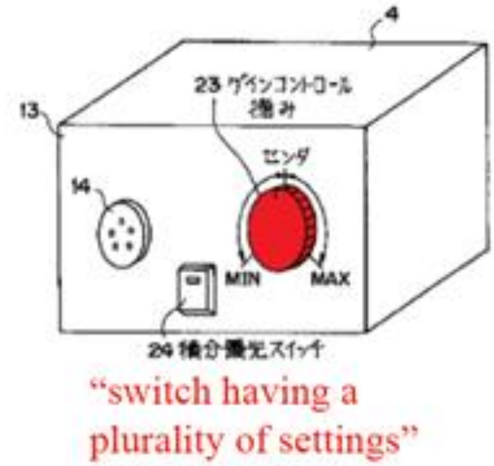
control to produce the image of a desired brightness.” Adair in view of Tomoyasu renders obvious element [1.g]. Tomoyasu discloses a time select switch (*e.g.*, “gain control[] knob 23) electrically communicating with [the “imaging means”] and remote from [the “imaging means”] (*e.g.*, “gain control[] knob 23” on “camera controlling unit [CCU 4], for driving the imaging means” as shown in Figure 1) for selectively varying integration periods to produce an image of a desired brightness (*e.g.*, “gain control[] knob 23 … changes the sensitivity by changing the time over which the image is integrated” to produce an image of desired brightness), said switch having a plurality of settings enabling selective control to produce the image of a desired brightness (*e.g.*, when the gain controlling knob 23 is turned past “center” when “integration priority switch 24 is OFF,” “the integration controlling voltage … gradually increases from zero, to increase the integrating function in accordance with the integration controlling voltage value”). Adair discloses the “first circuit board” located near the image sensor at the end of the endoscope.

129. While Adair does not explicitly describe a time select switch for “selectively varying integration periods to produce an image of desired brightness,” Tomoyasu provides for a time select switch, remote from and electrically coupled to the image sensor, in the form of a “gain controlling knob 23” as shown in annotated Figures 1 and 2 below:

【図1】



【図2】

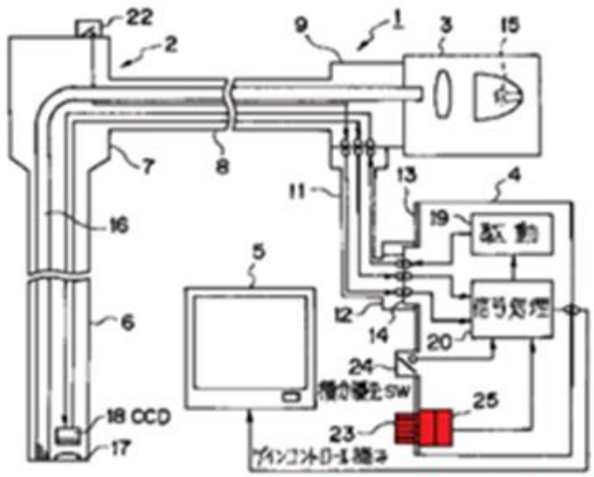


Tomoyasu, Figures 1 and 2 (color annotations added), *see also* Abstract, [0002].

130. For example, as shown in Figures 1 and 2, Tomoyasu discloses a “gain control knob 23” that is attached via a shaft to a pair of variable resistors that control the gain of the device and the charge accumulation time (*i.e.*, the integration time) of the device. *See, e.g.*, Tomoyasu, [0017] (“*The gain controlling knob 23 is attached to the shafts of variable resistors VR1 and VR2* that are linked to form the sensitivity adjusting means 25, *to perform linked adjustment of the gain* of the image signal by the signal amplifying means *and the sensitivity through the integrating function of the integrating means (which changes the sensitivity by changing the time over which the image is integrated, through changing the electronic charge accumulating time (the exposure time)*, where the integration priority switch 24 is a switch for causing the integrating function through the integrating means to have

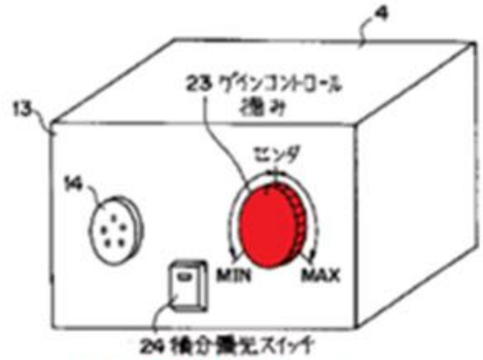
priority.”). The particular variable resistor that controls the integration time can be changed by pressing an “integration priority switch 24.” *See, e.g.*, Tomoyasu [0031] (“In the state of settings in FIG. 3 (the state *wherein the integration priority switch 24 is OFF), the variable resistor VR1 functions as gain adjusting means for adjusting the gain of the AGC circuit 27, and the variable resistor VR2 has the role of functioning as integration adjusting means* for adjusting the integrating function by the integrating means.”), [0033] (“In the state of settings in FIG. 3, *by turning the integration priority switch 24 ON, a mode can be set wherein the integrating function is determined by the integrating means, in the state set for the variable resistor VR1, and gain adjustment of the AGC circuit 27 is carried out by the state set for the variable resistor VR2*, that is, an integrating function priority mode can be set that gives priority to the integrating function by the integrating means”). As shown in the annotated versions of Figures 1 and 2 (above), the “gain control knob 23” can be set anywhere between the “MIN”, “Center”, and “MAX” positions:

【図1】



"a time select switch"

【図2】



"switch having a plurality of settings"

131. As explained in Section VIII.A.2, Tomoyasu teaches that the gain and the integration time may be controlled independently, and the operator can use the "integration priority switch 24" to select the variable that changes "first" (*i.e.*, as the gain controlling knob moves from a "MIN" position to a "Center" position) and the variable that changes "second" (*i.e.*, as the gain controlling knob moves from the "Center" position to the "MAX" position. *See* Section VIII.A.2.

132. For example, when the integration priority switch is selected, moving the gain control knob between the "MIN" and the "Center" positions will increase the integration time. *See, e.g.*, Tomoyasu, [0040] ("when observing a still image, or in a state that is near thereto, such that *image quality, that is, S/N, is that which is important, the integration priority switch 24 is pressed. Through this operation, from MIN to the center of the gain controlling knob 23 will be the range for varying the*

integration, and from center to MAX will be the range for varying the AGC gain.), [0041] ("That is, *with the gain controlling knob 23 from MIN to center, the voltage of the variable resistance terminal of the variable resistor VR1 will change from zero to Vcc, and the integration controlling circuit 31 will carry out integration control depending on the value of the voltage*. The voltage of the variable resistance terminal of the variable resistor VR2 will not change from zero, *and the AGC gain will remain at the minimum level*.").

133. By comparison, when the integration priority switch is not selected, moving the gain control knob between the "Center" position and the "MAX" position will gradually increase the integration time and further increase the brightness of the captured image. *See, e.g.,* Tomoyasu, [0031] ("In the state of settings in FIG. 3 (the state wherein the integration priority switch 24 is OFF) … the operation will be in the gain priority mode, wherein priority is given to the gain adjusting function."), [0032] ("In this case, when the gain controlling knob 23 is moved from the MIN position to the position of the center tap Rc, the gain of the AGC circuit 27 is increased…; however, when the position of the center tap Rc has been passed, … *the gain of the AGC circuit 27 will be unchanging, at the maximum state; however, when the center tap Rc is passed, the integration controlling voltage ... gradually increases from zero*."), [0045] ("*if the brightness is inadequate despite the AGC gain ... [being] at maximum, the amount of deficiency can be*

<u>*covered by the integrating function*</u>.”). *See also* Tomoyasu, [0009], [0013]-[0014], [0022].

134. As discussed in Section VIII.A.3, a person of ordinary skill in the art would have been motivated and found it obvious and straightforward to apply Tomoyasu’s known teachings of a control remote from the imaging means for modifying an integration time used by the timing circuitry in implementing Adair’s imaging system. For example, a person of ordinary skill in the art would have been motivated to locate such a control on a “camera controlling unit” (as disclosed in Tomoyasu) remote from, and electrically coupled to, the first circuit board (which Adair teaches is located near the image sensor at the end of the endoscope). Further, as discussed in Section VIII.A.3 a person of ordinary skill in the art would have recognized this combination (yielding the claimed limitation) would work as expected.

i. Claim 2

135. **Claim 2 recites “A device, as claimed in claim 1, wherein: said array of pixels includes an array of CMOS pixels.”**

136. Adair discloses said array of pixels includes an array of CMOS pixels (*e.g.*, “said first circuit board including an array of CMOS pixels…”). *See* Section VIII.A.4.b ([1.a]).

137. In addition, for example, Adair discloses that "the term 'image sensor' as used herein *describes the CMOS pixel array which captures images* and stores them within the structure of each of the pixels in the array." *See, e.g.*, Adair, 4:19-21.

138. Moreover, Adair's claim 1 recites, "[a] reduced area imaging device comprising: a first circuit board defining a profile area and lying in a first plane, *said first circuit board including an array of CMOS pixels* on said first plane for receiving images thereon." *See* Adair, Claim 1.

j. Element [13.pre]

139. **Element [13.pre] recites "A method of viewing an object with an imaging device."** To the extent the preamble is limiting, Adair discloses a method of viewing an object with an imaging device (*e.g.*, "imaging device[] enabling a surgeon or dentist to view a particular surgical area").

140. As discussed in relation to claim element [1.pre], Adair discloses an imaging device. *See* Section VIII.A.4.a. To the extent that additional disclosure is required, Adair also explicitly discloses that the imaging device can be used to view objects. *See, e.g.*, Adair, 1:13-17 ("… *imaging devices enabling a surgeon or dentist to view a particular surgical area* through a small diameter endoscope..."), 8:12-19 ("The array of pixels making up *the image sensor captures images and stores them* in the form of electrical energy by conversion of light photons to electrons.… The

structure of the endoscope 10 includes a flexible or rigid tubular portion 14 which is inserted into the body of the patient and is placed at the appropriate location for *viewing a desired surgical area*."), 4:2-7 ("the imaging device set forth herein can be applied to other functional disciplines wherein *the imaging device can be used to view difficult to access locations* for industrial equipment and the like.").

k. Element [13.a]

141. **Element [13.a] recites "providing an image sensor including an array of pixels."** Adair discloses element [13.a]. As discussed in relation to claim element [1.a], Adair discloses providing an image sensor including an array of pixels (*e.g.*, the "array of pixels making up the image sensor captures images"). *See* Section VIII.A.4.b.

l. Element [13.b]

142. **Element [13.b] recites "circuitry means coupled to said array of pixels for timing and control of said pixels."** Adair discloses element [13.b]. As discussed in relation to claim element [1.b], Adair discloses circuitry means coupled to said array of pixels for timing and control of said pixels (*e.g.,* "the CMOS image sensor 40 may include the timing and control circuits on the same planar structure," as shown in Figure 4a). *See* Section VIII.A.4.c.

m. Element [13.c]

143. **Element [13.c] recites "said image sensor producing a pre-video signal."** Adair discloses element [13.c]. As discussed in relation to claim element [1.c], Adair discloses said image sensor producing a pre-video signal (*e.g.*, "pre-video signal" output by "image sensor 40"). *See* Section VIII.A.4.d.

n. Element [13.d]

144. **Element [13.d] recites "providing first circuitry means for receiving said pre-video signal from said image sensor and for converting said pre-video signal to a post-video signal which may be received by a standard video device."** Adair discloses element [13.d]. As discussed in relation to claim elements [1.e], Adair discloses providing first circuitry means for receiving said pre-video signal from said image sensor and for converting said pre-video signal to a post-video signal which may be received by a standard video device (*e.g.*, "processing circuitry which … converts the pre-video signal to a post-video signal which may be accepted by a standard video device," as shown in Figure 4b.). *See* Sections VIII.A.4.e-f, VII.C.

145. To the extent that the "circuitry means for receiving said pre-video signal from said image sensor and for converting said pre-video signal to a post-video signal which may be received by a standard video device" limitation is construed under §112(6) (*see* Section VII.C, above), as discussed above, Adair's

processing circuitry that converts the pre-video signal to a post-video signal, which may be received by a standard video device as shown in Figure 4b, performs the same function of "receiving said pre-video signal from said image sensor and for converting said pre-video signal to a post-video signal which may be received by a standard video device" and has the same structure as the "processing circuitry which converts the pre-video signal to a post-video signal which may be accepted by a standard video device" disclosed in the '740 patent. *See* Sections VIII.A.4.f, VII.C.

o. Element [13.e] – [13.g]

146. **Element [13.e]-[13.g] recite "viewing the object and determining a desired level of brightness to be viewed; providing a time select switch remote from the image sensor and circuitry means; and adjusting a charge integration period of the imager by manipulating time select switch to maximize desired brightness of the image."** Adair in view of Tomoyasu renders obvious [13.e]-[13.g]. Tomoyasu discloses viewing the object and determining a desired level of brightness to be viewed (*e.g.*, "the mode for increasing sensitivity can be set depending on the preferences of the practitioner"); providing a time select time select switch remote from [the "imaging means"] (*e.g.*, "gain control[] knob 23" on "camera controlling unit [CCU 4], for driving the imaging means" as shown in Figure 1); and adjusting a charge integration period of the imager by manipulating time select switch to maximize desired brightness of the image (*e.g.*, "gain control[]

knob 23 … changes the sensitivity by changing the time over which the image is integrated, through changing the electronic charge accumulation time (the exposure time)" to maximize the desired brightness). Adair teaches viewing the object and discloses the "first circuit board" located near the image sensor at the end of the endoscope. *See* Section VIII.A.4.h.

147. In addition, Tomoyasu discloses viewing the object and determining a desired level of brightness to be viewed ("the mode for increasing sensitivity can be set depending on the preferences of the practitioner"). *See, e.g.*, Tomoyasu, [0047] ("[T]he *mode for increasing sensitivity can be set depending on the preferences of the practitioner, depending on that which is to be observed*, and the state of increase in sensitivity can be set as desired through a simple operation, improving the ease of operation.").

148. As discussed in relation to claim element [13.pre], Adair teaches viewing the object. *See* Section VIII.A.4.j. Tomayasu teaches the user then determining the desired level of brightness to be viewed and making an adjustment as discussed in [1.g]. *See* Section VIII.A.4.h.

149. As discussed in Section VIII.A.3, a person of ordinary skill in the art would have been motivated and found it obvious and straightforward to apply Tomoyasu's known teachings of control remote from the imaging means for modifying an integration time used by the timing circuitry in implementing Adair's

imaging system. For example, such a control located on a "camera controlling unit" (as disclosed in Tomoyasu) remote from, and electrically coupled to, the first circuit board (which Adair discloses is located near the image sensor at the end of the endoscope). Further, as discussed in Section VIII.A.3 a person of ordinary skill in the art would have recognized this combination (yielding the claimed limitation) would work as expected. Further, as discussed in Section VIII.A.3 a person of ordinary skill in the art would have recognized this combination (yielding the claimed limitation) would work as expected.

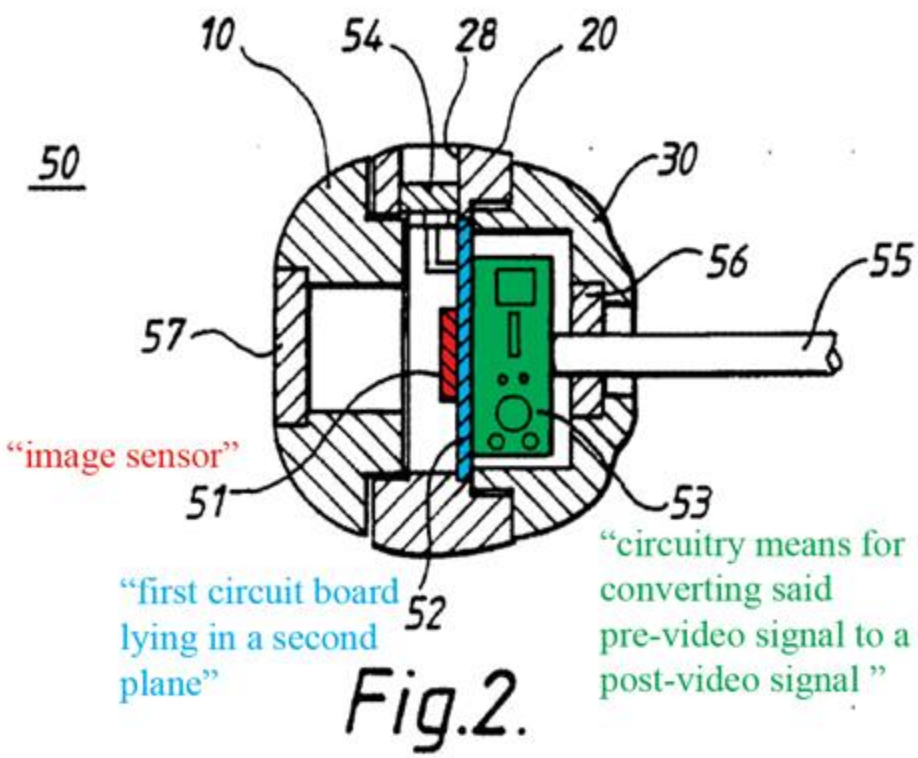
B. Claims 1, 2, and 13 Are Obvious Under §103 over Swift in View of Ackland and Tomoyasu (Ground 2)

1. Overview of WO 95/34977 ("Swift") (Ex. 1005)

150. Swift (Ex. 1005) was published on December 21, 1995, and I understand, is prior art to the '740 patent.

151. Swift describes a miniature camera suitable for purposes such as surveillance and security systems, and automated inspection apparatuses, among others. *See, e.g.*, Swift, 1:2-13. Swift teaches that "[i]n such systems, it is often desirable for a camera to be as small as possible" and describes its disclosed cameras as "small and compact." Swift, 1:3-16, 9:30-34. Swift's miniature video camera includes a CMOS image sensor and, specifically, of a CMOS/APS (Active Pixel Sensor) type. Swift, 4:11-15, 10:1-6.

152. As shown in Figure 2, Swift discloses an image sensor 51, lying in a first plane, mounted on a circular printed circuit board 52, lying in a second plane, and a rectangular circuit board 53, which includes various circuitry components "to provide power to the image sensor 51," and "process image signals received therefrom," including a video processor for converting the pre-video signal generated by the image sensor to a post-video signal. *See, e.g.*, Swift, 8:31-9:13, 3:32-4:4. Swift also teaches a "cable 55 is connected to the printed circuit board 53, and passes through the rear 15 bores 32, 33, to provide a connection between the miniature video camera 50 and external processing circuitry." Swift, 9:13-17.



Swift, Fig. 2 (annotated).

153. Swift teaches that to power the sensor, Swift's miniature camera uses a battery and a voltage regulator that provide power to the components on the printed circuit board(s) and the image sensor. *See, e.g.*, Swift, 3:31-4:4 ("image sensor assembly for a miniature camera, the assembly comprising a printed circuit board and, mounted thereon, the image sensor, a video processor, … and *a voltage regulator to accept a plurality of different input voltages and provide a substantially constant supply voltage to components on the printed circuit board*"), 4:21-22 ("camera … may incorporate a *battery*…"), 9:7-13 ("Various circuitry components are mounted on the circuit board 53, to *provide power to the image sensor 51*…"). Swift's battery and voltage regulator provide power to (and thus are electrically coupled to and drive) the "image sensor 51" (including its pixels) and circuit boards 52 and 53.

2. Overview of U.S. Patent 5,835,141 ("Ackland") (Ex. 1006)

154. Ackland (Ex. 1006) was filed July 3, 1996 and issued November 10, 1998, and I understand, is prior art to the '740 patent.

155. Ackland describes an active pixel imaging system using a "CMOS active pixel array" that may be used as a solid-state camera. *See, e.g.*, Ackland, 1:35-38, 7:62-63.

156. Ackland describes circuitry for timing and control of the array of CMOS pixels to generate a pre-video signal that is sent over a pre-video conductor.

See, e.g. Ackland, 8:24-35, 8:45-52, Fig. 6. As shown in the exemplary active pixel image sensor shown in Figure 6 below, Ackland teaches a timing controller coupled to the CMOS pixel array through row decoder 10. Ackland teaches that "[i]n operation, a timing controller 20 provides timing signals to the row decoder 10" and "[i]n response, the decoder 10 sequentially activates each row 25 of active pixels 35 via the control lines 55 to detect light intensity and to generate corresponding output voltage signals during each frame interval." Ackland, 8:24-35. The output voltage signals are amplified by amplifiers 18 and "[o]utput signals from the amplifiers 18 are provided to the common output line 19 in serial fashion based on timing control signals from the timing controller 20." Ackland, 8:45-52, 7:59-8:9, Fig. 6.

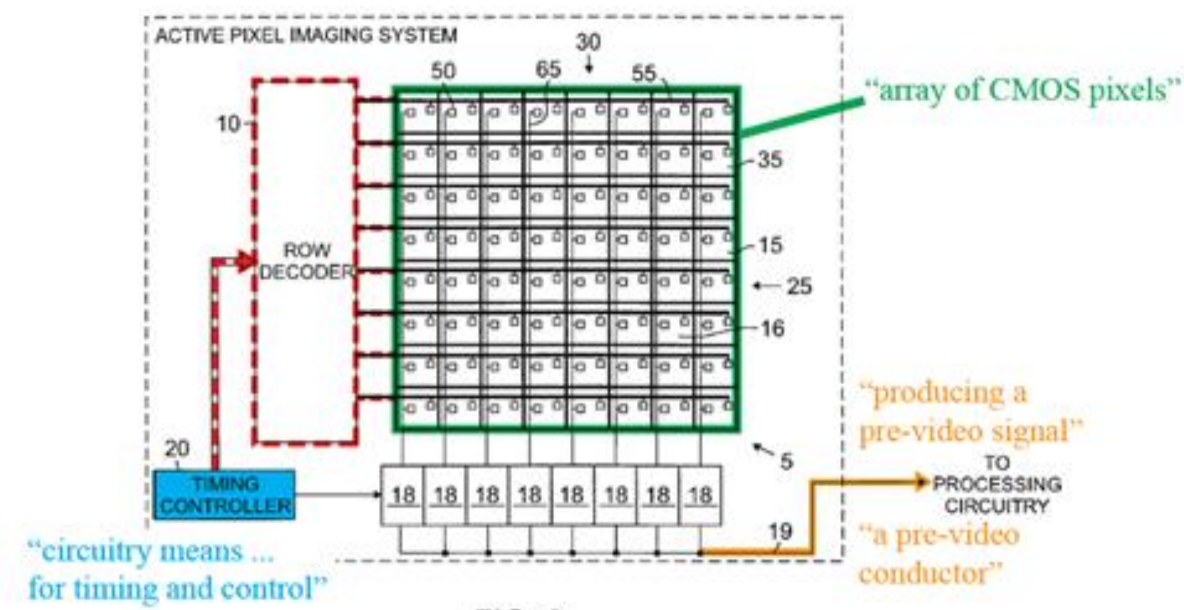


FIG. 6

Ackland, Fig. 6 (annotated).

3. Overview of JPH07275198 ("Tomoyasu") (Ex. 1021)

157. *See* Section VIII.A.2.

4. Motivation to Combine Swift, Ackland, and Tomoyasu

158. A person of ordinary skill in the art would have been motivated and found it obvious and straightforward to employ Ackland's express implementation detail teachings of an array of CMOS active pixels including its timing controller and pre-video conductor in implementing Swift's image sensor 51.

159. While Swift does not expressly state that its CMOS active pixels for receiving images thereon are configured in an array, Ackland expressly provides this additional implementation detail for an "active pixel imaging system," which includes a "CMOS … pixel array" for receiving images thereon. *See, e.g.,* Ackland, 1:35-38 ("CMOS active pixel array"), 2:19-23, 7:44-47, 7:59-65 ("[a] plurality of single polysilicon active pixels…"), Fig. 6. The '740 patent recognizes CMOS active pixel imaging systems were well known. '740 patent, 1:60-63 ("… area of <u>*CMOS imagers including active pixel-type arrays*</u> ...").

160. Similarly, while Swift does not expressly disclose how the timing of its pixels is controlled other than referring to sensor "selection and readout" circuitry (Swift, 10:2-4), Ackland describes circuitry including a "timing controller 20 provid[ing] timing signals" that control the imaging system "to achieve a desired frame rate." *See, e.g.,* Ackland, 8:24-35. The '740 patent admits that such timing

circuitry was well known. ’740 patent, 1:63-2:6 (“This [prior art] CMOS imager can incorporate a number of other different electronic controls…*timing circuits*…”), 14:27-34 (“A further discussion of the *timing and control circuitry which may be used in conjunction with an active pixel array is disclosed in U.S. Pat. No. 5,471,515 and is also described in an article* entitled ‘Active Pixel Image Sensor Integrated With Readout Circuits’ appearing in NASA Tech Briefs, October 1996, pp. 38 and 39.”). As shown in Figure 6 in red, Ackland’s timing controller 20 is coupled to the CMOS pixel array for timing and control of the pixels.

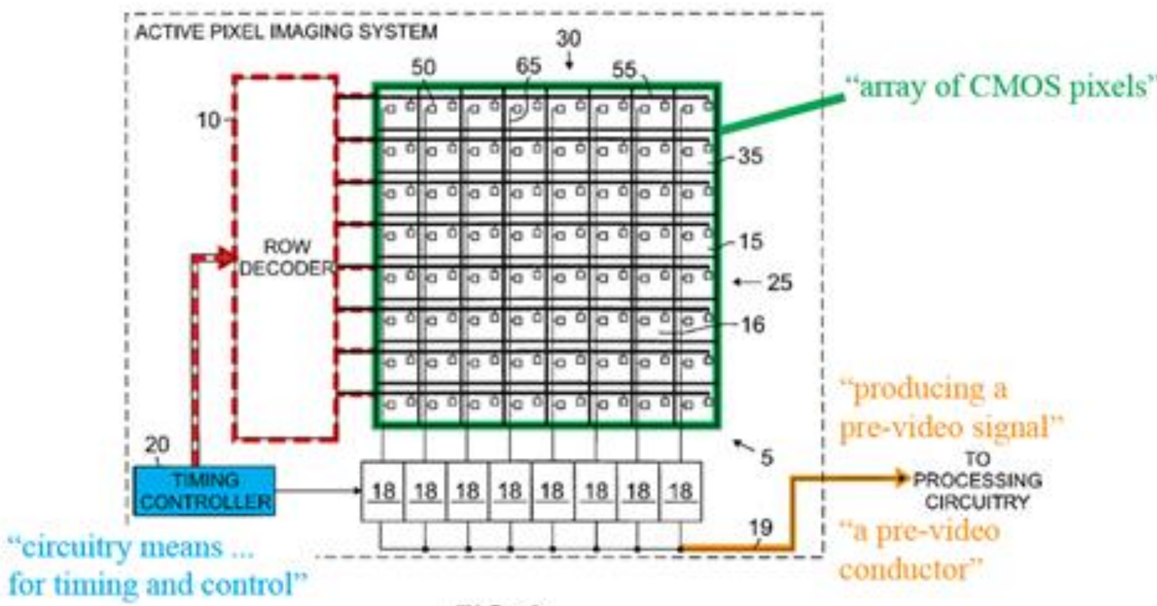


FIG. 6

Ackland, Fig. 6 (annotated).

161. In addition, while Swift discloses communicating an “image signal” from its image sensor to its image processor (*see* Swift, 9:5-10), Swift does not

expressly disclose that the pre-video signal is sent over a pre-video conductor. Ackland describes how the active pixel imaging system produces an output signal and a common output line 19 along which the output signals are transmitted from the active pixel imaging system (the image sensor) on the first end of the line to the second end. *See, e.g.*,, Ackland, 8:45-52 ("The *output voltage signals* generated by the activated row 35 are simultaneously *provided to the corresponding amplifiers 18* via the column output line 65" and "[o]utput signals from the amplifiers 18 are provided to the *common output line 19 in serial fashion based on timing control signals from the timing control 20*."), 7:59-8:9, Fig. 6.

162. A person of ordinary skill in the art would have been motivated to apply Ackland's known teachings described above in implementing Swift's "image sensor 51." Both Swift and Ackland are in the same field of art and are analogous art to the '740 patent —all are in the same field related to solid-state image sensors (*e.g.*, active CMOS image sensors) for use in cameras. *See, e.g.*, '740 patent, Abstract ("…The imaging device can be defined as a *CMOS-CID device* wherein a user may select an appropriate integration period… "), 1:20-21 ("…*solid state image sensors* and associated electronics…"), 8:39-42, 14:22-23 ("*CMOS type active pixel array*"); Swift, Abstract ("*miniature camera*"), 4:11-15 ("image sensor is preferably a *CMOS sensor*"); Ackland, 1:35-38, 3:27-29, 7:59-65. In addition, Swift and Ackland are also reasonably pertinent to the alleged problem(s) identified in the '740 patent of

arranging the circuitry of a CMOS image sensor, including to minimize the size of the device and for the device to be "low cost." *See, e.g.*, '740 patent, 3:20-36 ("It is one object of this invention to provide *reduced area imaging devices* … It is another object of this invention to provide *low cost imaging devices*…"); Swift, 1:7-18 ("Preferred embodiments of the present invention aim to provide *miniature cameras* which can be so constructed as to be *particularly small and compact*…"); Ackland, 2:10-15 ("…*lower per chip fabrication cost*").

163. A person of ordinary skill in the art would have been further motivated to apply Ackland's known teachings in implementing Swift's image sensors because, relative to other APS options, Ackland's teachings of an array of single-polysilicon active pixels requires no active drive signal for charge transfer. *See, e.g.,* Ackland**,** 2:34-43. This advantageously allows the image sensor to operate without requiring a "separate bias supply or clocking circuitry." *See, e.g.*, Ackland, 2:34-43 ("The structure of the single polysilicon active pixel allows for charge transfer, from the photosite to the pixel amplifier, with no active drive signal applied to the gate of the transfer transistor. This *eliminates the need for a separate bias supply or clocking circuitry*, as found in a double-polysilicon active pixels and photodiode pixel designs."), Abstract. In addition, through the use of single-polysilicon active pixels, a simpler fabrication process is possible, which lowers costs. Ackland, 2:10-15 ("It would be desirable to form an active pixel using a process wherein only one

polysilicon deposition is required" as "[t]his simple process would result in *lower per chip fabrication cost*."). Such a design also reduces image lag that "is observed in a double-polysilicon active pixel." *See, e.g.*, Ackland, 2:34-45 ("*Image lag is typically not observed* in the single-polysilicon active pixel when operating it in this manner.").

164. In light of the above, a person of ordinary skill in the art would have found it routine, straightforward and advantageous to apply Ackland's known teachings of an array of CMOS active pixels in an image sensor in implementing Swift's image sensor 51 of a CMOS/APS type, and would have known that such a combination (yielding the claimed limitations) would work as expected.

165. While Swift and Ackland do not explicitly describe a time select switch for "selectively varying integration periods to produce an image of desired brightness," Tomoyasu discloses the benefits of a time select switch in sensor imaging applications. *See* Sections VIII.B.1-3, VIII.A.2-3.

166. A person of ordinary skill in the art would have been further motivated and found it obvious and straightforward to employ Tomoyasu's express teachings of a control that varies brightness by varying the integration period in implementing Swift's imaging device (as modified by the teachings of Ackland discussed above) in order to control the overall sensitivity of the camera by manipulating the integration time of the imager.

167. Swift, Ackland, and Tomoyasu are all in the same field of art, and are analogous art to the ’740 patent as they all relate to methods of controlling and using solid-state image sensors. *See, e.g.*, ’740 patent, Abstract (“…The imaging device can be defined as a *CMOS-CID device* wherein a user may select an appropriate integration period… ”), 1:20-21 (“…*solid state image sensors* and associated electronics…”), 8:39-42, 14:22-23 (“*CMOS type active pixel array*”); Tomoyasu, [0110] (describing “[a]n imaging device wherein a gain level of an image signal and *an integration level for adjusting sensitivity through extended exposure time of a solid-state imaging element or through adding images together can be set variably*”); Swift, Abstract, 4:11-15; Ackland, 1:35-38, 3:27-29, 7:59-65.

168. In addition, Tomoyasu is also reasonably pertinent to the alleged problem identified in the ’740 patent of providing an “imaging device which utilizes selected charge integration periods in order to enhance the image in terms of a desired brightness or intensity.” *See, e.g.*, ’740 patent, 3:36-40 (“It is yet another object of the invention to provide a reduced area imaging device which *utilizes selected charge integration periods in order to enhance the image in terms of a desired brightness or intensity*.”), 3:37-40; Tomoyasu, Abstract, [0045], [0110] (describing “[a]n imaging device wherein a gain level of an image signal and *an integration level for adjusting sensitivity through extended exposure time of a solid-state imaging element or through adding images together can be set variably*).

169. A person of ordinary skill would have been further motivated to apply Tomoyasu's known teachings in implementing Swift's imaging device (as modified by the teachings of Ackland discussed above) in order to control the overall sensitivity of the camera—and the brightness of the resulting image—by manipulating the integration time used by the imager. Ackland teaches that an integration time may be set by a "timing controller." *See, e.g.*, Ackland, 4:46-61 ("The signal ***timing controller 190*** generates reset, select and photo gate control signals…. In the integration phase, ***the generated charge carriers are collected under the photo gate 101 for a predetermined period, referred to as the integration time***…."). A person of ordinary skill would have been motivated to apply Tomoyasu's known teaching of a control knob to allow an operator to selectively vary the integration period controlled by the timing controller, to produce an image of a given level of brightness. *See, e.g.*, Ackland, 4:46-61; Tomoyasu, [0045]. A person of ordinary skill in the art would have been further motivated to apply Tomoyasu's known teachings of a control placed remotely from the imager in implementing the imaging device of Swift (as modified by the teachings of Ackland) because it would allow a user to easily change the sensitivity level of the imager and generate images with a desired level of brightness. *See, e.g.*,, Tomoyasu, Abstract. For example, a person of ordinary skill in the art would have understood that providing remote control over the camera's integration period (exposure time)

advantageously lets the user adjust the camera to produce an image of a desired brightness, for example if an operator wants to view an image using various exposure settings to detect different features within an image. *See, e.g.*,, Swift, 17:25-32;

170. Moreover, as discussed in Section VIII.A.3, it was well-known prior to the earliest possible priority date of the '740 patent that it was advantageous to adjust the integration period of an image sensor based on the desired brightness of the image (*i.e.*, adjusting the sensitivity of the imaging device). *See, e.g.*, Kawabata, 2:65-3:9 ("…to operate over a relatively wide range of brightness, therefore, *a provision for adjusting the integration period ... remarkably extend the apparent dynamic range of the image sensor*"); 3:10-16 ("…when used… over a wide range of brightness, *a great advantage can be expected from the adjustment of the integration period*"); Endsley 2:26-27 ("By providing *two or more configurations* that are immediately accessible to the camera… *the flexibility of the camera is increased*."); *see also* Endsley 5:3-10, 5:34-35, 5:66-6:2 (explaining that "configuration" parameters include an integration time and a gain value that collectively determine the "exposure of each image").

171. Accordingly, applying Tomoyasu's known teachings of a control for selectively varying the integration period to produce images of a given level of brightness in implementing imaging device (as modified by the teachings of Ackland discussed above) would advantageously allow a user to have greater control over the

camera by adjusting the overall level of sensitivity. *See, e.g.*, Tomoyasu, Abstract (explaining that the purpose of the invention is "*to provide an electronic device with improved ease of operation*"); Kawabata, 2:65-3:16; Endsley, 2:22-28. Further, the gain control knob of Tomoyasu would have been an intuitive design choice for controlling image brightness, and would advantageously make the device more flexible and able to be used for different purposes. *See, e.g.*, Tomoyasu, Abstract.

172. In light of the above, a person of ordinary skill would have found it routine, straightforward and advantageous to apply Tomoyasu's known teachings of a control for modifying an integration period used by the timing circuitry in the imaging device of Swift (as modified by the teachings of Ackland). Additionally, a person of ordinary skill in the art would have had a reasonable expectation of success that applying these teachings would predictably work, regardless of whether an analog or digital signal is used to convey the control information, and provide the expected functionality as Tomoyasu teaches its gain control sends signals to the driving circuit to control the exposure time. Similarly, when applying Tomoyasu's known teachings in implementing Swift (as modified by the teachings of Ackland), signals from the gain control would be sent to the timing controller (as disclosed in Ackland) to manually set the integration period. *See, e.g.*,, Tomoyasu, [0014], [0022], Fig. 1. In applying Tomoyasu's known teachings of remotely controlling the integration period, a person of ordinary skill in the art would have been motivated

to apply these same teachings of sending signals from a remote switch (*e.g.*, at a central location) to the camera to provide for manual adjustment of the integration time (*e.g.*, to brighten the image if it is too dark for a security guard to properly monitor the area as Swift discloses). *See, e.g.*,, Swift, 1:7-10, 5:11-15, 7:4-5, 14:11-14, 15:4-9, Fig. 6. A person of ordinary skill in the art would have understood that modifying Swift's system in such a way that a user can adjust the integration period (*e.g.*, by implementing a remote control as disclosed in Tomoyasu) simply adds the ability for a user to manually control integration time set by the timing controller disclosed in Ackland.

5. Invalidity of Claims 1, 2, and 13 Over Swift in View of Ackland and Tomoyasu (Ground 3)

a. Element [1.pre]

173. **Element [1.pre] recites "A reduced area imaging device."** To the extent the preamble is limiting, Swift discloses a reduced area imaging device (*e.g.*, "miniature camera").

174. For example, Swift discloses "miniature cameras" for various applications, including "surveillance and security systems and also in automated inspection apparatus, and for incorporation in other devices." Swift, 1:2-10. Swift further discloses that "[i]n such systems, *it is often desirable for a camera to be as*

small as possible, so that it may be located discretely in such a way that it is not readily observed." Swift, 1:10-13.

b. Element [1.a]

175. **Element [1.a] recites "an image sensor lying in a first plane and including an array of pixels for receiving images thereon."** Swift in view of Ackland renders obvious element [1.a]. Swift discloses an image sensor (*e.g.*, "image sensor 51") lying in a first plane (*e.g.*, as shown in Figure 2). Ackland discloses an image sensor (*e.g.*, "active pixel imaging system") including an array of CMOS pixels for receiving images thereon (*e.g.*, "CMOS … pixel array").

176. Swift discloses the miniature camera includes a CMOS "*image sensor 51 []*" in a first plane, as shown in Figure 2. Swift, 8:31-9:18.

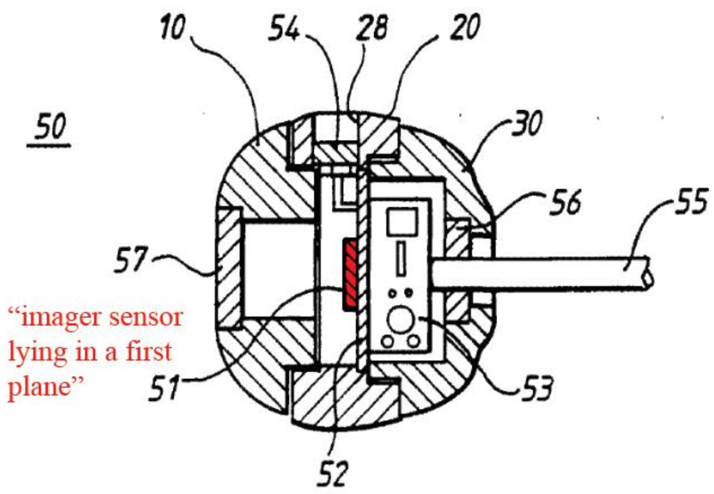


Fig.2.

Swift, Fig. 2 (annotated).

177. Swift discloses that "*image sensor 51* is preferably a *CMOS/APS (Active Pixel Sensor) type*," where "each pixel contains its own selection and readout transistor." Swift, 10:1-6, 4:11-13. Swift also discloses that additional information on "APS-type sensors may be found in the publication 'Laser Focus World', June 1993, Page 83." Swift, 10:1-6.

178. While Swift does not expressly state that its CMOS active pixels for receiving images thereon are in an array, Ackland provides additional implementation detail for an "active pixel imaging system," which includes a "CMOS … pixel array" for receiving images thereon. *See, e.g.*, Ackland, 1:35-38.

179. Ackland's teaches a "*CMOS active pixel* characterized by a single layer of polysilicon for forming the photo gate and the transfer gate ('single-polysilicon active pixel'), a method for operating the pixel, and *pixel arrays based on such a pixel*." Ackland, 2:19-23. Ackland's "CMOS active pixel 36 … may be comprised of the same elements that are used in a double polysilicon active pixel for providing read-out, reset and buffering functions." Ackland, 7:44-47.

180. For example, Ackland discloses an "*active pixel imaging system*, such as the exemplary imaging system 1 shown in FIG. 6," which "may be used as a solid-state camera." Ackland, 7:59-65. Ackland's active pixel imaging system, as shown in Figure 6 below, for example, "includes *an array 5 of active pixels*, a row decoder 10 and a plurality of output amplifiers 18." Ackland, 7:59-65.

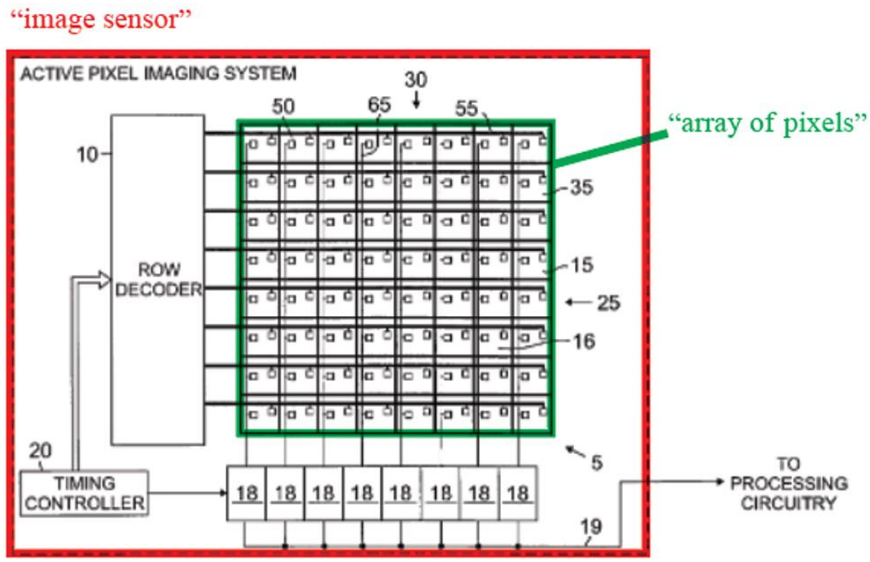


FIG. 6

Ackland, Figure 6 (annotated).

181. As discussed in Section VIII.B.4, a person of ordinary skill in the art would have been motivated and found it obvious and straightforward to apply Ackland's known teachings of an array of CMOS active pixels in an image sensor in implementing Swift's image sensor 51 of a CMOS/APS type and would have recognized this combination (yielding the claimed limitation) would work as expected.

c. **Element [1.b]**

182. **Element [1.b] recites "said image sensor further including circuitry means on said first plane and coupled to said array of pixels for timing and control of said array of pixels."** Swift in view of Ackland renders obvious element [1.b]. Swift discloses said image sensor on said first plane. Ackland discloses said

image sensor (*e.g.*, "active pixel imaging system") further including circuitry means (*e.g.*, "timing controller 20") coupled to said array of pixels for timing and control of said array of pixels (*e.g.*, "timing controller 20" coupled to the "CMOS … pixel array" through "row decoder 10" in the "exemplary active pixel image sensor" shown in Figure 6).

183. As discussed with respect to [1.a], Swift discloses image sensor 51 on a first plane.

184. While Swift does not expressly disclose how the timing of its pixels is controlled other than referring to sensor "selection and readout" circuitry, Ackland describes circuitry including a "*timing controller 20 provides timing signals*" that control the imaging system "to achieve a desired frame rate." Ackland, 8:24-35. As shown in Figure 6, the timing controller 20 is coupled to the pixel array for timing and control of the pixels.

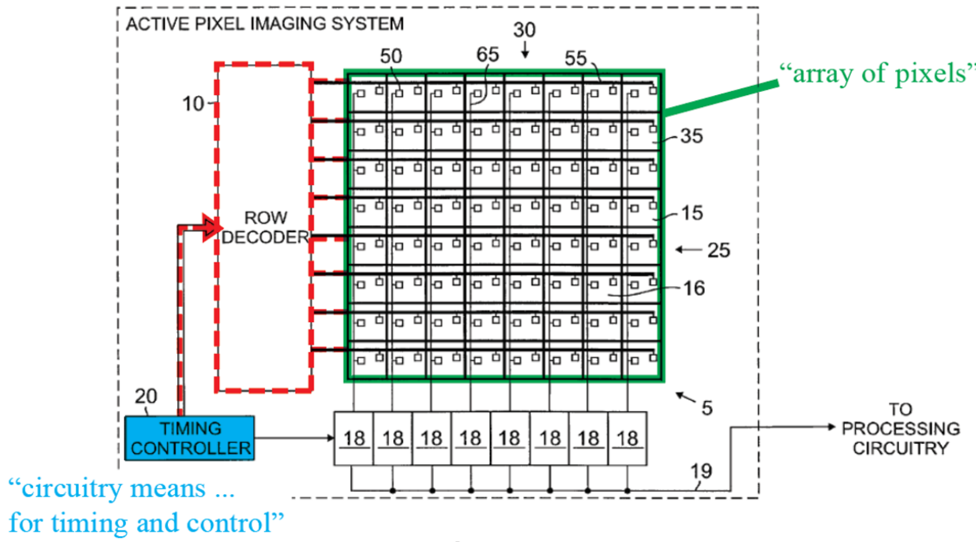


FIG. 6

Ackland, Fig. 6 (annotated), 3:6-7 ("FIG. 6 is a schematic of *an exemplary active pixel image sensor* according to the present invention."), 7:59-8:9 ("The imaging system 1 includes *an array 5 of active pixels*, a row decoder 10 and a plurality of output amplifiers 18.").

185. Specifically, Ackland discloses that the "*timing controller 20 provides timing signals to the row decoder 10*" and "[i]n response, the decoder 10 sequentially activates each row 25 of active pixels 35 via the control lines 55 to detect light intensity and to generate corresponding output voltage signals during each frame interval." Ackland, 8:24-30. Ackland explains that "[i]n the context of an array of pixels, the term 'frame' refers to a single complete cycle of activating and sensing the output from each pixel 35 in the array a single time over a predetermined frame time period." Ackland, 8:30-33. Ackland's "timing controller

20" controls the timing of the imaging system "*to achieve a desired frame rate*, such as 30 frames per second." Ackland, 8:24-35.

186. Ackland teaches that the signals output from the amplifiers 18, shown in Figure 6, "are provided to the common output line 19 in serial fashion *based on timing control signals from the timing control 20*. *The output signals are routed to suitable processing circuitry*." Ackland, 8:47-52. *See also* Ackland, 3:39-54, 4:45-49.

187. To the extent "circuitry means … for timing and control" limitation is construed under §112(6) (*see* Section VII.C, above), Ackland's "timing controller 20" performs the same function of timing and control of the array of CMOS pixels and has the same structure as "timing and control circuits 92," which control the release of the image signal from the pixel array disclosed in the '740 patent. *See* Section VII.C; '740 patent, 4:61-64 ("The terms *'timing and control circuits' or 'circuitry'* as used herein refer to the electronic components which *control the release of the image signal from the pixel array*"), 12:63-65, 13:36-38, Fig. 4a (disclosing "timing and control circuits 92").

188. To the extent further disclosure is required, for the reasons discussed above, Ackland's "timing controller 20," at minimum, discloses the equivalent of the corresponding '740 patent structure by performing the substantially same function (timing and control of the array of pixels), in substantially the same way

(using electronic components), to achieve the same result (outputting images from the pixel array at a desired frame rate).

189. Specifically, Ackland's timing controller 20 performs substantially the ***same function*** as the "timing and control circuits 92" of the '740 patent as both control the timing and control of the array of pixels. '740 patent, 4:61-64 ("The terms *'timing and control circuits' or 'circuitry'* as used herein refer to the electronic components which *control the release of the image signal from the pixel array*"), 13:36-38 ("*the timing and control circuits 92 are used to control the release of the image information* or images stored in the pixel array"); Ackland, 8:24-35 ("…*a timing controller 20 provides timing signals to the row decoder 10*…."), 8:47-52 ("Output signals from the amplifiers 18 are provided to the common output line 19 in serial fashion *based on timing control signals from the timing control 20*"), Fig. 6.

190. Ackland's timing controller 20 performs this function in substantially the ***same way*** as the '740 patent by using electronic components. '740 patent, 4:61-64 ("The terms 'timing and control circuits' or 'circuitry' as used herein refer to the *electronic components* which control the release of the image signal from the pixel array"), 12:63-65 ("FIG. 4a is a more detailed schematic diagram of image sensor 40 which contains an array of pixels 90 and the *timing and control circuits 92*"); Ackland, 8:24-35 ("…*a timing controller 20 provides timing signals to the row*

decoder 10….”), 8:47-52 (“Output signals from the amplifiers 18 are provided to the common output line 19 in serial fashion *based on timing control signals from the timing control 20*”), Fig. 6.

191. And, Ackland’s timing controller 20 produces the ***same result*** as the “timing and control circuits 92” of the ’740 patent—outputting images from the pixel array at a desired frame rate. ’740 patent, 4:61-64 (“The terms *‘timing and control circuits’ or ‘circuitry’* as used herein refer to the electronic components which *control the release of the image signal from the pixel array*”), 13:36-38 (“*the timing and control circuits 92 are used to control the release of the image information* or images stored in the pixel array”); Ackland, 4:46-55 (“The signal timing controller 190 generates reset, select and photo gate control signals…. *The integration time is dictated by the frame rate*, or in other words, the number of times per second an image is updated…”), 8:24-35 (“…*a timing controller 20 provides timing signals to the row decoder 10*….”), 8:47-52 (“Output signals from the amplifiers 18 are provided to the common output line 19 in serial fashion *based on timing control signals from the timing control 20*”).

192. As discussed in Section VIII.B.4, a person of ordinary skill in the art would have been motivated and found it obvious and straightforward to apply Ackland’s known teachings of an image sensor including timing and control circuitry in implementing Swift’s image sensor 51 of a CMOS/APS type, and would

have recognized this combination (yielding the claimed limitation) would work as expected.

d. Element [1.c]

193. **Element [1.c] recites "said image sensor producing a pre-video signal."** Ackland discloses element [1.c]. Ackland discloses said image sensor producing a pre-video signal (*e.g.*, "output signal" produced by the "active pixel imaging system").

194. While Swift discloses communicating an "image signal" from its image sensor to its image processor (*see*, *e.g.*, Swift, 9:5-18, Fig. 2), Ackland describes how the active pixel imaging system produces an output signal, which is a pre-video signal. For example, Ackland teaches that "[t]he output voltage signals generated by the activated row 35 are simultaneously provided to the corresponding amplifiers 18 via the column output line 65" and the "*[o]utput signals from the amplifiers are provided to the common output line 19 in serial fashion*." Ackland, 8:45-52, 7:59-8:9. These output signals are "routed to suitable processing circuitry." Ackland, 8:45-52.

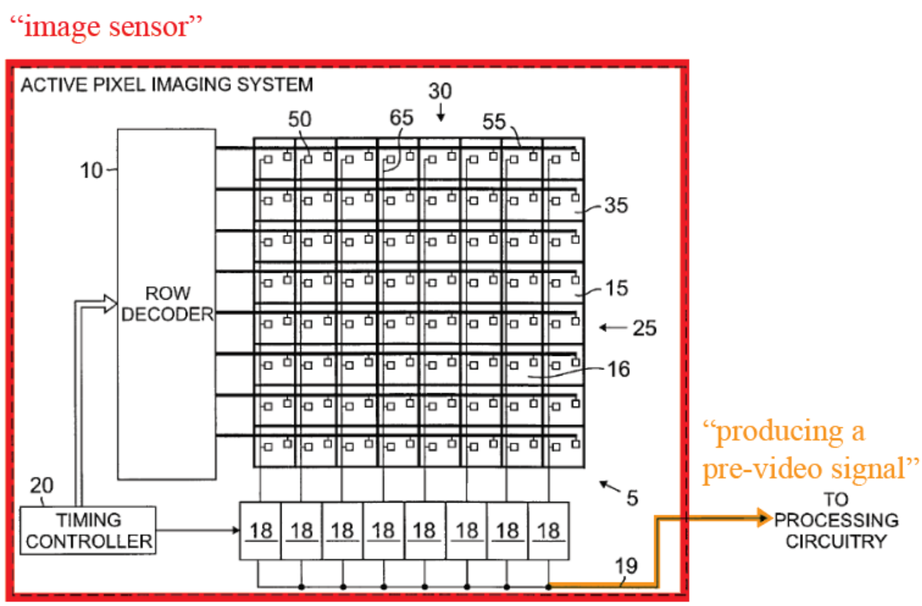


FIG. 6

Ackland, Fig. 6 (annotated).

195. As discussed in Section VIII.B.4, a person of ordinary skill in the art would have been motivated and found it obvious and straightforward to apply Ackland's known teachings of an image sensor producing a pre-video signal in implementing Swift's "image signals" from the "image sensor 51," and would have recognized this combination (yielding the claimed limitation) would work as expected.

e. Element [1.d]

196. **Element [1.d] recites "a first circuit board lying in a second plane and communicating with said image sensor by at least one pre-video conductor inner-connecting said image sensor and said first circuit board."** Swift in view

of Ackland renders obvious element [1.d]. Swift discloses a first circuit board (*e.g.*, "circuit board 53") lying in a second plane (*e.g.*, as shown in Figure 2) and communicating with said image sensor (*e.g.*, receiving "image signals" via a conductor from "image sensor 51"). Ackland discloses at least one pre-video conductor inner-connecting said image sensor and said first circuit board (*e.g.*, "common output line 19" connected to "the processing circuitry" as shown in Figure 6).

197. Swift discloses a *"further printed circuit board 53* is mounted on the first printed circuit board 52, substantially at right angles thereto." Swift, 9:5-7. The printed circuit board 53 defines a second plane as shown in Figure 2, which depicts a cross-section of the miniature camera.

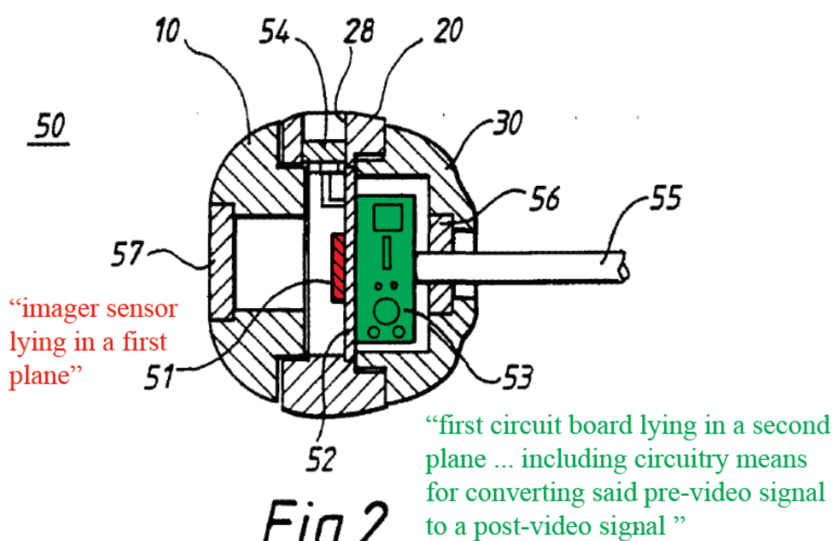


Fig.2.

198. Additionally, Swift discloses that "circuit board 53" is electrically connected to and receives the "image signals" (pre-video signal) from "image sensor 51." For example, Swift explains that the "*circuitry components* … mounted on the *circuit board 53*" "provide power *to the image sensor 51*, *process image signals received therefrom*…." Swift, 9:5-13.

199. While Swift discloses communicating a pre-video signal ("image signal") from its image sensor to its image processor, Swift does not expressly disclose that the pre-video signal is sent over a pre-video conductor. Ackland describes a common output line 19 along which the output signals are transmitted from the active pixel imaging system (the image sensor) on the first end of the line to the processing circuitry (the first circuit board) on the second end. Ackland, 8:45-52 ("*The output voltage signals generated by the activated row 35 are simultaneously provided to the corresponding amplifiers 18* via the column output line 65. *Output signals from the amplifiers 18 are provided to the common output line 19 in serial fashion* based on timing control signals from the timing control 20. *The output signals are routed to suitable processing circuitry*, not shown.").

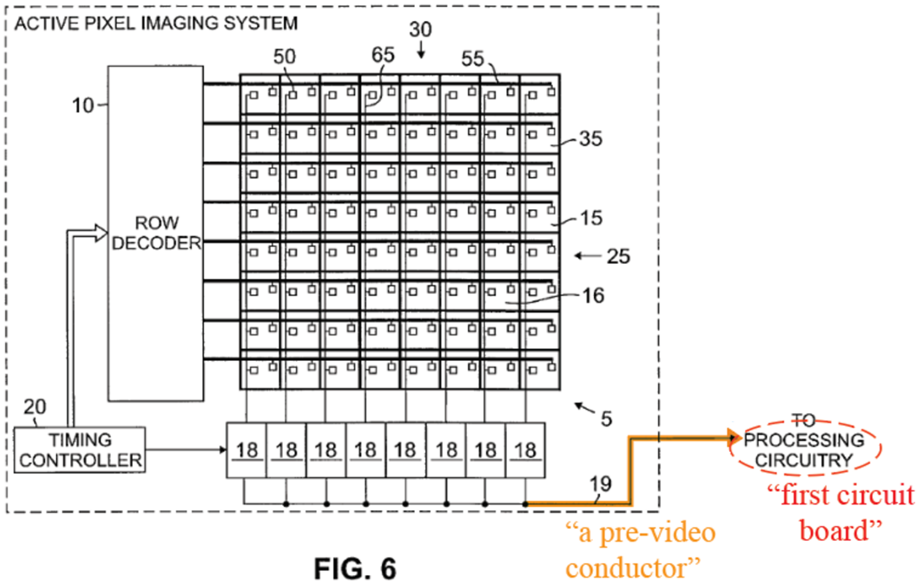


FIG. 6

200. As discussed in Section VIII.B.4, a person of ordinary skill in the art would have been motivated and found it obvious and straightforward to apply Ackland's known teachings of an image sensor outputting a pre-video signal over a pre-video conductor to a first circuit board in implementing Swift's image sensor, and would have recognized this combination (yielding the claimed limitation) would work as expected.

f. Element [1.e]

201. **Element [1.e] recites "said first circuit board including circuitry means for converting said pre-video signal to a post-video signal for reception by a standard video device."** Swift discloses element [1.e]. Swift discloses said first circuit board including circuitry means for converting said pre-video signal to a post-video signal for reception by a standard video device (*e.g.*, "video processor";

"circuitry components are mounted on the circuit board 53, to … process image signals received [from image sensor 51]" into a "video signal" for a "video monitor or TV 154" to "display").

202. Swift discloses that its "circuit board 53" receives image signals from image sensor 51 and includes a "video processor" and "circuitry components" that convert the received signal into a signal that may be received by a monitor or television. For example, Swift discloses "an image sensor assembly for a miniature camera, … comprising a printed *circuit board* and, mounted thereon, the image sensor, *a video processor*, …." Swift, 3:31-4:4. Swift further discloses that this video processor is part of the "circuitry components [that] are mounted on circuit board 53," or, alternatively, the single circuit board, and is used "to process image signals received from [image sensor]." Swift, 9:5-13. The processed video signals are converted to a post-video signal for reception by a standard video device, as Swift teaches "[a] *video monitor or TV 154 is provided, to display a signal received from the camera 152*." Swift, 15:7-8, 15:13-14 ("*The camera 152 and monitor 154 are connected by* means of *a cabling system* 160."), 17:34-18:3, 18:8-11.

203. To the extent the "circuitry means for converting said pre-video signal to a post-video signal for reception by a standard video device" limitation is construed under §112(6) (*see* Section VII.C), as discussed above, Swift's "circuit board 53" that includes a "video processor"/"circuitry components" performs the

same function of "converting said pre-video signal to a post-video signal for reception by a standard video device" and has the same structure as "processing circuitry which … converts the pre-video signal to a post-video signal which may be accepted by a standard video device" disclosed in the '740 patent, at least to the extent Patent Owner has interpreted the structure in the '740 patent.[4] *See* Section VII.C; '740 patent, 4:39-43, 4:57-61, 7:65-8:3 ("FIG. 4b is an enlarged schematic diagram of a video processing board having placed thereon the processing circuitry which *processes the pre-video signal generated by the array of pixels and which converts the pre-video signal to a post-video signal which may be accepted by a standard video device*."), 10:2-8, 14:35-55, 15:50-61, Fig. 4b (disclosing "video processing board 50").

204. To the extent further disclosure is required, for the reasons discussed above, Swift's "circuit board 53" that includes a "video processor"/"circuitry components" at minimum discloses the equivalent of the corresponding '740 patent

[4] Patent Owner has asserted in litigation against Samsung that products have this structure because "[t]he pre-video signal received from the image sensor is sent to a processor on the first circuit board, which converts the pre-video signal to a post-video signal that can be viewed on the [accused product] LCD screen." Ex. 1040, 9.

structure by performing substantially the same function (converting said pre-video signal to a post-video signal for reception by a standard video device), in substantially the same way (using electronic components), to achieve the same result (outputting a signal in a desired video format "accepted by a standard video device"), at least as Patent Owner has interpreted the equivalent structure.[5]

205. Specifically, Swift's "circuit board 53" that includes a "video processor"/"circuitry components" performs substantially the ***same function*** as the "processing circuitry" in the '740 patent—converting said pre-video signal to a post-video signal for reception by a standard video device. *See, e.g.*, '740 patent, 4:57-61 ("The term 'processing circuitry' as used herein refers to the electronic components within the imaging device which *receive the image signal from the image sensor and ultimately place the image signal in a usable format*."), 10:2-5 ("Video processing board 50 then carries out all the necessary conditioning of the

[5] Patent Owner has asserted in litigation that the accused products perform the function of the disclosed structure in the same way because "algorithms embedded in a memory of the [accused product], upon receiving an instruction such as an user input (for example, pressing a button, touching screen), will be executed and cause the processor to convert the pre-video signal into a signal that can be accepted by a standard video device (for example accepted by its display)." Ex. 1040, 11.

pre-video signal and *places it in a form so that it may be viewed directly on a standard video device, television or standard computer video monitor*.”); Swift, 15:7-8 (“*A video monitor or TV 154 is provided, to display a signal received from the camera 152*.”), 17:34-18:3 (“…With *the video signals provided from the camera 152 as* either *video* or UHF *signals*, *viewing of an image from the camera 152 may be selected on the television at will…*.”), 18:8-11.

206. Swift’s “circuit board 53” that includes a “video processor”/“circuitry components” performs this function in substantially the ***same way*** as the ’740 patent by using electronic components. ’740 patent, 4:57-61 (“The term ‘processing circuitry’ as used herein refers to the *electronic components* within the imaging device which receive the image signal from the image sensor and ultimately place the image signal in a usable format.”), 14:35-67; Swift, 3:31-4:4 (“image sensor assembly … comprising a printed circuit board and, mounted thereon, … *a video processor*…”), 9:5-13 (“*Various circuitry components* are mounted on the circuit board 52, to … *process image signals received [from image sensor 51]*.”).

207. Swift’s “circuit board 53” that includes a “video processor”/“circuitry components” achieves the ***same result*** as the ’740 patent of outputting a signal in a video format “accepted by a standard video device.” ’740 patent, 4:39-42 (“The term ‘imaging device’ as used herein describes the imaging elements and *processing circuitry which is used to produce a video signal which may be accepted by a*

standard video device"), 4:57-61 ("The term 'processing circuitry' as used herein refers to the electronic components within the imaging device which receive the image signal from the image sensor and ultimately place the image signal in a usable format"), 7:65-8:3 ("FIG. 4b is an enlarged schematic diagram of a video processing board having placed thereon the processing circuitry which processes the pre-video signal generated by the array of pixels and which *converts the pre-video signal to a post-video signal which may be accepted by a standard video device*."), 10:2-8 ("Video processing board 50 then carries out all the necessary conditioning of the pre-video signal and *places it in a form so that it may be viewed directly on a standard video device, television or standard computer video monitor*."); Swift, 15:7-8 ("*A video monitor or TV 154 is provided, to display a signal received from the camera 152*."), 17:34-18:3 ("…With *the video signals provided from the camera 152 as* either *video* or UHF *signals*, *viewing of an image from the camera 152 may be selected on the television at will…*."), 18:8-11.

g. Element [1.f]

208. **Element [1.f] recites "a power supply coupled with said image sensor for driving said array of pixels and said timing and control means, and electrically coupled to said first circuit board for driving said first circuit board."** Swift discloses element [1.f]. Swift discloses a power supply (*e.g.*, "battery," "voltage regulator") coupled with said image sensor for driving said array of pixels

and said timing and control means, and electrically coupled to said first circuit board for driving said first circuit board (*e.g.*, "a voltage regulator to … provide a substantially constant supply voltage to components" including "an image sensor assembly" and "a video processor" on the "circuit board").

209. Swift's battery and voltage regulator provide voltage to (and thus are electrically coupled to and drive) the "image sensor 51" (including its pixels) and the circuit boards 52 and 53. For example, Swift discloses that its image sensor assembly includes a "battery" and "a voltage regulator," which "*provide[s] a substantially constant supply voltage to components on the printed circuit board*," including the image sensor 51. Swift, 4:21-22 ("A camera as above may incorporate a *battery or voltage transformer means*."), 3:31-4:4 ("*[I]mage sensor assembly* … *comprising a printed circuit board* and, mounted thereon, the image sensor … *a voltage regulator to* accept a plurality of different input voltages and *provide a substantially constant supply voltage to components on the printed circuit board*."), 10:12-20, 9:7-13 ("Various circuitry components are mounted on the circuit board 53, to *provide power to the image sensor 51*").

210. Furthermore, at minimum, a person of ordinary skill in the art would have understood that Swift's battery and voltage regulator provide voltage to (and thus are electrically coupled to and drive) the "image sensor 51" (including its pixels) and the alternatives of the "single circuit board" and circuit boards 52 and 53.

h. Element [1.g]

211. **Element [1.g] recites "a time select switch electrically communicating with said first circuit board and remote from said first circuit board for selectively varying integration periods to produce an image of a desired brightness, said switch having a plurality of settings enabling selective control to produce the image of a desired brightness."** Swift in view of Tomoyasu renders obvious element [1.g]. Tomoyasu discloses a time select switch (*e.g.*, "gain control[] knob 23) electrically communicating with [the "imaging means" and remote from [the "imaging means"] (*e.g.*, "gain control[] knob 23" on "camera controlling unit [CCU 4], for driving the imaging means" as shown in Figure 1) for selectively varying integration periods to produce an image of a desired brightness (*e.g.*, "gain control[] knob 23 … changes the sensitivity by changing the time over which the image is integrated" to produce an image of desired brightness), said switch having a plurality of settings enabling selective control to produce the image of a desired brightness (*e.g.,* when the gain controlling knob 23 is turned past "center" when "integration priority switch 24 is OFF," "the integration controlling voltage … gradually increases from zero, to increase the integrating function in accordance with the integration controlling voltage value"). Swift discloses the "first circuit board" located near the image sensor at the end of the endoscope.

212. While Swift and Ackland do not explicitly describe a time select switch for "selectively varying integration periods to produce an image of desired brightness," Tomoyasu discloses a control for selectively varying the integration periods with a plurality of settings for simultaneously manipulating gain and charge accumulation time of the camera, thus controlling the brightness in the captured image.

213. As discussed in Section VIII.A.4.h, Tomoyasu discloses element [1.g].

214. As discussed in Section VIII.B.4, a person of ordinary skill in the art would have been motivated and found it obvious and straightforward to apply Tomoyasu's known teachings of a gain control remote from the imaging means for modifying an integration time used by the timing circuitry in Swift's imaging device (as modified by Ackland's teachings). For example, a person of ordinary skill in the art would have been motivated to locate such a control on a "camera controlling unit" (as taught in Tomoyasu) remote from, and electrically coupled to, the first circuit board (which Swift teaches is located near the image sensor at the end of the endoscope). A person of ordinary skill in the art would have known that such a combination (yielding the claimed limitations) would work as expected.

i. Claim 2

215. **Claim 2 recites "A device, as claimed in claim 1, wherein: said array of pixels includes an array of CMOS pixels."**

216. Ackland discloses said array of pixels includes an array of CMOS pixels (*e.g.*, "CMOS … pixel array").

217. *See* Section VIII.B.5.b ([1.a]).

j. Element [13.pre]

218. **Element [13.pre] recites "A method of viewing an object with an imaging device."** To the extent the preamble is limiting, Swift discloses a method of viewing an object with an imaging device (*e.g.*, "miniature camera" and a "video monitor … to display a signal received from the camera").

219. As discussed in relation to claim element [1.pre], Swift discloses an imaging device in the form of a "miniature camera." *See* Section VIII.B.5.a. To the extent that additional disclosure is required, Swift also explicitly discloses that the imaging device can be used to view objects. *See, e.g.*, Swift, 15:4-9 ("a video monitor or TV 154 is provided, to *display a signal received from the camera 152*"), 17:34-18:3 ("The monitor 154 may comprise a domestic television set. With the video signals provided from the camera 152 as either video or UHF signals, *viewing of an image from the camera 152 may be selected on the television at will*, and need

not interrupt normal television viewing."), 18:5-6 ("any of the cameras mentioned … may be connected to a cable TV system").

k. Element [13.a]

220. **Element [13.a] recites "providing an image sensor including an array of pixels."** Ackland discloses element [13.a]. As discussed in relation to claim element [1.a], Ackland discloses providing an image sensor (*e.g.*, "active pixel imaging system") including an array of pixels (*e.g.*, "CMOS … pixel array"). Section VIII.B.5.b.

221. As discussed in Section VIII.B.4, a person of ordinary skill in the art would have been motivated and found it obvious and straightforward to apply Ackland's known teachings of an array of CMOS active pixels in an image sensor in implementing Swift's image sensor 51 of a CMOS/APS type and would have recognized this combination (yielding the claimed limitation) would work as expected.

l. Element [13.b]

222. **Element [13.b] recites "circuitry means coupled to said array of pixels for timing and control of said pixels."** Ackland discloses element [13.b]. As discussed in relation to claim element [1.b], Ackland discloses circuitry means (*e.g.*, "timing controller 20") coupled to said array of pixels for timing and control of said pixels (*e.g.*, "timing controller 20" coupled to the "CMOS … pixel array"

through "row decoder 10" in the "exemplary active pixel image sensor" shown in Figure 6). *See* Section VIII.B.5.c.

223. As discussed in Section VIII.B.4, a person of ordinary skill in the art would have been motivated and found it obvious and straightforward to apply Ackland's known teachings of an image sensor including timing and control circuitry in implementing Swift's image sensor 51 of a CMOS/APS type, and would have recognized this combination (yielding the claimed limitation) would work as expected.

m. Element [13.c]

224. **Element [13.c] recites "said image sensor producing a pre-video signal."** Ackland discloses element [13.c]. As discussed in relation to claim element [1.c], Ackland discloses said image sensor producing a pre-video signal (*e.g.*, "output signal" produced by the "active pixel imaging system"). *See* Section VIII.B.5.d.

225. As discussed in Section VIII.B.4, a person of ordinary skill in the art would have been motivated and found it obvious and straightforward to apply Ackland's known teachings of an image sensor producing a pre-video signal in implementing Swift's "image signals" from the "image sensor 51," and would have recognized this combination (yielding the claimed limitation) would work as expected.

n. Element [13.d]

226. **Element [13.d] recites "providing first circuitry means for receiving said pre-video signal from said image sensor and for converting said pre-video signal to a post-video signal which may be received by a standard video device."** Swift discloses element [13.d]. As discussed in relation to claim elements [1.e], Swift discloses providing first circuitry means (*e.g.*, "circuit board 53") for receiving said pre-video signal from said image sensor (*e.g.*, receiving "image signals" via a conductor from "image sensor 51") and for converting said pre-video signal to a post-video signal which may be received by a standard video device (*e.g.*, "video processor"; "circuitry components are mounted on the circuit board 53, to … process image signals received [from image sensor 51]" into a "video signal" for a "video monitor or TV 154" to "display"). *See* Sections VIII.B.5.f, VII.C.

227. To the extent that the "circuitry means for receiving said pre-video signal from said image sensor and for converting said pre-video signal to a post-video signal which may be received by a standard video device" limitation is construed under §112(6) (*see* Section VII.C, above), as discussed above, Swift's "circuit board 53" that includes a "video processor"/"circuitry components" performs the same function of "receiving said pre-video signal from said image sensor and for converting said pre-video signal to a post-video signal which may be received by a standard video device" and has the same structure as the "processing

circuitry which … converts the pre-video signal to a post-video signal which may be accepted by a standard video device" disclosed in the '740 patent, at least to the extent Patent Owner has interpreted the structure in the '740 patent.[6]. *See* Sections VIII.B.5.f, VII.C.

228. To the extent further disclosure is required, for the reasons discussed above, Swift's "circuit board 53" that includes a "video processor"/"circuitry components" at minimum discloses the equivalent of the corresponding '740 patent structure by performing substantially the same function (receiving said pre-video signal from said image sensor and converting said pre-video signal to a post-video signal which may be received by a standard video device), in substantially the same way (using electronic components), to achieve the same result (outputting a signal

[6] Patent Owner has asserted in litigation against Samsung that products have this structure because "[t]he pre-video signal received from the image sensor is sent to a processor on the first circuit board, which converts the pre-video signal to a post-video signal that can be viewed on the [accused product] LCD screen." Ex. 1040, 9.

in a desired video format "accepted by a standard video device"), at least as Patent Owner has interpreted the equivalent structure.[7] *See* Sections VIII.B.5.f.

229. Specifically, Swift's "circuit board 53" that includes a "video processor"/"circuitry components" performs substantially the ***same function*** as the "processing circuitry" in the '740 patent— receiving said pre-video signal from said image sensor and converting said pre-video signal to a post-video signal for reception by a standard video device. *See, e.g.*, '740 patent, 4:57-61 ("The term 'processing circuitry' as used herein refers to the electronic components within the imaging device which *receive the image signal from the image sensor and ultimately place the image signal in a usable format*."), 10:2-5 ("Video processing board 50 then carries out all the necessary conditioning of the pre-video signal and *places it in a form so that it may be viewed directly on a standard video device, television or standard computer video monitor*."); Swift, 15:7-8 ("*A video monitor or TV 154 is*

[7] Patent Owner has asserted in litigation that the accused products perform the function of the disclosed structure in the same way because "algorithms embedded in a memory of the [accused product], upon receiving an instruction such as an user input (for example, pressing a button, touching screen), will be executed and cause the processor to convert the pre-video signal into a signal that can be accepted by a standard video device (for example accepted by its display)." Ex. 1040, 11.

provided, to display a signal received from the camera 152.”), 17:34-18:3 (“…With *the video signals provided from the camera 152 as* either *video* or UHF *signals*, *viewing of an image from the camera 152 may be selected on the television at will…*.”), 18:8-11.

230. Swift’s “circuit board 53” that includes a “video processor”/“circuitry components” performs this function in substantially the ***same way*** as the ’740 patent by using electronic components. ’740 patent, 4:57-61 (“The term ‘processing circuitry’ as used herein refers to the *electronic components* within the imaging device which receive the image signal from the image sensor and ultimately place the image signal in a usable format.”), 14:35-67; Swift, 3:31-4:4 (“image sensor assembly … comprising a printed circuit board and, mounted thereon, … *a video processor*…”), 9:5-13 (“*Various circuitry components* are mounted on the circuit board 52, to … *process image signals received [from image sensor 51]*.”).

231. Swift’s “circuit board 53” that includes a “video processor”/“circuitry components” achieves the ***same result*** as the ’740 patent of outputting a signal in a video format “accepted by a standard video device.” ’740 patent, 4:39-42 (“The term ‘imaging device’ as used herein describes the imaging elements and *processing circuitry which is used to produce a video signal which may be accepted by a standard video device*”), 4:57-61 (“The term ‘processing circuitry’ as used herein refers to the electronic components within the imaging device which receive the

image signal from the image sensor and ultimately place the image signal in a usable format"), 7:65-8:3 ("FIG. 4b is an enlarged schematic diagram of a video processing board having placed thereon the processing circuitry which processes the pre-video signal generated by the array of pixels and which *converts the pre-video signal to a post-video signal which may be accepted by a standard video device*."), 10:2-8 ("Video processing board 50 then carries out all the necessary conditioning of the pre-video signal and *places it in a form so that it may be viewed directly on a standard video device, television or standard computer video monitor*."); Swift, 15:7-8 ("*A video monitor or TV 154 is provided, to display a signal received from the camera 152*."), 17:34-18:3 ("…With *the video signals provided from the camera 152 as* either *video* or UHF *signals*, *viewing of an image from the camera 152 may be selected on the television at will…*."), 18:8-11.

o. Element [13.e] – [13.g]

232. **Element [13.e]-[13.g] recite "viewing the object and determining a desired level of brightness to be viewed; providing a time select switch remote from the image sensor and circuitry means; and adjusting a charge integration period of the imager by manipulating time select switch to maximize desired brightness of the image."** Swift in view of Tomoyasu renders obvious [13.e]-[13.g]. Tomoyasu discloses viewing the object and determining a desired level of brightness to be viewed ("the mode for increasing sensitivity can be set depending on the

preferences of the practitioner"); providing a time select time select switch remote from [the "imaging means"] (*e.g.*, "gain control[] knob 23" on "camera controlling unit [CCU 4], for driving the imaging means" as shown in Figure 1); and adjusting a charge integration period of the imager by manipulating time select switch to maximize desired brightness of the image (*e.g.*, "gain control[] knob 23 … changes the sensitivity by changing the time over which the image is integrated, through changing the electronic charge accumulation time (the exposure time)" to maximize the desired brightness). Swift teaches viewing the object and discloses the "first circuit board" located near the image sensor at the end of the endoscope.

233. *See* Sections VIII.B.5.h, VIII.A.4.o.

234. As discussed in relation to claim element [13.pre], Swift provides additional disclosure of viewing an object using the imaging device. *See* Section VIII.B.5.j. Tomayasu teaches the user determining the desired level of brightness to be viewed and making an adjustment as discussed with respect to [1.g] above (Section VIII.B.5.h ([1.g])).

235. As discussed in Section VIII.B.4, a person of ordinary skill in the art would have been motivated and found it obvious and straightforward to apply Tomoyasu's known teachings of a gain control for modifying an integration period in implementing Swift's imaging device (as modified by the teachings of Ackland)

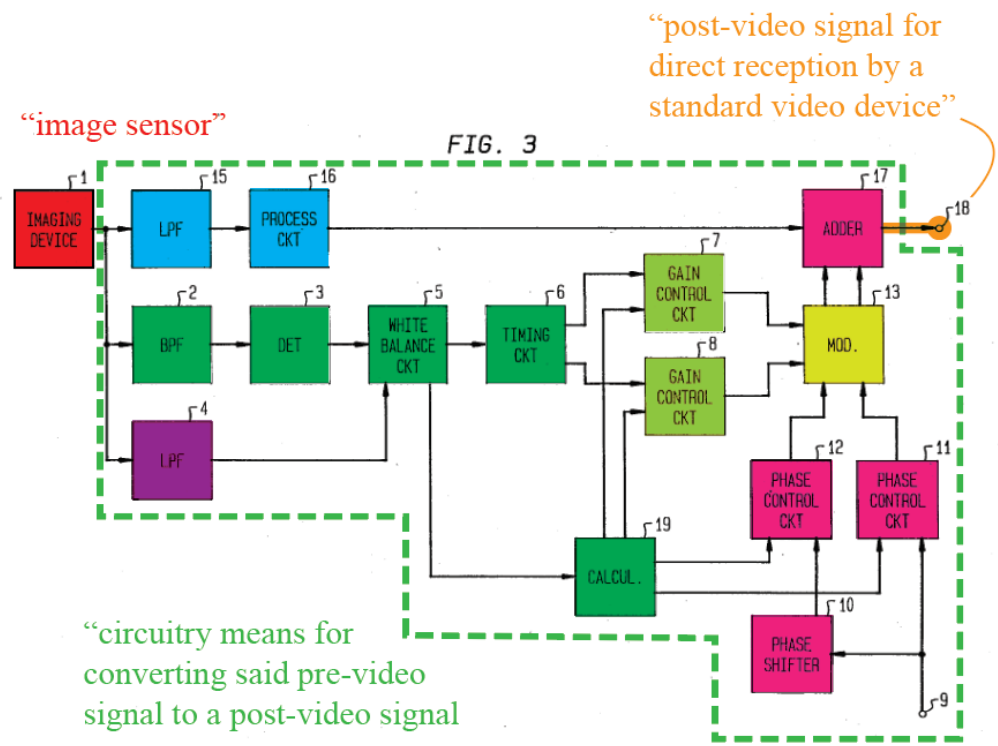
and would have known that such a combination (yielding the claimed limitations) would work as expected.

C. Claims 1, 2, and 13 Are Obvious Under §103 over Swift in View of Ackland, Tomoyasu, and Tanaka (Ground 3)

236. U.S. Patent 4,700,219 ("Tanaka") (Ex. 1005) is a patent titled "Color Imaging Apparatus" issued on October 13, 1987, and I understand, is prior art to the '740 patent.

237. Tanaka provides implementation details for a video processor, including a "white-balancing circuit" that converts the "output signal of an imaging device" into a "composite color video signal." Tanaka discloses white-balancing circuitry that receives the output from an "imaging device 1," and processes it into "composite color video signal whose color reproduction characteristics has been compensated." *See, e.g.*, Tanaka, Abstract, 1:66-2:6 ("…a luminance signal and two color difference-signals are derived from an *output signal of an imaging device*..."), 2:65-3:6 ("… In the *NTSC color television system*, the signal B-Y corresponds to the color sub-carrier having a phase of 0°, and the signal R-Y to that having a phase of 90°."), 3:48-53 ("…the output signal from the *imaging device 1* is supplied to a band-pass-filter 2..."), 4:40-53 ("…to *obtain at an output terminal 18 the composite color video signal whose color reproduction characteristic has been compensated.*"). In particular, as shown in Figure 3 below, Tanaka describes circuitry to convert a pre-

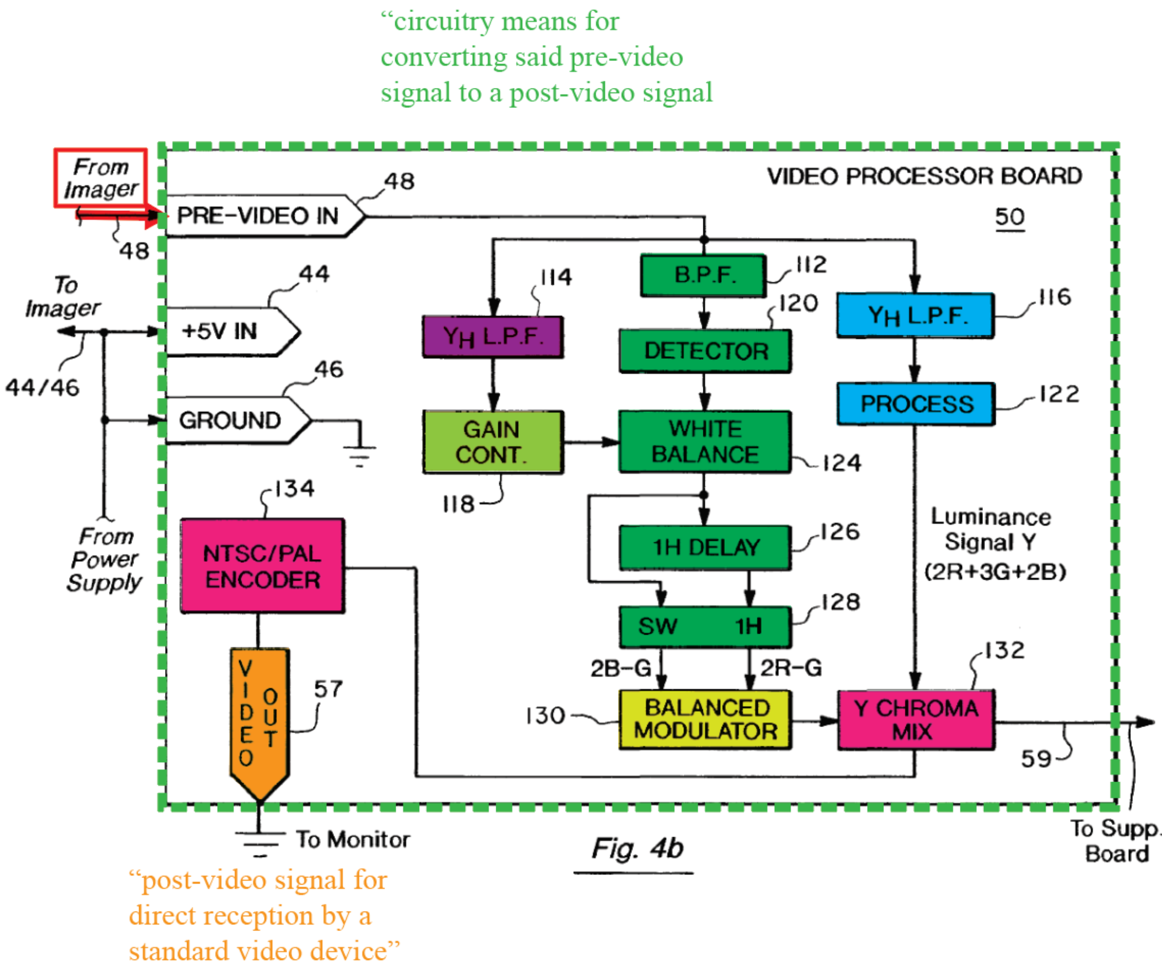
video signal to a post-video signal to be output to a standard video device, including band-pass/low-pass filters, processing blocks, white balance circuitry, timing elements, modulators, and mixers/adders to convert the output received from the imager into a composite color video signal.



Tanaka, Fig. 3 (annotations added).

238. To the extent the "circuitry means for converting said pre-video signal to a post-video signal for reception by a standard video device" (Claim 1)/"circuitry means for receiving said pre-video signal from said image sensor and for converting said pre-video signal to a post-video signal which may be received by a standard video device" (Claim 13) limitations are construed under §112(6), the Tanaka Figure

3 teachings disclose and/or render obvious the same functions of converting said pre-video signal to a post-video signal for reception by a standard video device (claim 1) and receiving said pre-video signal from said image sensor and for converting said pre-video signal to a post-video signal which may be received by a standard video device (claim 13) and the same structures and processing techniques as the "processing circuitry which … converts the pre-video signal to a post-video signal which may be accepted by a standard video device" disclosed in the '740 patent. *Compare* Tanaka Fig. 3 *with* '740 patent, Fig. 4b (disclosing a functionally identical arrangement of components, as shown by the color-coding of Tanaka Fig. 3 above and '740 patent Fig. 4b below, to convert the output received from the imager into a final video signal), 4:57-61, 14:35-67.



'740 patent, Fig. 3 (annotations added).

239. Specifically, Tanaka and the '740 patent both disclose a low-pass-filter followed by a process circuit (blue); a second low-pass-filter (purple); a band-pass filter, detector, white balance circuit, delay/timing circuits (dark green); gain control (light green); modulator (yellow); and mixer/adder/encoders (magenta) that convert the pre-video signal from the imager into a post-video signal which may be accepted by a television. *See, e.g.*, Tanaka, 3:32-4:56, Fig. 3; '740 patent, 14:35-67, Fig. 4b. The '740 patent describes that the NTSC/PAL encoder 134 adds *"composite*

frequencies" to produce the post-video signal. '740 patent, 14:35-67 ("…the output from the Y chroma mixer 132 is sent to the *NTSC/PAL encoder 134, commonly known in the art as a "composite" encoder. The composite frequencies are added to the signal leaving the Y chroma mixer 132 in encoder 134 to produce the post-video signal* which may be accepted by a television"). Similarly, Tanaka describes the output of "Adder 17" as "the *composite color video signal* whose color reproduction characteristic has been compensated," for output to a NTSC color television. *See, e.g.*,, Tanaka, 4:35-47 ("The carrier *chrominance signals are supplied to an adder …, thereby to obtain at an output terminal 18 the composite color video signal* whose color reproduction characteristic has been compensated"), 1:66-2:6, 5:34-37, 2:65-3:47 ("… In the *NTSC color television system*, the signal B-Y corresponds to the color sub-carrier having a phase of 0°, and the signal R-Y to that having a phase of 90°."). Thus, Tanaka discloses and/or renders obvious the same functions of functions of converting said pre-video signal to a post-video signal for reception by a standard video device (claim 1) and receiving said pre-video signal from said image sensor and for converting said pre-video signal to a post-video signal which may be received by a standard video device (claim 13) using the same or equivalent structure disclosed in the '740 patent.

240. While Swift does not describe its "video processor" and "circuitry components" that "process image signals received [from image sensor 51]" into a

"video signal" in extensive detail, Tanaka provides additional implementation details for such a video processor, including a "white-balancing circuit" that converts the "output signal of an imaging device" into a "composite color video signal." *See, e.g.*, Swift, 9:5-13 ("Various circuitry components are mounted on the circuit board, to … *process image signals received*..."); 15:7-8 ("[a] *video monitor or TV 154 is provided, to display a signal received from the camera 152*."); Tanaka, Fig. 3, 3:48-53 ("…the output signal from the *imaging device 1* is supplied to a band-pass-filter 2..."), 4:40-53 ("…to *obtain at an output terminal 18 the composite color video signal whose color reproduction characteristic has been compensated.*").

241. A person of ordinary skill in the art would have been motivated to apply Tanaka's known teachings of the video processing circuitry, in implementing the imaging device disclosed by Swift in order to improve the quality of the images, including production of higher-quality video with truer colors. *See, e.g.,* Tanaka, 3:25-31, 4:28-34, 4:40-47. Both Swift and Tanaka are in the same field of art and are analogous to the '740 patent—all are in the same field related to imaging apparatuses. *See*, *e.g.*, '740 patent, Abstract ("The imaging device can be defined as a CMOS-CID device wherein a user may select an appropriate integration period in order to *enhance the viewed image* to a desired level of brightness"), 1:20-23 ("This invention relates to *solid state image sensors and associated electronics*..."), 16:24-26 ("Microprocessor 146 may also control other *functions of the imaging device such*

as white balance.”); Swift, Abstract (“*miniature camera*”), 4:11-15 (“image sensor is preferably a *CMOS sensor*”); Tanaka, Abstract (“A color imaging apparatus which produces a luminance signal and a plurality of chrominance signals in order to *generate a composite color video signal*…”), 1:61-65 (“It is, therefore, *an object of this invention to provide a color imaging apparatus capable of compensating a deterioration of a color reproduction characteristic*”), 3:48-53 (“…the output signal from the *imaging device 1* is supplied to a band-pass-filter 2...”), 4:40-53 (“…to *obtain at an output terminal 18 the composite color video signal whose color reproduction characteristic has been compensated.*”). In addition, Swift and Tanaka are also reasonably pertinent to the alleged problem(s) identified in the ’740 patent of arranging the circuitry of a CMOS image sensor. *See, e.g.*, ’740 patent, 3:19-24 (“It is one object of this invention to *provide reduced area imaging devices which take advantage of “camera on a chip” technology, but rearrange the circuitry in a stacked relationship so that there is a minimum profile*); Swift, 1:7-18 (“Preferred embodiments of the present invention aim to provide *miniature cameras* which can be so constructed as to be *particularly small and compact*…”); Tanaka, 2:25-48 (“…However, *in the single-chip imaging device* in which the color difference signals are derived directly from the imaging device, in order to separately gain-control three primary color signals… is complicated and not practical”). Tanaka expressly discloses that through its use of a luminance signal and two color difference signals derived from the output of the imaging device, a higher quality video with more accurate colors is obtained.

242. A person of ordinary skill in the art would have been further motivated to apply Tanaka's known teachings in implementing Swift's imaging device because Tanaka expressly discloses that through its use of a luminance signal and two color difference signals derived from the output of the imaging device, this technique advantageously compensates for the variations of the color temperature of the light. *See, e.g.*, Tanaka, 1:66-2:6 ("…a luminance signal and two color difference-signals are derived from an *output signal of an imaging device*...") , 3:25-31 ("… the phase variation of the two color difference signals *is compensated by phase-controlling the color sub-carriers in response to the color temperature of the light*."), 4:28-34 ("…color sub-carriers are controlled *in response to the color temperature of the light* so as to compensate for the deterioration of the [] color reproduction characteristic…"), 4:40-47 ("The carrier chrominance signals are supplied to an adder …, thereby to obtain at an *output terminal 18 the composite color video signal whose color reproduction characteristic has been compensated*.").

243. To the extent it is argued that Tanaka's teachings are limited to CCD image sensors, a person of ordinary skill in the art would have understood that systems and methods for processing the output of a CCD camera would be equally applicable to the output of other types of solid-state imaging devices, including

CMOS imagers, or could be adapted for use with other types of solid-state imaging devices with minimal effort. This is confirmed in the prior art, which describes CCD and CMOS imaging technology as interchangeable components within the overall system.

244. For example, Martin (Ex. 1010) was filed on January 17, 1995, and I understand, is prior art to the ’740 patent. Martin discloses methods for capturing and filtering a captured image using a “directly addressable *CMOS APS, CID or a CCD camera array 22*.” Martin, 6:10-25; *see also* 5:55-64, 6:42-52, Fig. 1, Fig. 2. Regardless of the particular imager technology used, a “video dewarping engine” is disclosed that “accepts video data input *by whatever means* and corrects any predetermined distortion introduced by the imaging system.” Martin, 12:11-38, Fig. 9; *see also* 12:62-13:9. Afterwards, additional processing is done, and the signal can be converted into a standard video formal such as “NTSC, PAL, SECAM, etc.” Martin, 13:10-15. In other words, no matter how the video signals initially generated (e.g., using CMOS, CID, or CCD imagers), a person of ordinary skill would understand that the same general techniques can be used to process the signals and convert them into a standard video format. Accordingly, Martin describes itself as providing a method “for directly addressing an image captured using *a CCD camera array, a CMOS APS sensor or CID array* and outputing a signal for displaying a selected portion of that image in real time.” Martin, 13:15-31.

245. As another example, Olmstead (Ex. 1011) was filed on December 21, 1995, and I understand, is prior art to the ’740 patent. Olmstead generally describes a bar-code reader that captures an images and extracts information from it. *See* Olmstead, Abstract. Although Olmstead generally describes the use of a CCD imager in order to capture the image, Olmstead also explicitly states that the apparatus may be constructed “with CMOS active pixel sensor arrays in place of CCD arrays without fundamentally changing the inventive concept … namely, methods and apparatus for reading a bar code under ambient illumination.” Olmstead, 49:38-50. Once again, person of ordinary skill would understand that the same general techniques for processing and extracting information from the video data can be applied, regardless of the specific type of image sensor used.

246. As yet another example, Rapa (Ex. 1012) was filed June 12, 1997, and I understand, is prior art to the ’740 patent. Rapa generally describes a dental imaging apparatus that can be used to capture images with an image sensor located at the end of a handpiece, and convert the images into a standard video signal. *See* Rapa, Abstract, 2:15-18, 5:26-33, Fig. 1, Fig. 7. Similar to the other example discussed above, Rapa is agnostic to the precise type of image sensor used, saying that “[t]he image sensor 23 is preferably either a CCD (charge coupled device) or an APS (active pixel sensor array).” Rapa, 3:24-26. Once again, a person of ordinary

skill would have understoodd that similar techniques could be applied to retrieve and output video data from the array, regardless of the specific type of image sensor used.

247. In light of the above, a person of ordinary skill in the art would have found it routine, straightforward and advantageous to apply the teachings of the white-balancing circuitry disclosed in Tanaka in implementing the imaging device disclosed by Swift (as modified by the teachings of Ackland and Tomoyasu discussed in Section VIII.B.4), and would have known that such a combination (yielding the claimed limitations) would predictably work and provide the expected functionality.

IX. SECONDARY CONSIDERATIONS

248. The Challenged Claims of the ’740 patent are obvious under §103 based on the references presented herein.

249. Patent Owner submitted a declaration from the inventor in related prosecution (prosecution of the ’839 patent—related to the ’740 patent through multiple continuation-in-part applications) (’839 Patent File History (Ex. 1003), 83-95) that argued an unexpected result of decreased interference. Specifically, when image processing circuitry is removed from the same board or plane as the pixel array, decreased interference was argued as an unexpected result. In particular, inventor Jeffrey Adair asserted that:

> CCD devices cannot be used near an electrical surgical generator without requiring significant shielding for the CCD device. Such shielding requires intense grounding techniques for the CCD camera cables/conductors which trail the CCD imager, and also grounding for the actual CCD pixel array. These shielding techniques not only add significantly to the size of the CCD device, but also to the overall cost of the CCD camera system. Even when such shielding is incorporated, RFI levels are only brought to a reasonable level which may still result in an obstructed view of the surgical area.
>
> ’839 Patent File History, 85.

250. The Patent Owner further asserted that, “Even with standard CMOS devices which have processing circuitry on chip with the CMOS pixel array, at least some shielding is required to prevent RFI in order to optimize the image.” ’839 Patent File History, 86. It does not appear that the examiner relied upon this argument in finding patentability, nonetheless, I have been asked to address this Patent Owner argument.

251. My understanding of these noise benefits is that they were not unexpected, but were instead predictable. For example, as the declaration notes, they were using endoscopic cameras around an “electrosurgical generator” that was used to “cut or cauterize” tissue. ’839 File History, 85. It would have been understood by a person of ordinary skill in the art that such an electrosurgical generator would create a large amount of electromagnetic (“EM”) radiation.

Moreover, while the declaration does not clearly state how many wires were in the CCD system at issue, a person of ordinary skill in the art would have understood that such EM radiation would cause radio frequency interference ("RFI") in a system, and would have a more significant adverse effect on a system with more wires than a system with fewer wires. It was also known that a CCD sensor could have many more wires than a CMOS sensor. For example, according to the declaration, the prior art CCD sensor identified in the declaration ("Pelchy") includes "a large number of transmissions wires 33 which interconnect the circuit boards placed perpendicular to the pixel array with an external processor 13." '839 File History, 92. Thus, in a CCD sensor with many wires, the radio frequency interference would have a relatively large effect on the quality of images produced by the image sensor. On the other hand, CMOS sensors require only a few wires to connect to the pixel array, and thus interference created in a CMOS image sensor would be much smaller than in such a CCD arrangement. Moreover, while the declaration does not specify what the structure of the processing circuitry was that was removed from the plane with the image sensor, it would have been understood that removing processing circuitry from the image sensor would further reduce interference for various reason, depending on the circuitry removed. As but one example, it was well understood that interference would be caused by placing analog and digital circuitry too close to each other, and that a way to reduce interference was to place analog and digital circuitry on separate circuit boards. *See* Phillips (Ex. 1085) ("The PCRM 100 handles internal EMI between analog and digital circuitry using separate circuit boards, shielding and isolation."). Thus, it was known that EMI/RFI could be further reduced by removing the processing circuitry from the image sensor. Importantly, because, as explained above, Swift and Adair disclose placing the processing circuitry on a separate circuit board placed closely adjacent the CMOS pixel array (*See* Sections VIII.A, VIII.B), it was already known to locate the processing circuitry away from the image sensor, and the results of doing so (e.g., decreased interference) were already known and utilized in the field.

252. In addition, the benefits of using CMOS image sensors instead of CCD image sensors, including reduced cost, low noise, small size, easier manufacturing process and a higher tolerance of lower quality material, were not unexpected, and were explicitly noted by those in the field at the time, as well as their applicability to medical devices. *See, e.g.*, '740 patent, 1:47-2:6; NASA (Ex. 1060, publicly available 3/6/195 through Business Week, and I understand is prior art to the '839 patent) (describing benefits of active pixel image sensor over CCD sensors, including lower power consumption, smaller size, no need for a custom manufacturing process, and can tolerate lower material quality); Monroe (Ex. 1007), 1:7-17, 7:59-65 (describing a medical otoscope (similar to an endoscope) with a CMOS image sensor with separate video processing circuitry).

253. Patent Owner did not present any other evidence of secondary considerations during prosecution and the clear teachings. In light of the above, to the extent this aspect of the prosecution history can be considered "secondary considerations," such would not change my opinions expressed herein.

X. PUBLIC ACCESSIBILITY OF RICQUIER (EXS. 1033, 1038)

254. I have been informed that a reference is publicly accessible if it has been disseminated or otherwise made available to the extent that persons interested and ordinarily skilled in the subject matter or art exercising reasonable diligence, can locate it.

255. I have been informed that Ricquier is a conference paper that was presented at the Charge-Coupled Devices and Solid State Optical Sensors IV 1994 conference, which was a part of the Electronic Imaging 1994 symposium, and published in volume 2172 of the Proceedings of SPIE. In the 1990s, SPIE's journals, conferences, and conference proceedings were among the most prominent sources of information on optics, photonics, optoelectronics, lasers, and electronic imaging, and this remains true today. The Proceedings of SPIE contained papers presented at SPIE conferences, and these papers were known to be especially useful because they represented recent advances in their respective fields. The Proceedings of SPIE was a known source of research in the area of digital imaging in the 1990s. Since 1982, I have personally attended over thirty SPIE Conferences and have published over

sixty papers in the Proceedings of SPIE. By 1997, I had read hundreds of papers published in the Proceedings of SPIE.

256. Persons of ordinary skill would have known that in the late 1990s the full set of the Proceedings of SPIE was available in libraries or available for purchase from SPIE, whether as a single volume or as part of a subscription service for all volumes and would have further known that individual articles within the Proceedings were available for purchase from SPIE. In this timeframe, I regularly accessed the Proceedings of SPIE from the libraries at Caltech and UT Austin.

257. The International Symposium on Electronic Imaging: Science and Technology, 1994, and the Charge-Coupled Devices and Solid State Optical Sensors IV 1994 conference within the symposium, was a well-known, respected conference in the area of solid-state imaging. Persons of ordinary skill and other members of the public with an interest in advances in the area of digital imaging would have attended this conference.

258. Exs. 1033 and 1038 confirm that Ricquier was included on pages 2-10 of volume 2172 of the Proceedings of SPIE, which served as the record of the Charge-Coupled Devices and Solid State Optical Sensors IV 1994 conference.

259. Ex. 1038 at Pages 3 of 16, as marked by the exhibit labels, confirms that volume 2172 of the Proceedings was available at the University of Wisconsin library as of May 27, 1994.

260. Ex. 1033 at Page 1 of 18, as marked by the exhibit labels, confirms that SPIE published Volume 2172 by April 4, 1994 and began shipping Volume 2172 of the Proceedings of SPIE as of April 5, 1994. According to the declaration, I am informed that SPIE shipped 100-120 print copies of Volume 2172 to library customers by May 1, 1994, which is consistent with the availability date at the University of Wisconsin library as of May 27, 1994.

261. Based on its inclusion in the Proceedings of SPIE, Ricquier was disseminated by SPIE and made readily available to persons of ordinary skill in the art at libraries, including the University of Wisconsin library, and through distribution by SPIE, at least one year prior to the earliest October 6, 1997 priority date.

XI. CONCLUSION

262. In summary, I have concluded that each of the Challenged Claims is unpatentable as obvious under 35 U.S.C. § 103 in light of the prior art references as discussed above and the knowledge of one of ordinary skill in the art, as described above.

263. Specifically, in my opinion, for at least the reasons above, Adair in view of Tomoyasu renders obvious claims 1, 2, and 13; Swift in view of Ackland, and Tomoyasu renders obvious claims 1, 2, and 13; and Swift in view of Ackland, Tomoyasu, and Tanaka renders obvious claims 1, 2, and 13.

264. To the extent it is argued that any further disclosure is required for a limitation in claims 1, 2, and 13 that I have identified as being disclosed (explicitly or inherently) by Adair, Swift, Ackland, Tomoyasu, and/or Tanaka, a person of ordinary skill in the art would certainly have found that limitation obvious to include based on the same explicit disclosure or inherent disclosures and analysis I have identified above.

265. I reserve the right to supplement my opinions in the future to respond to any arguments that Patent Owner or its expert(s) may raise and to take into account new information as it becomes available to me.

266. I hereby declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct, and that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true.

Sworn to this 15th day of February, 2020 in Austin Texas.

Dean P. Neikirk, Ph.D.

APPENDIX A (CURRICULUM VITAE)

Dean P. Neikirk

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The University of Texas at Austin
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Austin, TX 78712

Education:

Oklahoma State University (Physics and Mathematics; with Honors)	B.S.	1979
California Institute of Technology (Applied Physics)	M.S.	1981
California Institute of Technology (Applied Physics)	Ph.D.	1984

Professional Experience:

Assistant Professor, University of Texas at Austin, Jan. 1984 - Aug. 1988
Associate Professor, University of Texas at Austin, Sept. 1988- Aug. 1992
Full Professor, University of Texas at Austin, Sept. 1992-present
Associate Dean of Graduate Studies, August 2014 - present

Honors and Awards:

- 1984 Marconi International Fellowship Young Scientist Award "for contributions to the development of millimeter wave integrated circuits especially in the areas of detectors and imaging arrays."
- Listed in the Second Edition of Who's Who in Frontiers of Science and Technology, 5th Edition of Who's Who in Technology Today, 1994 American Men & Women of Science; 1985 Outstanding Young Man of America, 1989 Outstanding Young Man of America; 7th Edition of Who's Who in Technology.
- 1984-85 Engineering Foundation Faculty Award, University of Texas at Austin Engineering Foundation Advisory Council.
- 1985-90 General Motors Foundation Centennial Teaching Fellowship, University of Texas at Austin.
- 1985-86 IBM Corporation Faculty Development Award
- 1986 National Science Foundation Presidential Young Investigator.

- 1987 Award for Outstanding Engineering Teaching by an Assistant Professor, College of Engineering, University of Texas at Austin.
- 1990-1992 Temple Foundation Endowed Faculty Fellowship (No. 1), University of Texas at Austin.
- 1992-present Cullen Trust for Higher Education Professorship in Engineering (No. 7), University of Texas.
- 1997 College of Engineering Award for Outstanding Teaching in the Department of Electrical and Computer Engineering, University of Texas at Austin.
- 2003 Department of Electrical and Computer Engineering Gordon T. Lepley IV Endowed Memorial Teaching Award, University of Texas at Austin.
- 2007 Lockheed Martin Aeronautics Company Award for Excellence in Engineering Teaching
    - each year since 1956, Lockheed Martin and its predecessor, has sponsored an award for excellence in engineering teaching to reward one College of Engineering faculty member for exceptional teaching. This prestigious award is given to a faculty member dedicating time and energy in abundance to teaching undergraduate and graduate students. As a result, his or her work leaves a mark of excellence on the entire College of Engineering. Nominations for this award are made by The University of Texas at Austin engineering students and faculty. Final selection is made by a committee composed the five most recent faculty recipients of the award and the student presidents of the Student Engineering Council (SEC) and the Graduate Engineering Council (GEC).
- 2015 Civitatis Award: The University of Texas at Austin Civitatis Award was established in 1997 to recognize outstanding faculty citizenship. The Civitatis Award is conferred upon a member of the faculty in recognition of dedicated and meritorious service to the University above and beyond the regular expectations of teaching, research, and writing. The award is made by the President upon the recommendation of the Faculty Council Executive Committee. Prof. Neikirk was nominated for the award for his “extensive, effective and distinguished service record to his department, college and [the] University of Texas.”

<u>Vita for Dean P. Neikirk:</u>

Dean P. Neikirk was born in Oklahoma City, Oklahoma, on October 31, 1957. He received the B.S. degree (1979) in physics from Oklahoma State University, and the M.S. (1981) and Ph.D. (1984) degrees in applied physics from the California Institute of Technology. He joined the faculty of The University of Texas at Austin in 1984, and is currently a Professor in the Department of Electrical and Computer Engineering, holding the Cullen Trust for Higher Education Professorship in Engineering (No. 7). Dr. Neikirk developed the first monolithic, high resolution focal plane detector array for use at wavelengths between 0.1 mm and 1 mm, and in 1984 received the Marconi International Fellowship Young Scientist Award "for contributions to the development of millimeter wave integrated circuits especially in the area of detectors and imaging arrays." He has also been named a 1986 National Science Foundation Presidential Young Investigator.

Dr. Neikirk's current research interests concentrate on the fabrication and modeling of electromagnetic and micromachined sensors and actuators. His work also includes projects involving integrated circuit processing and the high frequency properties of transmission lines. His work concentrates on the use of advanced fabrication techniques, including silicon micromachining, for new device and sensor development. Dr. Neikirk developed the teaching laboratory for semiconductor device fabrication at The University of Texas at Austin, and is an active member of The University of Texas at Austin Microelectronics Research Center. Recently Dr. Neikirk's research project related to the development of new chemical sensors (an "electronic taste" sensor) was selected for a commercialization venture between the University of Texas and LabNow, Inc. Dr. Neikirk has also served as the Graduate Advisor of the Department of Electrical and Computer Engineering at UT-Austin, an Associate Chairman of the ECE Department, the Chair of the UT-Austin Graduate Assembly, the Chair of the UT-Austin Faculty Council, the Secretary of the General Faculty at UT-Austin, and is currently Associate Dean of the University of Texas at Austin Graduate School.

Professional Societies:

Senior Member, Institute of Electrical and Electronics Engineers

- Associate Editor for Solid State and VLSI Electronics, **IEEE Transactions on Education** (March 1991- Oct. 1994)

Commercialization of Technology:

Two companies have been founded based on technology developed by Dr. Neikirk's research group. In both cases the technology was developed at The University of Texas at Austin and licensed to start-ups.

From a University of Texas news release:
Firm commercializing University of Texas technology rounds up $14 million venture capital investment (October 1, 2004)

AUSTIN, Texas—LabNow Inc. has received $14 million in first-round venture investment for its point-of-care diagnostic system from the Soros Group, Austin Ventures and other investors.

The money will be used to develop the company's technology and to launch its initial product, CD4Now™, a point-of-care diagnostic tool for HIV/AIDS patients.

The device, which is based on technology developed at The University of Texas at Austin, quickly and accurately analyzes complex fluids such as blood.

Patents

1. US Patent 5,080,870: "Sublimating and Cracking Apparatus," Jan. 14, 1992; Inventors: B. G. Streetman, T. J. Mattord, D. P. Neikirk

2. US Patent 5,408,107: "Semiconductor Device Having Multiple Current-Voltage Curves and Zero-Bias Memory," April 18, 1995;
Inventors: Dean P. Neikirk and Kiran Kumar Gullapalli

3. US Patent 6,589,779: "General signaling protocol for chemical receptors in immobilized matrices," July 8, 2003;
Inventors: McDevitt; John T.; Anslyn; Eric V.; Shear; Jason B.; Neikirk; Dean P.
Assignee: Board of Regents, The University of Texas System (Austin, TX)

4. US Patent 6,602,702: "Detection system based on an analyte reactive particle," August 5, 2003
Inventors: McDevitt; John T. (Austin, TX); Anslyn; Eric V. (Austin, TX); Shear; Jason B. (Austin, TX); Neikirk; Dean P. (Austin, TX)

Assignee: The University of Texas System (Austin, TX)

5. US Patent 6,649,403: "Method of preparing a sensor array," November 18, 2003
Inventors: McDevitt; John T. (Travis, TX); Anslyn; Eric V. (Austin, TX); Shear; Jason B. (Austin, TX); Neikirk; Dean P. (Travis, TX)
Assignee: Board of Regents, The University of Texas Systems (Austin, TX)

6. US Patent 6,680,206, "Sensor arrays for the measurement and identification of multiple analytes in solutions," January 20, 2004
Inventors: McDevitt; John T. (Travis, TX); Anslyn; Eric V. (Austin, TX); Shear; Jason B. (Austin, TX); Neikirk; Dean P. (Travis, TX)
Assignee: Board of Regents, The University of Texas Systems (Austin, TX)

7. US Patent 6,713,298, "Method and apparatus for the delivery of samples to a chemical sensor array, " March 30, 2004
Inventors: McDevitt; John T. (Travis, TX); Anslyn; Eric V. (Travis, TX); Shear; Jason B. (Travis, TX); Neikirk; Dean P. (Travis, TX)
Assignee: Board of Regents, The University of Texas System (Austin, TX)

8. US Patent 6,908,770, "Fluid based analysis of multiple analytes by a sensor array," June 21, 2005
Inventors: McDevitt; John T. (Austin, TX); Anslyn; Eric V. (Austin, TX); Shear; Jason B. (Austin, TX); Neikirk; Dean P. (Austin, TX)
Assignee: Board of Regents, The University of Texas System (Austin, TX)

9. US Patent 7,022,517, "Method and apparatus for the delivery of samples to a chemical sensor array," April 4, 2006, filed: July 14, 2000
Inventors: McDevitt; John T. (Austin, TX); Anslyn; Eric V. (Austin, TX); Shear; Jason B. (Austin, TX); Neikirk; Dean P. (Austin, TX); Borich; Damon V. (Austin, TX)
Assignee: Board of Regents, The University of Texas System (Austin, TX)

10. US Patent 7,316,899, "Portable sensor array system," January 8, 2008, filed: January 31, 2001
Inventors: McDevitt; John T. (Austin, TX); Anslyn; Eric V. (Austin, TX); Shear; Jason B. (Austin, TX); Neikirk; Dean P. (Austin, TX)
Assignee: Board of Regents, The University of Texas System (Austin, TX)

11. US Patent 7,491,552, "Fluid based analysis of multiple analytes by a sensor array," February 17, 2009, filed: January 20, 2005
Inventors: McDevitt; John T. (Austin, TX); Anslyn; Eric V. (Austin, TX); Shear; Jason B. (Austin, TX); Neikirk; Dean P. (Austin, TX)
Assignee: Board of Regents, The University of Texas System (Austin, TX)

12. United States Patent 7,651,868, "Method and system for the analysis of saliva using a sensor array," January 26, 2010, Filed: December 13, 2004

Inventors: McDevitt; John T. (Austin, TX), Anslyn; Eric V. (Austin, TX), Shear; Jason B. (Austin, TX), Neikirk; Dean P. (Austin, TX), Christodoulides; Nick J. (Austin, TX)
Assignee: The Board of Regents of The University of Texas System (Austin, TX)

13. United States Patent 8,101,431, "Integration of fluids and reagents into self-contained cartridges containing sensor elements and reagent delivery systems," January 24, 2012, Filed: December 22, 2004
Inventors: McDevitt; John T. (Austin, TX), Ballard; Karri L. (Pflugerville, TX), Floriano; Pierre N. (Austin, TX), Christodoulides; Nick J. (Austin, TX), Neikirk; Dean (Austin, TX), Anslyn; Eric (Austin, TX), Shear; Jason (Austin, TX)
Assignee: Board of Regents, The University of Texas System (Austin, TX)

14. United States Patent 8,105,849, "Integration of fluids and reagents into self-contained cartridges containing sensor elements," January 31, 2012, Filed: December 22, 2004
Inventors: McDevitt; John T. (Austin, TX), Ballard; Karri L. (Pflugerville, TX), Floriano; Pierre N. (Austin, TX), Christodoulides; Nick J. (Austin, TX), Neikirk; Dean (Austin, TX), Anslyn; Eric (Austin, TX), Shear; Jason (Austin, TX)
Assignee: Board of Regents, The University of Texas System (Austin, TX)

15. United States Patent 8,257,967, "Method and system for the detection of cardiac risk factors," September 4, 2012, Filed: April 28, 2003
Inventors: McDevitt; John T. (Austin, TX), Anslyn; Eric V. (Austin, TX), Shear; Jason B. (Austin, TX), Neikirk; Dean P. (Austin, TX), Christodoulides; Nick J. (Austin, TX)
Assignee: Board of Regents, The University of Texas System (Austin, TX)

16. United States Patent 9,291,586, "Passive wireless self-resonant sensor," March 22, 2016, Filing Date: May 5, 2013
Inventors: Neikirk, Dean P. (Austin, TX, US), Pasupathy, Praveenkumar (Austin, TX, US), Zhang, Sheng (Austin, TX, US), Leonhardt, Brad (Austin, TX, US), Ekerdt, John G. (Austin, TX, US), Korgel, Brian A. (Austin, TX, US), Holmberg, Vincent C. (Seattle, WA, US), Shipman, Catherine D. (Reston, TX, US), Bogart, Timothy D. (Oxford, GB), Chockla, Aaron (Chicago, IL, US)
Assignee: Board of Regents, The University of Texas System (Austin, TX, US)

17. United States Patent 9,581,559, "Corrosion detection sensor embedded within a concrete structure with a diffusion layer placed over the sacrificial transducer," February 28, 2017, Filing Date: August 14, 2014
Inventors: Neikirk; Dean P. (Austin, TX), Wood; Sharon L. (Austin, TX), Pasupathy; Praveenkumar (Austin, TX), Yosef; Ali Abu (Austin, TX)
Assignee: Board of Regents, The University of Texas System (Austin, TX)

<u>Publications:</u>

A: Refereed archival journal publications

1. D. P. Neikirk and R. C. Powell, "Laser Time-Resolved Spectroscopy of Host-Sensitized Energy Transfer in $Bi_4Ge_30_{12}$:Er^{3+} Crystals," **J. Lumin.**, vol. 20, 1979, pp. 261- 270.

2. R. C. Powell, D. P. Neikirk, J. M. Flaherty, and J. G. Gualtieri, "Lifetime Measurements, Infrared and Photoacoustic Spectroscopy of NdP_50_{14}," **J. Phys. Chem. Solids**, vol. 41, 1980, pp. 345-350.

3. R. C. Powell, D. P. Neikirk, and D. Sadar, "Radiationless Decay Processes of Nd^{3+} Ions in Solids," **J. Opt. Soc. Am.**, vol. 70 (5), May 1980, pp. 486-490.

4. D. P. Neikirk, D. B. Rutledge, M. S. Muha, H. Park, and C. X. Yu, "Far-Infrared Imaging Antenna Arrays," **Appl. Phys. Lett.**, vol. 40 (3), l February 1982, pp. 203-205.

5. D. P. Neikirk, D. B. Rutledge, M.S. Muha, H. Park, and C. X. Yu, "Progress in Millimeter-Wave Integrated-Circuit Imaging Antenna Arrays," **Proc. Soc. Photo-Opt. Instr. Eng.**, vol. 317, 1981, pp. 206-211.

6. D. P. Neikirk, D. B. Rutledge, P.P. Tong, H. Park, and P. E. Young, "Imaging Antenna Array at 119μm," **Appl. Phys. Lett.**, vol. (41), 15 August 1982, pp. 329-331.

7. D. P. Neikirk and D. B. Rutledge, "Self-Heated Thermocouples for Far-Infrared Detection," **Appl. Phys. Lett.**, vol. 41, (5), 1 September 1982, pp. 400-402

8. P.P. Tong, D. P. Neikirk, D. Psaltis, D. B. Rutledge, K. Wagner, and P. E. Young, "Tracking Antenna Arrays for Near- Millimeter Waves," **IEEE Trans. Antennas Propagat.**, vol. AP- 31, May, 1983, pp. 512-515.

9. D. P. Neikirk and D. B. Rutledge, "Air-Bridge Microbolometer for Far-Infrared Detection," **Appl. Phys. Lett. 44**,15 Jan. 1984, pp. 153-155.

10. P.P. Tong, D. P. Neikirk, D. B. Rutledge, P. E. Young, W. A. Peebles, N. C. Luhmann, Jr., "Imaging Polarimeter Arrays for Near-Millimeter Waves," **IEEE Trans. Microwave Theory Tech. MTT-32**, March 1984, pp. 507-512.

11. D. P. Neikirk, D. B. Rutledge, and W. Lam, "Far-Infrared Microbolometer Detectors," **Int. J. Infrared and Millimeter Waves 5**, March 1984, pp. 245-277.

12. D. P. Neikirk and D. B. Rutledge, "Far-Infrared Imbedding Impedance Measurements,"

Int. J. Infrared and Millimeter Waves 5, July 1984, pp. 1017-1026.

13. P. E. Young, D. P. Neikirk, P.P. Tong, D. B. Rutledge, and N. C. Luhmann, Jr., "Multichannel far-infrared phase imaging for fusion plasmas," **Rev. Sci. Instrum. 56**, Jan. 1985, pp. 81-89.

14. P. E. Young, N. C. Luhmann, Jr., R. J. Taylor, D. P. Neikirk, and D. B. Rutledge, "Far-infrared imaging of tokamak plasma," **Rev. Sci. Instrum. 56**, May 1985, pp. 903-904.

15. Y. Fukuoka, Q. Zhang, D. Neikirk, and T. Itoh, "Analysis of multilayer interconnection lines for a high speed digital integrated circuit," **IEEE Trans. Microwave Theory Tech. MTT- 33**, June 1985, pp. 527-532.

16. N. Song, D. P. Neikirk, and T. Itoh, "Modeling of Ion-implanted GaAs MESFETs by the Finite Element Method," **IEEE Electron Device Lett. EDL-7**, April 1986, pp. 208-210.

17. V. P. Kesan, D. P. Neikirk, B. G. Streetman, and P. A. Blakey, "A New Transit Time Device Using Quantum Well Injection," **IEEE Electron Device Lett. EDL-8**, April 1987, pp. 129-131.

18. A. C. Cambell, V. P. Kesan, G. E. Crook, C. M. Maziar, D. P. Neikirk, and B. G. Streetman, "Impedance Switching Effects in GaAs/AlAs Barrier Structures," **Electronics Letters 23**, Aug 27, 1987, pp. 926-927.

19. Y. D. Lin, D. P. Neikirk, and T. Itoh, "Coplanar Waveguide Phase Shifter Controlled by a Spatially Periodic Optical Illumination," **Int. J. Infrared and Millimeter Waves 8**, Sept. 1987, pp. 1027-1036.

20. C. W. Farley, G. E. Crook, V. P. Kesan, T. R. Block, H. A. Stevens, T. J. Mattord, D. P. Neikirk, and B. G. Streetman, "Substrate Rotation and Carbon Generation in a Molecular Beam Epitaxy System," **J. Vac. Science Tech. B**, Sept./Oct. 1987, pp. 1374-1376.

21. V. P. Kesan, D. P. Neikirk, T. D. Linton, P. A. Blakey, and B. G. Streetman, "Influence of Transit Time Effects on the Optimum Design and Maximum Oscillation Frequency of Quantum Well Oscillators," **IEEE Trans. Electron Devices ED-35**, April 1988, pp. 405-413.

22. A. C. Campbell, V. P. Kesan, G. E. Crook, C. M. Maziar, D. P. Neikirk, and B. G. Streetman, "Capacitive Hysteresis Effects in 5.0 nm Single and Double Barrier AlAs Tunneling Structures Grown by MBE," **J. Vac. Science Tech. B 6**, Mar/Apr 1988, pp. 651-656.

23. V. P. Kesan, A. Mortazawi, D. P. Neikirk, and T. Itoh, "Monolithic Millimeter-Wave Oscillator using a Transmission Line Periodically Loaded by QWITT Diodes," **Electronics Letters** , May 26, 1988, pp. 666-667.

24. T. J. Mattord, V. P. Kesan, G. E. Crook, T. R. Block, A. C. Campbell, D. P. Neikirk, and B. G. Streetman, "Baffle-free Refractory Dimer Source for Molecular Beam Epitaxy," **J. Vac Sci. Technol. B 6**, Nov./Dec. 1988, pp. 1667-1670.

25. V. P. Kesan, A. Dodabalapur, D. P. Neikirk, and B. G. Streetman, "Growth and Rapid Thermal Annealing of AlGaAs/InGaAs Pseudomorphic Modulation-doped Structures," **Appl. Phys. Lett. 53**, 22 Aug. 1988, pp. 681-683.

26. T. J. Mattord, V. P. Kesan, D. P. Neikirk, and B. G. Streetman, "A Single-filament Effusion Cell with Reduced Thermal Gradient for Molecular Beam Epitaxy," **J. Vac Sci. Technol. B 7**, Mar/Apr 1989, pp. 214-216.

27. A. Dodabalapur, V. P. Kesan, T. R. Block, D. P. Neikirk, and B. G. Streetman, "Optical and Electrical Characterization of Pseudomorphic AlGaAs/InGaAs/GaAs Modulation-doped Structures Processed by Rapid Thermal Annealing," **J. Vac Sci. Technol. B 7**, March/April 1989, pp. 380-383.

28. V. P. Kesan, A. Mortazawi, D. R. Miller, T. Itoh, B. G. Streetman, and D. P. Neikirk, "Microwave Frequency Operation of the Quantum Well Injection Transit Time (QWITT) Diode," **Electronics Letters 24**, 24 Nov. 1988, pp. 1473-1474.

29. C. S. Kyono, V. P. Kesan, D. P. Neikirk, C. M. Maziar, and B. G. Streetman, "Dependence of Apparent Barrier Height on Barrier Thickness for Perpendicular Transport in AlAs/GaAs Single Barrier Structures Grown by MBE," **Appl. Phys. Lett. 54**, 6 Feb. 1989, pp. 549-551.

30. R. L. Rogers and D. P. Neikirk, "Use of Broadside Twin Element Antennas to Increase Efficiency on Electrically Thick Dielectric Substrates," **Int. J. Infrared and Millimeter Waves 9**, Nov. 1988, pp. 949-969.

31. R. L. Rogers and D. P. Neikirk, "Radiation Properties of Slot and Dipole Elements on Layered Substrates," **Int. J. Infrared and Millimeter Waves 10**, June 1989, pp. 697-728.

32. A. Dodabalapur, V. P. Kesan, D. R. Hinson, D. P. Neikirk, and B. G. Streetman, "Photoluminescence Studies of Pseudomorphic modulation-doped AlGaAs/ InGaAs/ GaAs Quantum Wells," **Appl. Phys. Lett. 54**, 24 April 1989, pp. 1675-1677.

33. A. C. Campbell, V. P. Kesan, T. R. Block, G. E. Crook, D. P. Neikirk, and B. G. Streetman, "Influence of MBE Growth Temperature on GaAs/AlAs Resonant Tunneling Structures," **Journal of Electronic Materials 18**, 1989, pp. 585-588.

34. S. M. Wentworth, D. P. Neikirk, and C. R. Brahce, "The High Frequency Characteristics of Tape Automated Bonding (TAB) Interconnects," **IEEE. Trans. Components, Hybrids, and Manufacturing Tech. 12**, Sept. 1989, pp. 340-347.

35. V. P. Kesan, A. Mortazawi, D. R. Miller, V. K. Reddy, D. P. Neikirk, and T. Itoh, "Microwave and Millimeter Wave QWITT Diode Oscillators," **IEEE Trans. Microwave Theory Tech. MTT-37** , Dec. 1989, pp. 1933-1941.

36. P. Cheung, D. P. Neikirk, and T. Itoh, "A Schottky-Biased, Optically-Controlled Coplanar Waveguide Phase Shifter," **Electronics Letters 25**, Sept. 14, 1989, pp. 1301-1302.

37. S. M. Wentworth and D. P. Neikirk, "Far Infrared Microbolometers made with Tellurium and Bismuth," **Electronics Letters 25**, Nov. 9, 1989, pp. 1558-1560.

38. A. Dodabalapur, V. P. Kesan, D. P. Neikirk, and B. G. Streetman, "Photoluminescence and Electroreflectance Studies of Modulation-Doped Pseudomorphic AlGaAs/ InGaAs/ GaAs Quantum Wells," **Journal of Electronic Materials 19**, 1990, pp. 265-270.

39. P. Cheung, D. P. Neikirk, and T. Itoh, "Optically Controlled Coplanar Waveguide Phase Shifters," **IEEE Trans. Microwave Theory Tech. MTT-38** , May 1990, pp. 586-595.

40. S. M. Wentworth, R. L. Rogers, J. G. Heston, D. P. Neikirk, and T. Itoh, "Millimeter Wave Twin Slot Antennas on Layered Substrates," **Int. J. Infrared and Millimeter Waves 11**, Feb. 1990, pp. 111-131.

41. J. G. Heston, J. M. Lewis, S. M. Wentworth, and D. P. Neikirk, "Twin slot antenna structures integrated with microbolometer detectors for 94 GHz imaging," **Microwave and Optical Technology Letters 4**, no. 1, Jan. 5, 1991, pp. 15-19.

42. R. L Rogers, S. M. Wentworth, D. P. Neikirk, and T. Itoh, "A twin slot antenna on a layered substrate coupled to a microstrip feed line," **Int. J. Infrared and Millimeter Waves 11**, no. 10, October 1990, pp. 1225-1249.

43. T. Y. Chu, D. P. Neikirk, and B. G. Streetman, "Properties and Applications of $Al_xGa_{1-x}As$ Grown at Low Temperatures," **J. Crystal Growth 111**, 1991, pp. 26-29.

44. V. K. Reddy, A. J. Tsao, and D. P. Neikirk, "High Peak-to-Valley Current Ratio AlGaAs/AlAs/GaAs Double Barrier Resonant Tunneling Diodes," **Electronics Letters 26**, Oct. 11, 1990, pp. 1742-1744.

45. A. J. Tsao, V. K. Reddy, and D. P. Neikirk, "Epitaxial Liftoff of AlAs/GaAs Double Barrier Resonant Tunneling Diodes," **Electronics Letters 27**, March 14, 1991, pp. 484-486.

46. D. R. Miller and D. P. Neikirk, "Simulation of Intervalley Mixing in Double Barrier Diodes Using the Lattice Wigner Function," **Appl. Phys. Lett. 58**, 17 June 1991, pp. 2803-2805.

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48. S. M. Wentworth and D. P. Neikirk, "Composite Microbolometers with Tellurium Detector Elements," **IEEE Trans. Microwave Theory Tech. MTT-40**, no. 2, Feb. 1992, pp. 196-201.

49. T. D. Linton, Jr., P.A. Blakey, and D. P. Neikirk, "The impact of three-dimensional effects on EEPROM cell performance," **IEEE Trans. Electron Devices 39**, April 1992, pp. 843-850.

50. V. K. Reddy and D. P. Neikirk, "Influence of Growth Interruption on I - V Characteristics of AlAs/GaAs Double Barrier Resonant Tunneling Diodes," **J. Vac. Sci. Technol. B 10**, Mar/Apr 1992, pp. 1045-1047.

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54. S. Javalagi, V. Reddy, K. Gullapalli, and D. Neikirk, "High efficiency microwave diode oscillators," **Electronics Letters 28**, 27 August 1992, pp. 1699-1701.

55. K. K. Gullapalli, A. J. Tsao, and D. P. Neikirk, "Multiple self-consistent solutions at zero bias and multiple conduction curves in quantum tunneling diodes containing N^- - N^+ - N^- spacer layers," **Appl. Phys. Lett. 62**, 7 June 1993, pp. 2971-2973.

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57. V. K. Reddy and D. P. Neikirk, "High breakdown voltage AlAs/InGaAs quantum barrier varactor diodes," **Electronics Letters 29**, 4 March 1993, pp. 464-466.

58. T. R. Block, D. P. Neikirk, and B. G. Streetman, "Molecular-beam epitaxial growth condition dependence of reflection high-energy electron diffraction dampening and quantum well photoluminescence," **J. Vac. Sci. Technol. B 11**, May/June 1993, pp. 791-

794.

59. Y. C. Albert Shih, D. P. Neikirk, B. G. Streetman, and C. W. Magee "Effects of As flux on Si δ-doped GaAs," **J. Vac. Sci. Technol. B 11**, May/June 1993, pp. 905-907.

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157. Sheng P. Zhang, Praveenkumar Pasupathy, Dean P. Neikirk, "Microfabricated self-resonant structure as a passive wireless chemical sensor," Proc. SPIE 8066, 80661L (2011); doi:10.1117/12.886895, SPIE International Symposium on Microtechnolgies, Conference 8066 Smart Sensors, Actuators and MEMS (EMT101), Prague, Czech Republic, 18-20 April 2011, Paper 8066-57.

158. Joo-Yun Jung, Jong Yeon Park, Dean P. Neikirk, Aniruddha S. Weling, Will Hafer, James H. Goldie, and Paul D. Willson, "Experimental LWIR spectral characterization of wavelength selective microbolometers," SPIE Defense, Security, and Sensing, Infrared Technology and Applications XXXVII Proceedings of SPIE, paper number 8012-38, 25-29 April 2011, Orlando, Florida.

159. Jong Yeon Park, James E. Gardner, Praveen Pasupathy, Ji Won Suk, Rodney S. Ruoff, and Dean P. Neikirk, "Fabrication and Characterization of Wavelength Selective Microbolometers using a Planar Self-aligned Process for Low Deformation Membranes," in MOEMS and Miniaturized Systems XI, part of SPIE MOEMS-MEMS, San Francisco, California, 25 Jan 2012, SPIE Paper Number 8252-33, Proc. SPIE 8252, 82520Y (2012); http://dx.doi.org/10.1117/12.906290 , 7 pages.

160. Ye Chen, Praveen Pasupathy, Tanuj Trivedi, Dean P. Neikirk and Sharon L. Wood, "Improved magneto-inductive waveguide as wireless sensor net for structural health monitoring," Nondestructive Characterization for Composite Materials, Aerospace Engineering, Civil Infrastructure, and Homeland Security 2012, San Diego, California, USA, Proc. SPIE 8347, 83472H (2012); http://dx.doi.org/10.1117/12.915227, Monday 12 March 2012, 8 pages.

161. Ali E. Abu-Yosef, Praveen Pasupathy, Sharon L. Wood and Dean P. Neikirk, "Detection of multiple corrosion thresholds in reinforced concrete structures using

passive sensors," Nondestructive Characterization for Composite Materials, Aerospace Engineering, Civil Infrastructure, and Homeland Security 2012, San Diego, California, USA, Proc. SPIE 8347, 83470J (2012); http://dx.doi.org/10.1117/12.915164 , Monday 12 March 2012, 7 pages.

162. JinYoung Kim, Praveenkumar Pasupathy, Sharon L. Wood and Dean P. Neikirk, "Enhanced resolution of passive wireless conductivity sensors," Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems 2012, San Diego, California, USA, Proc. SPIE 8345, 83451B (2012); http://dx.doi.org/10.1117/12.916754 , Monday 12 March 2012, 7 pages.

163. Tanuj Trivedi, Frank Raffaeli, Praveen Pasupathy, Ali E. Abu-Yousef, Ye Chen, Dean Neikirk and Sharon Wood, "A reflectometer-based reader for passive wireless structural surveillance sensors," Nondestructive Characterization for Composite Materials, Aerospace Engineering, Civil Infrastructure, and Homeland Security 2012, San Diego, California, USA, Proc. SPIE 8347, 83470I (2012); http://dx.doi.org/10.1117/12.915223 Monday 12 March 2012, 7 pages.

164. Hoo Kim and Dean P. Neikirk, "Three Dimensional Dual-band Stacked Microbolometer Design using resistive dipoles and slots," SPIE Infrared Technology and Applications XXXIX, edited by Bjørn F. Andresen, Gabor F. Fulop, Charles M. Hanson, Paul R. Norton, Proc. of SPIE Vol. 8704, 870419, 11 June 2013.

165. Dean P. Neikirk, Hoo Kim, Jong Yeon Park, Joo-Yun Jung, "Patterned resistive sheets for use in infrared microbolometers," SPIE Security + Defence, 25 Sep 2013 4:00 PM - 4:20 PM.

C. Published Abstracts

1. P.E. Young, Q.-X. Yu, W. A. Peebles, N.C. Luhmann, Jr., D. P. Neikirk, and D. B. Rutledge, "Application of Far-Infrared Imaging Arrays to Plasma Density and Magnetic Field Measurements," 4th APS Topical Conference on High Temperature, 1982.

2. P.E. Young, Q.-X. Yu, W.A. Peebles, N.C. Luhmann, Jr., D. P. Neikirk, and D. B. Rutledge, "Demonstration of Far-Infrared Phase Imaging," 24th Annual Meeting, Division of Plasma Physics, New Orleans, La., November, 1982.

3. P. E. Young, W.A. Peebles, N.C. Luhmann, Jr., R.J. Taylor, D. B. Rutledge, D. P. Neikirk, and P.P. Tong, "Current Profile Measurements in a Tokamak Plasma," 25th Ann. APS Meeting, Div. of Plasma Physics, Nov., 1983.

4. D. B. Rutledge, D. P. Neikirk, P.P. Tong, P.E. Young, W.A. Peebles, N.C. Luhmann, Jr., and R.J. Taylor, "Demonstration of a FIR Imaging System as a Multi-Channel Interferometer," 25th Ann. APS Meeting, Div. of Plasma Physics, Nov., 1983.

5. P.E. Young, N.C. Luhmann, Jr., R.J. Taylor, D. P. Neikirk, and D. B. Rutledge, 26th Annual Meeting of the Division of Plasma Physics, Boston, MA, Oct 29- Nov 2, 1984.

6. D.L. Brower, W.A. Peebles, S. Kim, R.L. Savage, Jr., T. Lehecka, N.C. Luhmann, Jr., J. Wagner, D. B. Rutledge, D. P. Neikirk, P.E. Young, and H.K. Park, "Recent advances in multichannel far-infrared collective scattering and interferometry systems," Eleventh Symposium on Fusion Engineering, Austin, TX, Nov. 18-22, 1985.

7. A.C. Campbell, V.P. Kesan, G.E. Crook, C.M. Maziar, D. P. Neikirk, and B. G. Streetman, "Capacitive Hysteresis Effects in 5.0nm single and double barrier AlAs Tunneling Structures," 8th Molecular Beam Epitaxy Workshop, Los Angeles CA, September 9-11, 1987.

8. A.C. Campbell, V.P. Kesan, G.E. Crook, D. P. Neikirk, and B. G. Streetman, "Capacitance Transient Analysis of GaAs/AlAs Tunneling Structures," 1988 Electronics Materials Conference, University of Colorado, Boulder, Colorado, June 22-24, 1988.

9. V.P. Kesan, A. Dodabalapur, D. P. Neikirk, and B. G. Streetman, "Influence of MBE Growth and Rapid Thermal Annealing Conditions on the Electrical Properties of Normal and Inverted AlGaAs/InGaAs Pseudomorphic HEMT Structures," IEEE 46th Annual Device Research Conference, June 20-22, 1988, Boulder, CO.

10. A. Dodabalapur, V.P. Kesan, T.R. Block, D. P. Neikirk, and B. G. Streetman, "Optical and Electrical Characteristics of Normal and Inverted AlGaAs/InGaAs Pseudomorphic HEMT Structures Processed by RTA," 9th Molecular Beam Epitaxy Workshop, West Lafayette, Indiana, September 21-23, 1988.

11. A. Sharif, D. P. Neikirk, and D.R. Diller, "Design and Fabrication of a Multi-Sensor Cryomicroscope Stage using VLSI Technology," Cryo 89, Charleston, SC, June 1989, published in **Physics in Medicine and Biology 33.**

12. A. Dodabalapur, V.P. Kesan, D. P. Neikirk, B. G. Streetman, M.H. Herman, and I.D. Ward, "Photoluminescence and Electroreflectance Characterization of Modulation-Doped Quantum Wells," Journal of Electronic Materials 18, July 1989, p. 51.

13. V.K. Reddy and D. P. Neikirk, "Influence of Growth Interruption on I - V Characteristics of AlAs/GaAs Double Barrier Resonant Tunneling Diodes," 11th Annual Molecular Beam Epitaxy Workshop, Austin TX, Sept. 16-18, 1991.

14. A.J. Tsao, V.K. Reddy, D.R.Miller, K.K. Gullapalli, and D. P. Neikirk, "The effect of barrier thickness asymmetries on the electrical characteristics of AlAs/GaAs double barrier resonant tunneling diodes," 11th Annual Molecular Beam Epitaxy Workshop, Austin TX, Sept. 16-18 1991.

15. T.R. Block, D. P. Neikirk, and B. G. Streetman, "MBE growth condition dependence

of RHEED dampening and QW photoluminescence," Twelfth North American Conference on Molecular Beam Epitaxy, Ottawa, Canada, Oct. 12-14, 1992.

16. T.J. Mattord, D. P. Neikirk, A. Srinivasan, A. Tang, K. Sadra, Y.C. Shih, and B. G. Streetman, "Real time flux monitoring and feedback control of a valved arsenic source" Twelfth North American Conference on Molecular Beam Epitaxy, Ottawa, Canada, Oct. 12-14, 1992.

17. Y.C. Shih, D. P. Neikirk, and B. G. Streetman, "Effects of As flux on Si δ-doped GaAs," Twelfth North American Conference on Molecular Beam Epitaxy, Ottawa, Canada, Oct. 12-14, 1992.

18. Y. Kim and D. P. Neikirk, "Monolithically integrated optically interrogated pressure microsensor," **J. Acoust. Soc. Am.**, Vol. 92, No. 4 (pt. 2), October 1992, p. 2353.

19. O. Hartin, D. P. Neikirk, A. Anselm, and B. Streetman, "Memory Switching Simulation in Resonant Tunneling Devices," 1997 American Physical Society March Meeting, Kansas City, MO, March 17-21, Bulletin of the American Physical Society, Vol. 42, No. 1, 1997, p. 548.

20. O. Hartin and D. P. Neikirk, "Tight Binding Simulation of Memory Switching in Resonant Tunneling Devices," 1997 American Physical Society International Conference on Computational Physics, University of California, Santa Cruz, Aug. 25, 1997.

21. D. Neikirk, "Embedded Passive Sensors for State Monitoring," presented at NSF Workshop on Exploring the Uses of Autoadaptive Media in Geotechnical Earthquake Engineering, Austin, TX, January 10-12 2001.

22. Lavigne, John J.; Savoy, Steve; Best, Michael; Anslyn, Eric V.; Shear, Jason B.; McDevitt, John T.; Neikirk, Dean, "Toward the development of an 'electronic tongue'," Book of Abstracts, 219th ACS National Meeting, San Francisco, CA, March 26-30, 2000 (2000), AGFD-193.

23. Wood, Sharon; Neikirk, Dean, "Development of a passive sensor to detect cracks in welded steel construction," US-Japan Joint Workshop and Third Grantees Meeting, US-Japan Cooperative Research in Urban Earthquake Disaster Mitigation, Monbu-Kgagku-sho and The National Science Foundation, Seattle, August 15-16, 2001.

24. McCleskey, Shawn C.; Goodey, Adrian P.; Rodriguez, Marc D.; McDevitt, John T.; Anslyn, Eric V.; Neikirk, Dean P., "Development of a multi-component sensor array for the simultaneous detection of various analytes in solution," Abstracts of Papers, 222nd ACS National Meeting, Chicago, IL, United States, August 26-30, 2001.

D. Other Major Publications

V. Kesan and D. P. Neikirk, "Quantum Well Devices," **Microwaves and RF**, vol. 25, July 1986, pp. 93-97.

D. P. Neikirk, P. Cheung, M.S. Islam, and T. Itoh, "Optically Controlled Coplanar Waveguide Phase Shifters," **Microwave Journal**, Dec. 1989, pp. 77-88.

D. P. Neikirk, "Quantum Wells and Other Deep Subjects," **Discovery**, Vol. 11, No. 3, 1989, pp. 5-8.

S. M. Wentworth, J. M. Lewis, and D. P. Neikirk, "Antenna-Coupled Thermal Detectors of mm-Wave Radiation," **Microwave Journal**, Jan. 1993, pp. 94-103.

E. Book Chapter

D. B. Rutledge, D. P. Neikirk, and D. Kasilingam "Integrated- Circuit Antennas," in **Infrared and Millimeter Waves**, vol. 11, editor K.J. Button, 1984.

Nicolaos Christodoulides, Priya Dharshan, Jorge Wong, Pierre N. Floriano, Dean Neikirk and John T. McDevitt, “A Microchip-Based Assay for Interleukin-6,” In: Methods in Molecular Biology, Volume 385: Microchip-Based Assay Systems, Humana Press, ISBN 978-1-58829-588-0 (Print) 978-1-59745-426-1 (Online), Copyright 2008, pages 131-144.

F. Technical Reports

C-K Tzuang, D. P. Neikirk, and T. Itoh, "Finite Element Analysis of Slow-Wave Schottky Contact Printed Lines," Microwave Laboratory Report No. 87-P-2, AFOSR Grant 86-0036, Feb., 1987.

D. P. Neikirk and T. Itoh, "Monolithic Phase Shifter Study," Microwave Laboratory Report No. 87-P-3, AFOSR Grant 86-0036, Jan., 1987.

V. P. Kesan and D. P. Neikirk, "Quantum Well Devices," Electrical Engineering Research Laboratory Report No. 87-P-8, Joint Services Electronics Program Research Contract AFOSR F49620-86-C-0045, August 7, 1987.

Stuart M. Wentworth and D. P. Neikirk, "High Frequency Characteristics of Tape Automated Bonding (TAB) Interconnects," Microwave Laboratory Report No. 87-P-7, August 26, 1987.

Stuart M. Wentworth and D. P. Neikirk, "Characterization of Tape Automated Bonding (TAB) Interconnects at High Frequency ," Microwave Laboratory Report No. 87-P-9, October 23, 1987.

D. P. Neikirk and T. Itoh, "Monolithic Phase Shifter Study," Microwave Laboratory Report No. 90-P-1, Final Technical Report for AFOSR Grant 86-0036, Feb., 1990.

A. Mortazawi, D. Neikirk, and T. Itoh, "Microwave and millimeter wave oscillators and planar power combining structures for QWITT and Gunn diodes," Microwave Laboratory Report No. 90-P-4, Technical Report for ARO Grant DAAL03-88-K-0005 and JSEP Grant F49620-89-0044, Aug., 1990.

Oral Presentations

A. Professional Society Presentation

D. B. Rutledge and D. P. Neikirk, "Imaging Antenna Arrays," Invited Keynote Speakers, Sixth International Conference on Infrared and Millimeter Waves, Miami. Fl., Dec. 7-12, 1981.

D. P. Neikirk and D. B. Rutledge, "Advances in Microbolometers," Invited Keynote Speakers, Eighth International Conference on Infrared and Millimeter Waves, Miami, Fl., Dec. 12-17, 1983.

D. P. Neikirk, "Optically Controlled Coplanar Waveguide Millimeter Wave Phase Shifter," Tenth International Conference on Infrared and Millimeter Waves, Lake Buena Vista, Fl., Dec. 9-13, 1985.

D. P. Neikirk, "Picosecond Response of an Optically Controlled Millimeterwave Phase Shifter," Second Topical Meeting on Picosecond Electronics and Optoelectronics, Jan., 1987.

D. P. Neikirk, "Influence of Transit Time Effects on the Optimum Design and Maximum Oscillation Frequency of Quantum Well Oscillators," 12th International Conference on Infrared and Millimeter Waves, Dec. 14-18, 1987.

D. P. Neikirk, "Measurements of an Optically Controlled Coplanar Waveguide Phase-Shifter," 12th International Conference on Infrared and Millimeter Waves, Dec. 14-18, 1987.

D. P. Neikirk, "High Frequency Characterization of Tape-Automated Bonding Interconnects," 5th Annual Texas Regional Symposium, International Society of Hybrid Manufacturing, April 11, 1988.

D. P. Neikirk, "Time Dependent Simulation of the Quantum Well Injection Transit Time Diode," 13th International Conference on Infrared and Millimeter Waves, Dec. 5-9, 1988.

D. P. Neikirk, "Experimental Performance of a Periodically Illuminated Optically Controlled Coplanar Waveguide Phase Shifter," 13th International Conference on Infrared and Millimeter Waves, Dec. 5-9, 1988.

B. Invited Lectures

1. D. P. Neikirk, "Exotic Heterojunction Devices for Microwave Circuits," NSF Workshop on Future Research Opportunities in Electromagnetics, Arlington, TX., January 29-31, 1986.

2. D. P. Neikirk, "Optical Control of a Monolithic Millimeter Phase Shifter," ARO Workshop on Fundamental Issues in Millimeter and Submillimeter Waves, Los Angeles, Ca., Sept. 15-16, 1986.

3. Dean P. Neikirk, "Quantum Well Oscillators for Millimeter Wave Applications," 1987 Workshop on Compound Semiconductor Microwave Materials and Devices (WOCSEMMAD), Hilton Head Island, S.C., March 2-4, 1987.

4. S.M. Wentworth and D. P. Neikirk, "High Frequency Tape-Automated Bonding (TAB) Interconnect Characterization," IEEE 6th Annual VLSI and GaAs Packaging Workshop, Sept. 14-16, 1987.

5. D. P. Neikirk, "The quantum well injection transit time diode," Engineering Foundation Conference on Advanced Heterostructure Transistors, Keauhou-Kona, Hawaii, Dec. 5-10, 1988.

6. D. P. Neikirk, ""The High Frequency Characteristics of Tape Automated Bonding (TAB) Interconnects," presented to the Microelectronics and Computer Technology Corporation, April 19, 1989.

7. Dean P. Neikirk, "Impedance measurements of quantum well diodes for millimeter wave applications," 1990 Workshop on Compound Semiconductor Microwave Materials and Devices (WOCSEMMAD), San Francisco, CA., Feb. 12-14, 1990.

8. Dean P. Neikirk, "Twin-slot multi-layer substrate-supported antennas and detectors for terahertz imaging," First International Symposium on Space Terahertz Technology, University of Michigan, Ann Arbor, Mich., March 5-6, 1990.

9. Dean P. Neikirk, "Microwave and Millimeterwave Oscillators using Quantum Well Diodes," Joint IEEE MTT/ED Dallas Chapter meeting, Sept. 27, 1990.

10. Dean P. Neikirk, "Quantum Transport Simulations of Resonant Tunneling Diodes," 1991 Workshop on Compound Semiconductor Microwave Materials and Devices (WOCSEMMAD), Ft. Lauderdale, FL., Feb. 18-20, 1991.

11. Dean P. Neikirk, “The Application of Physics in Electrical Engineering (or is it Engineering in Physics?): Electromagnetics in Very High Frequency Semiconductor Devices,” Physics Colloquium, Oklahoma State University, March 5, 1992.

12. D. P. Neikirk and B. G. Streetman, "MBE growth of multilayer heterostructures for photonic and high-speed electronic devices," Engineering Foundation Conference on High Speed Optoelectronic Devices and Circuits II, Banff, Alberta, Canada, Aug. 9-13, 1992.

13. L. T. Pillage, D. P. Neikirk, and R. Mercer, "Design automation techniques and algorithms for application specific electronic modules (ASEMs)," ARPA Electronic Packaging & Interconnect Principle Investigator Meeting, Marina del Ray, CA, Feb. 14-18, 1994.

14. D. P. Neikirk, "Micro-sensors - What happens when you make classical devices small?: Integrated Bolometric Radiation Detectors," Texas Instruments, Dallas, Texas, Oct. 20, 1994.

15. Dean P. Neikirk, "Micromachined sensors," Motorola Sensors Steering Committee, Albuquerque, New Mexico, March 28, 1995.

16. D. P. Neikirk, E. Tuncer, and B.-T. Lee, "The Use of Effective Internal Impedance Approximations in Lossy Transmission Line Modeling," *Progress in Electromagnetics Research Symposium PIERS 95*, The Universtity of Washington, Seattle, Washington, July 28, 1995.

17. D. P. Neikirk, M. S. Islam, and E. Tuncer, "Accurate Quasi-Static Modeling of Transmission Lines on Semiconducting Substrates," *Progress in Electromagnetics Research Symposium PIERS 95*, The Universtity of Washington, Seattle, Washington, July 28, 1995.

18. D. P. Neikirk, "Impact of Finite Metal Conductivity on Inductance Extraction of Interconnects and Packages," Sematech meeting on Electrical Modeling Challenges Faced by Packaging Designers, Austin, Texas, Nov. 19, 1995.

19. D. P. Neikirk, "Micromachined Fabry-Perot Pressure Transducers," Hughes Research Laboratory, Malibu, California, Nov. 21, 1995.

20. D. P. Neikirk, "Classical Devices Made Small; or 'What's the big deal about little machines?'", Manufacturing 2000, University of Texas at Austin, Feb. 23, 1996.

21. D. P. Neikirk, "Interconnect Inductance Modeling from DC to the Skin Effect Limit," Quad Designs, Camarillo, CA, July 10. 1996.

22. D. P. Neikirk, "Efficient Conductor Boundary Conditions in the dc to Skin Effect Limit," DARPA MAFET Program Review, Fairfax, VA, Oct. 27-31, 1997.

23. Micromachined Array-based Multi-analyte Chemical Sensors: Towards the Fabrication of an "Electronic Tongue" South, Texas Local Section of The Electrochemical Society Meeting, April 17, 1999.

24. D. P. Neikirk, “Resonant Chemical Surveillance Tags,” IEEE Electron Device Chapter, Central Texas Section, September 25, 2008.

25. D.P. Neikirk, “Near Borehole Condition Sensing,” Nanotechnology Conference and Trade Show - Nanotech 2009, Houston, TX May 3-7, 2009, Nanotech & Cleantech for Oil & Gas Session, (Session chair: Sean Murphy, Advanced Energy Consortium), May 5, 2009.

26. D.P. Neikirk, “Integrated Threshold Nanosensor Systems,” Advanced Oil Consortium Microfabricated Sensors Workshop, Houston Research Center, Bureau of Economic Geology, University of Texas at Austin, September 8th-9th, 2010.

27. D. P. Neikirk, “Sensing systems for “harsh” environments,” Engineering Challenges for Deepwater Drilling at the “U.S. Offshore Oil Exploration: Managing Risks to Move Forward,” James A. Baker III Institute for Public Policy and PFC Energy, Rice University, Houston, TX, February 11, 2011.

C. Other Conference Presentations

Praveen Pasupathy, Mingxiang Zhuzhou, Shasi K. Munukutla, Dean P. Neikirk, and Sharon L. Wood, “Resonant Wireless Sensor Nets for Civil Infrastructure Health Monitoring,” 2009 National Science Foundation Division of Civil, Mechanical and Manufacturing Innovation (CMMI) Engineering Research and Innovation Conference, Honolulu, Hawaii, June 22-25, 2009.

Technical Consulting

Teltech Resource Network (1985-1993)
Ardex, Inc. (1986-88)
University and Polytechnic Grants Committee, Consultancy to examine Equipment Requirements for the Hong Kong University of Science and Technology, July, 1989
E. P. Hamilton Associates, (1987-90)
Burnett Company, Microwave Heating for Secondary Oil Recovery, July, 1990
Microelectronics and Computer Technology Corporation, June, 1990
Microelectronics and Computer Technology Corporation, Oct., 1994 - Sept., 1996
Baker-Hughes

University Committee Assignments

Departmental:

Graduate Student Financial Aid, Sept. 1984- Sept. 1987
Faculty Recruiting, Sept. 1984- Aug. 1985
Microelectronics Jr. Faculty Recruiting, Sept. 1985- Sept. 1987 (chairman)
ECE Safety Committee, Sept. 1985- Aug. 1993 (chairman, 1985-89)
ECE Electronics Shop Coordinating Committee, March 1986- Aug. 1993
Solid State Electronics Area Graduate Advisor, Aug. 1986- Aug. 89
ECE Space Allocation Committee, Sept. 1989-Aug. 1993 (chairman)
ECE Facilities Committee, Sept. 1993- Aug. 1996 (chairman)
ECE Areas Committee, Electromagnetics/Acoustics, Sept. 1993-present
ECE Ad Hoc Committee to Review the Undergraduate Curriculum, Jan. 1995- Aug. 1995
ECE World Wide Web Home Page Committee, Sept. 1995-Aug. 1996
ECE Ad Hoc Committee to Review the Undergraduate Curriculum, Jan. 1997- Aug. 1997
ECE Areas Committee, Materials and Quantum Electronics, Sept. 1993- present; chairman, Sept. 1996-present
Chair of ECE Graduate Studies Committee, May 1998-August 2006
ECE Chair's council, November 1999-2010
ECE Graduate Advisor, Sept. 1999- 2010
ECE Associate Chair, Sept. 2001-Dec. 2010
ECE peer Faculty Annual Review Committee, Sept. 2012-Aug. 2013

College:

Engineering Scholastic Appeals, Sept. 1984- Aug. 1985
Engineering Safety Committee, Sept. 1985- Aug. 1994 (chairman, Sept. 1989- Aug. 1994)

Aerospace Engineering Machine Shop, Sept. 1989-Aug. 1993
College Annual Report Quality Team, Jan. 1994- Aug. 1994
College Multimedia Committee, Sept. 1995-Aug. 2000
Equal Opportunity in Engineering (EOE) Program, 1995-Dec. 1996
Graduate Fellowship Review Committee, Sept. 2011-Aug. 2013

University:

Presidential Ad Hoc Committee on Research Infrastructure Enhancement, Jan. 1988 - Aug. 1994
Research Safety Advisory Committee, Oct. 1991-present (chairman, Sept. 1996-1999)
Ad Hoc Consultative Committee for the Selection of a Dean of the College of Engineering, Nov. 1995-May 1996
Faculty Building Advisory Committee, Sept. 1995-Aug. 2000; Aug. 2003-Aug. 2004
Ad Hoc Project Committee for Parking Garage # 4A, Sept. 1996-Aug. 2000
Faculty Council, Sept. 1996-Aug. 2000; Sept. 2002 - Aug. 2004
Faculty Advisory Committee on the Budget, Sept. 99 - Aug. 2000; Sept. 2008 – Aug. 2011 (vice chair Sept. 2009- Aug. 2010)
Graduate Assembly, April 1997- Aug. 2000; Sept. 2001 - Aug. 2008
Administrative sub-committee of GA, Sept. 1997-Aug. 1998; Sept. 2006-Aug. 2007
Academic sub-committee of GA, Sept. 1998-Aug. 2000; Sept. 2001-Aug. 2006; Sept. 2007-Aug. 2008
Chair, Graduate Assembly, 2004-2005
Academy of Distinguished Teachers selection committee, academic year 1999-2000
Outstanding Graduate Adviser selection committee, academic year 1999-2000
Outstanding Graduate Coordinator selection committee, academic year 1999-2000
Faculty Council, Sept. 2008 – Aug. 2012; Chair-elect Sept. 2009- Aug. 2010; Chair Sept. 2010- Aug. 2011; past chair: Sept. 2011-Aug. 2012
Faculty Council Executive Committee, Sept. 2009 – Aug. 2012
General Faculty Rules and Governance Committee, Sept. 2010 – Aug. 2015 (Chair, Sept. 2011 – Aug. 2013)
Ad Hoc Consultative Committee for the Selection of a Dean of the Graduate School, Nov. 2012 – Sept. 2012
Secretary of the General Faculty and Faculty Council, Sept. 2013 – Aug. 2015
Committee on Undergraduate Degree Program review, Sept. 2013 – Aug. 2015
Faculty Council Executive Committee, Sept. 2013 – Aug. 2015
Faculty Committee on Committees, *ex officio* member, Sept. 2013 – Aug. 2015

UT System:

Task Force on Doctoral Programs and Post-Doctoral Experience, Spring-Fall 2006

University of Texas System Faculty Advisory Council, Sept. 2009- Aug. 2011

State of Texas:

Texas Higher Education Coordinating Board Graduate Education Advisory Committee (GEAC), September 1, 2015 - August 31, 2018.

Evidence of Teaching Effectiveness

Senior Design Projects:

Umer Yousafzai and Venuka Jayatilaka, Spring 1994

Chris Eiting and Sonny Gonzalez, Spring 1994

David Lee and David Onsongo, Fall 1996

Dave Pyle and Aruna Murthy, Spring 1999

Hitesh Mehta and Edward Zhu, Spring 1999, “Giving the electronic tongue a sense of good taste: image analysis tools and GUI”

Gus Espinosa and Donnie Garcia, Spring 1999, “Design and Implementation of a Computer Interfacing Circuit to Control LED's for use with a Chemical Sensor”

Natthanant Pon Skulkaew and Prem Nainani, Spring 2001, “PC-based data acquisition and wireless transmission system”

Matthew Andringa and Allen Hall, Spring 2001, “Non-Invasive RFID Weld Inspection”

Michael Amalfitano and Sapun Parekh, Spring 2002, “Output circuitry for a transmitter used in an Electronic Structural Surveillance system”

Kunal Patel and Jacy Little, Spring 2002, “Swept, high frequency oscillator to work in an Electronic Structural Surveillance (ESS) system”

Dong Pak, Spring 2002, “Automated image-processing software of an electronic chemical sensor”

Rajesh Nerlikar, Jonathan Solomon, Spring 2003, “Wireless Data Acquisition System for Bluetooth-enabled RFID Readers”

Nola Li, Judith Chen, Maria Huang, Fall 2003, “Design and build a tuning network for a swept frequency reader used in structural health analysis”

Tuenlap (Daniel) Chan, Imranul Islam, Derek Choi, Spring 2004, “Design and build an RFID Interrogator Receiver”

John McKee and Terence Man, Spring 2007, “Improved Corrosion Sensors”

Abdulaziz Beayeyz , Sravan Bhagavatula, Rahul Mitra, Shasi Munukutla, Spyder Spann, Fall 2009, “Portable Corrosion Detector”

Jonathan Pham, Po-Han Wu, Josh Schulte, Pritesh Solanki, Mesele Bedasa, Spring 2011- Fall 2011, “Multi-Sensor Robotics Platform”

Raymund Lee, Simon Chow, Connor Landy, Kevin Woo, and Anirudh Kashyap, Fall 2012-Spring 2013, “Variable Frequency RFID Tag and Reader”

Javier Chacon, Joshua Poncik, Joshua Orozco, Sebastian Salomon, Yongcong Zou, Fall 2013-Spring 2014, “Environmental Sensor Monitoring Network”

Organized Classes Taught:

EE 363M Introduction to Microwaves, Spring 1984, # 16455
EE 396K VLSI Fabrication Techniques, Fall 1984, # 16255
EE 379K Integrated Circuit Fabrication, Spring 1985, # 16055
EE 396K VLSI Fabrication Techniques, Fall 1985, # 16275
EE 379K Integrated Circuit Fabrication, Fall 1985, # 16070
EE 396K VLSI Fabrication Techniques, Spring 1986, # 17680
EE 379K Integrated Circuit Fabrication, Spring 1986, # 17450
EE 396K VLSI Fabrication Techniques, Fall 1986, # 15245
EE 379K Integrated Circuit Fabrication, Fall 1986, # 15020
EE 396K VLSI Fabrication Techniques, Spring 1987, # 15205
EE 379K Integrated Circuit Fabrication, Spring 1987, # 14970
EE 396K VLSI Fabrication Techniques, Fall 1987, # 15010
EE 440 Integrated Circuit Fabrication, Fall 1987, # 14545
EE 363M Introduction to Microwaves, Spring 1988, # 14535
EE 396K VLSI Fabrication Techniques, Spring 1988, # 14865
EE 440 Integrated Circuit Fabrication, Spring 1988, # 14390
EE 396K VLSI Fabrication Techniques, Fall 1988, # 15165
EE 440 Integrated Circuit Fabrication, Fall 1988, # 14705
EE 363M Introduction to Microwaves, Spring 1989, # 14525
EE 396K VLSI Fabrication Techniques, Spring 1989, # 14855
EE 396K VLSI Fabrication Techniques, Fall 1989, # 15165
EE 440 Integrated Circuit Fabrication, Fall 1989, # 14705
EE 363M Introduction to Microwaves, Spring 1990, # 14050
EE 396K VLSI Fabrication Techniques, Spring 1990, # 14355, 14360
EE 440 Integrated Circuit Fabrication, Spring 1990, # 13915, 13920
EE 396K VLSI Fabrication Techniques, Fall 1990, # 14630, 14635
EE 440 Integrated Circuit Fabrication, Fall 1990, # 14200, 14205
EE 363M Introduction to Microwaves, Spring 1991, # 14365
EE 396K VLSI Fabrication Techniques, Spring 1991, # 14660, 14665, 14670
EE 440 Integrated Circuit Fabrication, Spring 1991, # 14220, 14225, 14230
EE 396K VLSI Fabrication Techniques, Fall 1991, # 14865, 14860
EE 440 Integrated Circuit Fabrication, Fall 1991, # 14425, 14430
EE 363M Introduction to Microwaves, Spring 1992, # 14270
EE 396K VLSI Fabrication Techniques, Spring 1992, # 14545, 14550, 14555
EE 440 Integrated Circuit Fabrication, Spring 1992, # 14130, 14135
EE 396K VLSI Fabrication Techniques, Fall 1992, # 15095, 15100, 15105
EE 440 Integrated Circuit Fabrication, Fall 1992, # 14670, 14675
EE 397K Microwave Devices, Spring 1993, # 14805
EE 396K VLSI Fabrication Techniques, Fall 1993, # 14800, 14805, 14810
EE 440 Integrated Circuit Fabrication, Fall 1993, # 14385, 14390
EE 363M Introduction to Microwaves, Spring 1994, # 14370
EE 396K VLSI Fabrication Techniques, Fall 1994, # 14365

EE 440 Integrated Circuit Fabrication, Fall 1994, # 13870
EE 397K Electromagnetics in Packaging, Spring 1995, # 14555
EE 396K VLSI Fabrication Techniques, Fall 1995, # 14765
EE 440 Integrated Circuit Fabrication, Fall 1995, # 14260
EE 397K Electromagnetics in Packaging, Spring 1996, # 14695
EE 382M Simulation Methods in CAD/VLSI, Spring 1996, # 14500
EE 396K VLSI Fabrication Techniques, Fall 1996, # 14535
EE 440 Integrated Circuit Fabrication, Fall 1996, # 14090
EE 382M Simulation Methods in CAD/VLSI, Spring 1997, # 14325
EE 363M Introduction to Microwaves, Spring 1997, # 14120
EE 396K VLSI Fabrication Techniques, Fall 1997, # 15315
EE 440 Integrated Circuit Fabrication, Fall 1997, # 14820
EE 363M Introduction to Microwaves, Spring 1998, # 14530
EE 397K Microwave Devices, Spring 1998, # 14950
EE 396K VLSI Fabrication Techniques, Fall 1998, # 15475
EE 440 Integrated Circuit Fabrication, Fall 1998, # 14965
EE 363M Introduction to Microwaves, Spring 1999, # 14825
EE 397K Microwave Devices, Spring 1999, # 15260
EE 396K VLSI Fabrication Techniques, Fall 1999, # 15340
EE 440 Integrated Circuit Fabrication, Fall 1999, # 14820
EE 363M Introduction to Microwaves, Spring 2000, # 14755
EE 396K VLSI Fabrication Techniques, Fall 2000, # 15600
EE 440 Integrated Circuit Fabrication, Fall 2000, # 15100
EE 397K Micro-electromechanical Systems (MEMS), Spring 2001, #15170
EE 396K VLSI Fabrication Techniques, Fall 2001, # 15725
EE 440 Integrated Circuit Fabrication, Fall 2001, # 15230
EE 397K Micro-electromechanical Systems (MEMS), Spring 2002, #15330
EE 396K VLSI Fabrication Techniques, Fall 2002, # 16050
EE 440 Integrated Circuit Fabrication, Fall 2002, # 15485
EE 397K Microwave Devices, Spring 2003, # 15110
EE 396K VLSI Fabrication Techniques, Fall 2003, # 15580
EE 440 Integrated Circuit Fabrication, Fall 2003, # 15095
EE 325 Electromagnetic Engineering, Spring 2004, # 14345
EE 396K VLSI Fabrication Techniques, Fall 2004, # 16250
EE 440 Integrated Circuit Fabrication, Fall 2004, # 15715
EE 396K 26-Microelectromechanical Systems, Spring 2005, # 15690
EE 396K VLSI Fabrication Techniques, Fall 2005, # 16455
EE 440 Integrated Circuit Fabrication, Fall 2005, # 15930
EE 396K VLSI Fabrication Techniques, Fall 2006, # 17040
EE 440 Integrated Circuit Fabrication, Fall 2006, # 16430
EE 325 Electromagnetic Engineering, Spring 2007, # 15765
EE 396K VLSI Fabrication Techniques, Fall 2007, # 17425
EE 440 Integrated Circuit Fabrication, Fall 2007, # 16770
EE 396K-26 Microelectromechanical Systems, Spring 2008, # 16815
EE 396K VLSI Fabrication Techniques, Fall 2008, # 17380
EE 325 Electromagnetic Engineering, Spring 2009, # 16000

EE 396K-24 Microwave Devices, Spring 2010, # 16975
EE 396K VLSI Fabrication Techniques, Fall 2010, # 17075, 17080, 17085, 17090
EE 440 Integrated Circuit Fabrication, Fall 2010, # 16540, 16545, 16550, 16555
EE 396K VLSI Fabrication Techniques, Fall 2011, # 17295, 17300, 17305, 17310
EE 440 Integrated Circuit Fabrication, Fall 2011# 16760, 16765, 16770, 16775
EE 396K 26-Microelectromechanical Systems, Spring 2012, #17070
EE 396K VLSI Fabrication Techniques, Fall 2012, # 17185, 17190, 17195, 17200
EE 440 Integrated Circuit Fabrication, Fall 2012, # 16640, 16645, 16650, 16665
EE 363M Introduction to Microwaves, Spring 2013, # 16605
EE 396K Ultra Large Scale Integrated Circuit Fabrication Techniques, Fall 2013, # 17425, 17430, 17435, 17440
EE 440 Integrated Circuit Nanomanufacturing Techniques, Fall 2013, # 16790, 16795, 16800, 16805
EE 396K-24 Microwave Devices. Spring 2014, #17440
EE 396K Ultra Large Scale Integrated Circuit Fabrication Techniques, Fall 2014, #17525, 17530, 17535, 17540
EE 440 Integrated Circuit Nanomanufacturing Techniques, Fall 2014, #16960, 16965, 16970, 16975
EE 363M Microwave and Radio Frequency Engineering, Spring 2015, #16355
EE 396K Ultra Large Scale Integrated Circuit Fabrication Techniques, Fall 2015, #16965, 16970, 16975
EE 440 Integrated Circuit Nanomanufacturing Techniques, Fall 2015, #16480, 16485, 16490
EE 363M Microwave and Radio Frequency Engineering, Spring 2016, #16550
EE 396K Ultra Large Scale Integrated Circuit Fabrication Techniques, Fall 2016
EE 440 Integrated Circuit Nanomanufacturing Techniques, Fall 2016
EE 396K 26-Microelectromechanical Systems, Spring 2017
EE 363M Microwave and Radio Frequency Engineering, Spring 2018, #15890

Continuing Education Courses Taught

"Microelectronics Fabrication - Chemical Aspects," with Isaac Trachtenberg, Continuing Engineering Studies, College of Engineering, The University of Texas at Austin, June 1-4, 1987.

"Integrated Circuit Process & Design," with M. R. Mercer, Motorola short course, Continuing Engineering Studies, College of Engineering, The University of

Texas at Austin:
- Aug.-Sept., 1987
- Nov.-Dec., 1987
- Nov.-Dec., 1988
- March-April, 1989
- Aug.-Sept., 1989
- Nov.-Dec., 1989
- Feb.-March, 1990
- April, 1990
- Aug., 1990

"Integrated Circuit Processing and Design," with L. T. Pillage, Advanced Micro Devices short course, Continuing Engineering Studies, College of Engineering, The University of Texas at Austin:
- Oct.-Nov., 1990
- June-July, 1991

"Microelectronics Fabrication," for the Fellows of the Senior Service College Fellowship Program, Continuing Engineering Studies, College of Engineering, The University of Texas at Austin, yearly 1993-2003.

Cases: Dean P. Neikirk
Trial experience: five jury trials (Federal District Court); two ITC bench trials; two California State Court trials (trade secrets)
Expert reports: over 40
Depositions: over 30

1. Jan. 2003-June 2003: Vinson & Elkins, counsel for International Rectifier, Patent infringement case: Hitachi Ltd., et. al. v. International Rectifier
Corporation, in the United States District Court for the Central District of California, Case No. CV-02-0077-R; [no testimony or depositions]
Semiconductor / IC processing

2. August 2003-August 2004: Wilmer Cutler Pickering Hale and Dorr LLP, counsel for Analog Devices, patent infringement case: Motorola, Inc. v. Analog Devices, Inc. TX Eastern - Beaumont Civil Action No. 1:03-cv-131 (RHC); case settled [three depositions]
Semiconductor / IC processing

3. April 2004-March 2005: Fish & Richardson P.C., counsel for Micron, patent infringement case: Micron Technology, Inc. adv. Motorola, Inc. USDC-W.D. TX (Austin) - Civil Action No. A04 CA 007; case settled [no testimony or depositions]
Semiconductor / IC processing

4. Jan 2004- July 2004: Howrey Simon Arnold & White, counsel for ASM in patent litigation with Applied Materials; case settled [no testimony or depositions]
Semiconductor processing equipment

5. May 2004-Dec. 2006: Vinson & Elkins, counsel for Advanced Micro Devices, patent infringement case: Advanced Micro Devices, Inc. v Oki America, Inc., et al.
Originally TX Eastern District Marshall, Civil action No. 2:03-CV-373, transferred to Northern California; case settled [depositions and expert reports]
Semiconductor / IC processing

6. April 2004-May 2006: Fish & Richardson P.C., counsel for AVID Identification Systems, patent infringement case: Avid v. Crystal Import Corporation, et al., USDC-EDTX Marshall Div. Case No. 2:04-cv-183; [depositions and expert reports; jury trial May 2006]
RFID

7. November 2005 – 2006: Keker & Van Nest, LLP, counsel for Intel, patent infringement case: Ohmi v. Intel Corp., et al.- 2:05CV-209 TJW [no testimony or depositions].
Semiconductor / IC processing

8. July 2006 – March 2007: Fish & Richardson P.C., counsel for Applied Materials, patent infringement case: Semiconductor / IC processing SEZ Holdings AG, et al. vs. Applied Materials, Inc. USDC-D. Del. - C.A. No. 05-552-SL; case settled [expert report submitted, otherwise no depositions or testimony]; case settled

Semiconductor / IC processing

9. July 2006 – May 2007: Kenyon & Kenyon, counsel for FCI; patent infringement case: FCI USA, Inc. v. Tyco Electronics, Case No. 2:06cv128; case settled [no testimony or depositions]
Printed circuit board connector design

10. January 2007 – Dec. 2007: Vinson & Elkins, counsel for Lutron Electronics Co., Inc. in ITC matter Lutron Electronics Co. vs. Leviton Manufacturing Co., Inc., United States International Trade Commission, Honorable Carl C. Charneski, Investigation No. 337-TA-599, In the matter of certain lighting control devices including dimmer switches and/or switches and parts thereof. [no testimony or depositions]; case closed
RF lighting controls

11. February 2007 – Dec. 2007: LATHAM & WATKINS LLP counsel for FLIR Systems, Inc and Indigo Systems Corp. (plaintiff) v. William Parrish, E. Timothy Fitzgibbons, Superior Court of the State of California, County of Santa Barbara, case no. 1220581. [expert report, deposition; trial testimony]
Infrared sensors

12. May 2007 – Feb. 2008: Vinson & Elkins L.L.P., on behalf of Silicon Labs ("SiLabs") in connection with Analog Devices, Inc., Plaintiff, v. Silicon Laboratories, Inc., Defendant, United States District Court, District of Massachusetts, Civil Action No. 06-12240 (WGY) [expert reports, deposition]; case settled
Digital isolators

13. November 2006 – January 2010: Jones Day, counsel for Sercel, Input/Output, Inc., et al. v. Sercel, Inc., Case No. 5:06-CV-236-DF/CMC, [deposition; trial testimony (jury trial)]; trial January 2010, July 2010.
MEMS sensors and fabrication

14. February 2007 – Dec 2008: Vinson & Elkins, counsel for Lutron Electronics Co., Inc. in *Lutron Electronics Co., Inc. vs. CONTROL4 Corp. Case No. 2:06-CV-00401 DAK, US District Court, District of Utah* ; case settled [deposition].
RF lighting controls

15. June 2007 – July 2011: Kirkland & Ellis LLP, counsel for AVID, in Allflex USA, Inc. v. AVID Identification Systems, Inc., UNITED STATES DISTRICT COURT CENTRAL DISTRICT OF CALIFORNIA Case No. EDCV-06-1109-SGL (OPx) [declaration, expert report]
RFID

16. January 2008 – May 2009: Gibbs & Bruns, L.L.P., counsel for LONESTAR INVENTIONS, L.P., Plaintiff, v. NINTENDO OF AMERICA, INC., Defendant, UNITED STATES DISTRICT COURT FOR THE EASTERN DISTRICT OF TEXAS,TYLER DIVISION, CASE NO. 6:07-CV-261-LED; case settled [deposition].
Semiconductor devices.

17. May 2008 – Dec 2009: Heller Ehrman LLP, counsel for Maxim Integrated Products, Inc. v. Freescale Semiconductor, Inc., United States District Court, Northern District of California, Case No.: 3:08-cv-00979-BZ [no depositions or testimony]
Semiconductor / IC processing / electronic packaging

18. January 2008 – November 2008: Gibbs & Bruns, L.L.P., counsel for LONESTAR INVENTIONS, L.P., Plaintiff, v. SANDISK CORPORATION, Defendant, UNITED STATES DISTRICT COURT FOR THE EASTERN DISTRICT OF TEXAS,TYLER DIVISION, CASE NO. 6:07-CV-374; LONESTAR INVENTIONS, L.P., Plaintiff, v. XILINX, INC., Defendant, UNITED STATES DISTRICT COURT FOR THE EASTERN DISTRICT OF TEXAS,TYLER DIVISION, CASE NO. 6:07-CV-0393-LED. Case settled.
Semiconductor devices.

19. November 2008 – April 2009: Wilson Sonsini Goodrich & Rosati, counsel for Luna Innovations, Incorporated, in Hansen Medical, Inc. v. Luna Innovations, Incorporated, Superior Court of the State of California County of Santa Clara Case No. 107 CV 088551.[expert report; deposition; trial testimony]
Optical devices.

20. February 2009 – Dec 2009: Finnegan, Henderson, Farabow, Garrett & Dunner, L.L.P., Fish & Richardson P.C., Howrey LLP, Kenyon & Kenyon, LLP, and Hartline, Dacus, Barger, Dreyer & Kern, L.L.P. (collectively, “Defendants’ Counsel”) representing Audi/VW, BMW, Hyundai/Kia, Isuzu, Nissan, Porsche, and Subaru (collectively, the “Defendant Companies”) in MHL TEK, LLC v. Nissan Motor Company, et al., Civil Action No. 2:07-cv-00289, U.S. District Court for the Eastern District of Texas. Summary judgment of non-infringement [two expert reports; one deposition]
Pressure sensors

21. January 2010 – April 2010: King & Spalding LLP, counsel for Spansion in Complaint in United States International Trade Commission Investigation No. 337-TA-664, respondents Samsung, Apple, Hon Hai Precision Industry, Asus, Kingston, Lenovo, PNY, Research In Motion, Sony, Beijing SE Putian Mobile Communication Co, Transcend, Verbatim. [one deposition]
Semiconductor devices.

22. December 2010-April 2011: Thompson & Knight LLP, counsel for STMicroelectronics, Inc. (ST) in ST v. Avago, Civil Action No. 3:10-cv-1460, United States District Court, Northern District of Texas, Dallas Division.
Semiconductor devices.

23. October 2010-June 2011: McDermott Will & Emery, counsel for Spansion in Spansion LLC v. Samsung Electronics Co. Civil Action No. 08-855 (D. Del.).
[Case settled]
Semiconductor devices.

24. October 2010-June 2011: McDermott Will & Emery, counsel for Spansion in Spansion, LLC, et al. v. Samsung Electronics Co., et al., Civil Action Nos. 3:10-cv-453 and 3:1O-cv-685 (W.D. Wisc.).
[Case settled]
Semiconductor devices.

25. June 2007-July 2011: Kirkland & Ellis LLP, counsel for AVID in Allflex USA, Inc. v. AVID Identification Systems, Inc., UNITED STATES DISTRICT COURT CENTRAL DISTRICT OF CALIFORNIA Case No. EDCV-06-1109-SGL (OPx) [expert reports]
[Case settled]
RFID tags.

26. August 2011- September 2011: Patterson & Sheridan, LLP, counsel for Silicon Laboratories, Case No. 1:10-cv-0607-LY; Silicon Laboratories, Inc. v. Airoha Technology Corp.; In the United States District Court for the Western District of Texas
[case settled]
Semiconductor devices.

27. March-April 2012-: Fish & Richardson P.C., counsel for Cypress Semiconductor Corporation in Commonwealth Research Group, LLC v. Microchip Technology Incorporated, et al., USDC-D. Del. – C.A. No. 11-655-RGA
[case closed]
Semiconductor devices.

28. September 2010 – December 2013: Vinson & Elkins and Hatch, James, & Dodge, counsel for Lutron Electronics Co., Inc. in *Lutron v. Crestron, et at., Case No. 2:09cv707, pending in the United States District Court for Utah*; [expert reports; two depositions].
[case settled]
RF lighting controls

29. March 2011-August 2012: SNR Denton US LLP, counsel for Kilopass Technology, Inc. in Kilopass Technology, Inc. v. Sidense Corporation -- Case No. 3:10-CV-02066-SI, Northern District of California (San Francisco Division). [three expert reports, one deposition]
[Summary judgment, case closed]
Semiconductor devices.

30. April 2011- August 2012: Alston & Bird counsel for X2Y Attenuators, LLC ("X2Y") in the Matter of CERTAIN MICROPROCESSORS, COMPONENTS THEREOF, AND PRODUCTS CONTAINING SAME, International Trade Commission Investigation No. 337-TA-781, X2Y v. Intel Corporation. [two expert reports; deposition; ITC trail August 2012]
Semiconductor packaging.

31. July 2012 – September 2013: Vinson & Elkins L.L.P. counsel for Silicon Laboratories, in SILICON LABORATORIES INC., Plaintiff, vs. MAXLINEAR, INC., Defendant Case No. 3:12CV1765-WQH-WVG UNITED STATES DISTRICT COURT SOUTHERN DISTRICT OF CALIFORNIA, SAN DIEGO. [expert report; deposition]
[case settled]

RF ICs

32. February 2012 – October 2013: Haynes and Boone, LLP, counsel for L-3, in L-3 COMMUNICATIONS CORPORATION, Plaintiff/Counterclaim Defendant, v. SONY CORPORATION, SONY ELECTRONICS INC. and SONY ERICSSON MOBILE COMMUNICATIONS (USA) INC., Defendants/Counterclaim Plaintiffs., C.A. No. 10-734-RGA IN THE UNITED STATES DISTRICT COURT FOR THE DISTRICT OF DELAWARE. [expert reports; depositions; jury trial October 2013]
Inage sensors

33. February 2013-October 2013: McKool Smith, counsel for Ericsson, Inc., in the Matter of CERTAIN WIRELESS COMMUNICATIONS EQUIPMENTAND ARTICLES THEREIN, Investigation No. 337-TA-866 in UNITED STATES INTERNATIONAL TRADE COMMISSION. [expert reports; ITC trial October 2013]
Microwave amplifiers

34. January 2013-March 2013: Finnegan, Henderson, Farabow, Garrett & Dunner, L.L.P., counsel for Axis Communications AB and Axis Communications, Inc. in the case of patent infringement litigation and inter partes review proceedings, Network-l Security Solutions Inc. v. Alcatel-Lucent USA Inc., et al., No. 6:11-cv-00492-LED-JDL and Sony Corporation of America; Axis Communications AB; and Axis Communications, Inc. v. Patent of Network-l Security Solutions, Case IPR2013-00092. [case inactive pending IPR]

35. April 2013- August 2013: Alston & Bird LLP, counsel for AmTran, in the matter of Freescale v. Vizio (Defendants Amtran Technology Co., Ltd., Amtran Logistics, Inc., Vizio, Inc. , MediaTek, Inc., Zoran Corporation, CSR Technology, Inc. Sanyo Electric Co., Ltd., Sanyo North America Corporation, Sanyo Manufacturing Corporation, TPV Technology Limited TPV International (USA) Inc., Top Victory Electronics Co., Ltd., Envision Peripherals, Inc., Marvell Semiconductor, Inc.) Case No. A-12-CV-644-LY.

36. February 2013-February 2014: Quinn Emanuel, counsel for STMicroelectronics, in the matter of STMICROELECTRONICS, INC., Plaintiff, vs. INVENSENSE, INC., Defendant, UNITED STATES DISTRICT COURT NORTHERN DISTRICT OF CALIFORNIA SAN FRANCISCO DIVISION, CASE NO. 12-CV-2475-JSW [expert reports]
[case settled]
MEMS accelerometers

37. November 2012 – August, 2013: Haynes and Boone, LLP, counsel for Xilinx, Inc., in the matter of the Inter Partes Review of Patent 7,566,960 Title: INTERPOSING STRUCTURE, before the UNITED STATES PATENT AND TRADEMARK OFFICE BEFORE THE PATENT TRIAL AND APPEAL BOARD, INTELLECTUAL VENTURES MANAGEMENT, LLC, Petitioner, v. Patent of XILINX, INC., Patent Owner, Case IPR2012-00018. [expert report; deposition]
IC packaging

38. May 2014 – December 2014: Taylor Dunham and Rodriguez LLP, counsel for Andrew Katrinecz and David Byrd, in Civil Action No. 1:12-cv-235-LY, Andrew Katrinecz and David

Byrd v. Motorola Mobility LLC, in the United States District Court for the Western District of Texas, Austin Division, [expert reports, deposition] [expert report; deposition] [case settled].
Data entry devices

39. February 2015 – February 2016: Ropes & Gray, counsel for Samsung Electronics, in in Civil Action No. 4:14-cv-00371 (E.D. Tex.), Imperium IP Holdings (Cayman), Ltd. v. Samsung Electronics Co., Ltd., Samsung Electronics America, Inc., Samsung Telecommunications America, LLC, and Samsung Semiconductor, Inc. [expert report; deposition; jury trial]
Cell phone cameras

40. March 2015 – September 2015: Baker Botts LLP, on behalf of Dell, in Certain Electronic Products, Including Products with Near-Field Communication ("NFC") System-Level Functionality and/or Battery Power-up Functionality, Components thereof, and Products Containing Same 337-TA-950 (International Trade Commission) and NXP B.V. v. Dell Inc., 1:14-cv-00146-UNA [case settled]
laptop power and data communications

41. March 2015 – September 2015: Baker Botts LLP, in Inter Partes Review of U.S. Patents 7412230, 6590365, 8065389, 8204959.

42. October 2015 – December 2015: Baker Botts LLP, in Inter Partes Review of U.S. Patent 7,926,978, "Light Set with Surface Mounted Light Emitting Components" by Kenneth Tsai, owned by Real Bonus Ltd. [declaration]
String LED lights

43. January 2013 – November 2017: Finnegan, Henderson, Farabow, Garrett & Dunner, L.L.P., on behalf of Axis Communications AB and Axis Communications, and McDermott Will & Emery on behalf of Hewlett-Packard, in Network-1 Technologies Inc. v. Alcatel-Lucent USA Inc., et al., No. 6:11-cv-00492-RWS-KNM and Network-1 Technologies Inc. v. Axis Communications AB., et al., No. 6:13-cv-00080-RWS-KNM. Trial 11/6/17 - 11/13/17. [jury trial]
Power over Ethernet

44. November 2015 – July 2016: DLA Piper LLP on behalf of Samsung Electronics Co., Ltd., Samsung Electronics America, Inc. and Samsung Telecommunications America, LLC, in UNITED STATES INTERNATIONAL TRADE COMMISSION, In the Matter of CERTAIN RF CAPABLE INTEGRATED CIRCUITS AND PRODUCTS CONTAINING THE SAME, Investigation No. 337-TA-982 [reports] [case settled]
RF mixers

45. February 2016: Baker & Hostetler on behalf of Sony, in Raytheon Company v. Sony Corporation, et al., C.A. No. 2:15-cv-342 (E.D. Tex.) and Raytheon Company v. Samsung Electronics Co., Ltd., et al., C.A. No. 2-15-cv-00341 (E.D. Tex.). [case closed]
Cell phone cameras

46. October-November 2016: Baker & McKenzie LLP on behalf of Continental Automotive, in IN THE UNITED STATES DISTRICT COURT FOR THE EASTERN DISTRICT OF MISSOURI,

WATLOW ELECTRIC MANUFACTURING COMPANY Plaintiff, v. CONTINENTAL AUTOMOTIVE SYSTEMS, INC. and CONTINENTAL AUTOMOTIVE SYSTEMS US, INC. Defendants. [case closed]

47. Sept. 2016 – May 2017: Alston & Bird on behalf of Nokia in ITC action In the Matter of Certain Electronic Devices, Including Mobile Phones, Tablet Computers and Components Thereof, Inv. No. 337-TA-1039. [case settled]

48. Dec. 2016 – August 2017: Jones Day on behalf of Bio-Rad Laboratories in Thermo Fisher Scientific Inc. v. Bio-Rad Laboratories. Inc. CIPR2017-00054 and IPR2017-00055, and Bio-Rad Laboratories, Inc. v. Thermo Fisher Scientific Inc. (1:17-cv-00469-RGA, USDC - Wilmington, DC). [declaration, deposition]

49. March 2017: Baker Botts L.L.P. on behalf of AMD. [related to ASETEK DANMARK A/S, Plaintiff, VS. CMI USA, INC., fka COOLER MASTER USA, INC., Defendant]

50. April 2017 – present: Baker & Hostetler LLP, on behalf of Renesas Electronics Corp., in Lone Star Silicon Innovations LLC v. Renesas Electronics Corp., et al. (E.D. TX), and associated IPRs. [declarations and depositions]

51. October 2017: Dorsey & Whitney LLP on behalf of Global Foundries.

52. September 2017 – September. 2018: Bunsow De Mory Smith & Allison LLP on behalf of VLSI Technology LLC.

53. June 2018 – Nov. 2018: O'Melveny & Myers LLP on behalf of Samsung in Certain Wafer-Level Packaging Semiconductor Devices and Products Containing Same (Including Cellular Phones, Tablets, Laptops, and Notebooks) and Components Thereof, ITC No. 337-3262; Tessera Advanced Techs., Inc. v. Samsung Elecs. Co., Ltd., et al., No. 2:17-cv-00671 (E.D. Tex.); Tessera Advanced Techs., Inc. v. Samsung Elecs. Am., Inc., et al., No. 2:17-cv-07621 (D.N.J.); Invensas Corp. v. Samsung Elecs. Co., Ltd., et al., No. 2:17-cv-00670 (E.D. Tex.); Invensas Corp. v. Samsung Elecs. Co., Ltd., et al., No. 1:17-cv-01363 (D. Del.); Invensas Bonding Techs., Inc. v. Samsung Elecs. Am., Inc., et al., No. 1:17-cv-07609 (D.N.J.); FotoNation Ltd. et al. v. Samsung Elecs. Co., Ltd., et al., No. 2:17-cv-00669 (E.D. Tex.). [case settled]

54. October 2018 – present: Irell & Manella LLP on behalf of VLSI Technology LLC. [IPRs] [semiconductor devices, processing, and packaging]

55. March 2019 – present: Alston & Bird LLP, on behalf of Cellco Partnership d/b/a Verizon Wireless in FRACTUS, S.A., Plaintiff, v. AT&T MOBILITY LLC, Defendant. SPRINT COMMUNICATIONS COMPANY, L.P., ET AL., Defendants. T-MOBILE US, INC. ET AL., Defendants. VERIZON COMMUNICATIONS INC. ET AL., Defendants. [reports, deposition]

56. Dec. 2018- present: Fish & Richardson P.C., on behalf of Wasica Finance

GMBH and Bluearc Finance AG in WASICA FINANCE GMBH and BLUEARC FINANCE AG, Plaintiffs, v. SCHRADER INTERNATIONAL, INC. and SCHRADER-BRIDGEPORT INTERNATIONAL, INC., Defendants, C.A. No. 13-1353-LPS. [reports, deposition] [TPMS]

APPENDIX B (LIST OF MATERIALS CONSIDERED)

Ex. 1001	U.S. Patent No. 6,982,740 ("'740 patent")
Ex. 1002	File History of U.S. Patent No. 6,982,740 ("'740 Patent File History")
Ex. 1003	File History of U.S. Patent No. 6,043,839 ("'839 Patent File History")
Ex. 1005	WO Application Publication No. 95/34988 ("Swift")
Ex. 1006	U.S. Patent No. 5,835,141 ("Ackland")
Ex. 1007	U.S. Patent No. 5,919,130 ("Monroe")
Ex. 1009	U.S. Patent No. 4,700,219 ("Tanaka")
Ex. 1010	U.S. Patent No. 6,243,131 ("Martin")
Ex. 1011	U.S. Patent No. 5,814,803 ("Olmstead")
Ex. 1012	U.S. Patent No. 6,002,424 ("Rapa")
Ex. 1015	U.S. Patent No. 5,233,426 ("Suzuki")
Ex. 1017	Plaintiff Cellect LLC's Amended and Supplemental Objections and Responses to Defendants Samsung Electronics Co., Ltd., and Samsung Electronics America, Inc.'s Interrogatory No. 2
Ex. 1018	WO Application Publication No. 99/18613 ("Adair")
Ex. 1019	U.S. Patent Application No. 09/586,768
Ex. 1020	U.S. Patent Application No. 09/368,246
Ex. 1021	Japanese Patent No. JPH07275198 with Certified English Translation ("Tomoyasu")
Ex. 1022	U.S. Patent Application No. 08/976,976

Ex. 1023	Redline comparison of ’740 patent specification and claims and Adair specification and claims
Ex. 1024	U.S. Patent No. 4,377,742 (“Kawabata”)
Ex. 1025	U.S. Patent No. 6,005,613 (“Endsley”)
Ex. 1027	U.S. Patent No. 5,903,706 (“Wakabayashi”)
Ex. 1033	Ricquier, N., *et al.* “CIVIS sensor: a flexible smart imager with programmable resolution,” Charge-Coupled Devices and Solid State Optical Sensors IV. Vol. 2172. International Society for Optics and Photonics, 1994. (“Ricquier SPIE”)
Ex. 1038	Ricquier, Nico, *et al.* “CIVIS sensor: a flexible smart imager with programmable resolution,” Charge-Coupled Devices and Solid State Optical Sensors IV. Vol. 2172. International Society for Optics and Photonics, 1994 (“Ricquier”)
Ex. 1039	Excerpts from Plaintiff Cellect’s Infringement Contentions Cover Document (“PO’s Infringement Contentions”)
Ex. 1040	Exemplary chart from Cellect’s Infringement Contentions for the ’740 patent
Ex. 1042	Hurwitz, *et al.*, “An 800K-Pixel Color CMOS Sensor For Consumer Still Cameras” (“Hurwitz”)
Ex. 1043	U.S. Patent No. 5,837,994 (“Stam”)
Ex. 1044	U.S. Patent No. 5,221,964 (“Chamberlain”)
Ex. 1045	Charles Hamilton, A Guide to Printed Circuit Board Design (1984)

Ex. 1046	Hurwitz, *et al.*, "An 800K-Pixel Color CMOS Sensor For Consumer Still Cameras" ("Hurwitz Cornell")
Ex. 1047	Hurwitz, et al., "An 800K-Pixel Color CMOS Sensor For Consumer Still Cameras" ("Hurwitz SPIE")
Ex. 1060	"NASA's Tiny Camera Has A Wide-Angle Future," Business Week (March 6, 1995)
Ex. 1085	U.S. Patent No. 5,859,878 ("Phillips")

* I also considered any additional materials referenced in my declaration.