

UNITED STATES PATENT AND TRADEMARK OFFICE

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**BEFORE THE PATENT TRIAL AND APPEAL BOARD**

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SAMSUNG ELECTRONICS CO., LTD.  
AND SAMSUNG ELECTRONICS AMERICA, INC.,  
Petitioners

v.

NEODRON LTD,  
Patent Owner.

**EXPERT DECLARATION OF DR. ANDREW WOLFE  
IN SUPPORT OF SAMSUNG ELECTRONICS CO., LTD.  
AND SAMSUNG ELECTRONICS AMERICA, INC.'S  
PETITION FOR *INTER PARTES* REVIEW  
OF U.S. PATENT NO. 7,821,502**

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**LIST OF EXHIBITS**

<b>Exhibit No.</b>	<b>Description</b>
1001	U.S. Patent No. 7,821,502
1003	Curriculum Vitae of Dr. Andrew Wolfe
1004	U.S. Patent No. 3,757,322 (“Barkan”)
1005	U.S. Patent Publication No. 2006/0017701 (“Marten”)
1006	U.S. Patent No. 5,463,388 (“Boie”)
1007	U.S. Patent Publication No. 2003/0067451 (“Tagg”)
1008	Prosecution History for U.S. Patent Application No. 11/428,670

I, Andrew Wolfe, declare as follows:

**I. INTRODUCTION**

1. I have prepared this Declaration in connection with Samsung Electronics America, Inc. and Samsung Electronics Co., Ltd.'s (collectively, "Petitioners") Petition for *Inter Partes* Review of U.S. Patent No. 7,821,502 ("the '502 Patent") (Ex. 1001), which I understand is to be filed concurrently with this Declaration.

2. In the course of preparing this Declaration, I reviewed the '502 Patent as well as its prosecution file history. I understand that the claims at issue in this proceeding are Claims 1-21. Claims 1 and 17 are independent, with Claims 2-16 and 18-21 depending from those claims, respectively. In addition to the '502 Patent, I have also reviewed the documents discussed in this Declaration.

**II. EXPERIENCE AND QUALIFICATIONS**

3. My professional qualifications, experience, publications and presentations, and a listing of previous cases in which I have provided expert testimony are set forth in my CV, attached as Exhibit 1003. I am being compensated at my usual rate of \$600 per hour for work on this case. My compensation is in no way related to the outcome of this case.

4. I am the founder and sole employee of Wolfe Consulting. Through Wolfe Consulting, I provide technical and business analysis to businesses on

processor technology, computer systems, consumer electronics, software, design tools, data security, cryptography and intellectual property issues. I have more than thirty years' experience developing products, researching, consulting, and teaching in those fields. In that time, I have worked as a computer architect, computer system designer, and as an executive in the PC and electronics business. I have also taught at some of the world's leading institutions in those fields, including Stanford University, Princeton University, Carnegie Mellon University, and Santa Clara University.

5. In 1985, I earned the B.S.E.E. degree in Electrical Engineering and Computer Science from The Johns Hopkins University. In 1987, I received the M.S. degree in Electrical and Computer Engineering from Carnegie Mellon University and in 1992, I received the Ph.D. degree in Computer Engineering from Carnegie Mellon University. My doctoral dissertation proposed a new approach for the architecture of a computer processor.

6. In 1983, I began designing touch sensors, microprocessor-based computer systems, and I/O (input/output) cards for personal computers as a senior design engineer for Touch Technology, Inc. During the course of my design projects with Touch Technology, I designed I/O cards for PC-compatible computer systems, including the IBM PC-AT, to interface with interactive touch-based computer terminals that I designed for use in public information systems. I

continued designing and developing related technology as a consultant to the Carroll Touch division of AMP, Inc., where in 1986 I designed one of the first custom touch-screen integrated circuits. I designed the touch/pen input system for the Linus WriteTop, which many believe to be the first commercial tablet computer. The Linus WriteTop included handwriting recognition.

7. From 1986 through 1987, I designed and built a high-performance computer system as a student at Carnegie Mellon University. From 1986 through early 1988, I also developed curriculum, and supervised the teaching laboratory, for processor design courses.

8. In the latter part of 1989, I worked as a senior design engineer for ESL-TRW Advanced Technology Division. While at ESL-TRW, I designed and built a bus interface and memory controller for a workstation-based computer system, and also worked on the design of a multiprocessor system.

9. At the end of 1989, I (along with some partners) reacquired the rights to the technology I had developed at Touch Technology and at AMP, and founded The Graphics Technology Company. Over the next seven years, as an officer and a consultant for The Graphics Technology Company, I managed the company's engineering development activities and personally developed dozens of touch screen sensors, controllers, and interactive touch-based computer systems.

10. I have consulted, formally and informally, for a number of fabless semiconductor companies. In particular, I have served on the technical advisory boards for two processor design companies: BOPS, Inc., where I chaired the board, and Siroyan Ltd., where I served in a similar role for three networking chip companies—Intellon, Inc., Comsilica, Inc., and Entridia, Inc.—and one 3D game accelerator company, Ageia, Inc.

11. I have also served as a technology advisor to Motorola and to several venture capital funds in the U.S. and Europe. Currently, I am a director of Turtle Beach Corporation, providing guidance in its development of premium audio peripheral devices for a variety of commercial electronic products.

12. From 1991 through 1997, I served on the Faculty of Princeton University as an Assistant Professor of Electrical Engineering. At Princeton, I taught undergraduate and graduate-level courses in Computer Architecture, Advanced Computer Architecture, Display Technology, and Microprocessor Systems, and conducted sponsored research in the area of computer systems and related topics. From 1999 through 2002, I taught the Computer Architecture course to both undergraduate and graduate students at Stanford University multiple times as a Consulting Professor. At Princeton, I received several teaching awards, both from students and from the School of Engineering. I have also taught advanced microprocessor architecture to industry professionals in IEEE and ACM



sponsored seminars. I am currently a lecturer at Santa Clara University teaching courses on Computer Organization and Architecture and Mechatronics.

13. From 1997 through 2002, I held a variety of executive positions at a publicly held fabless semiconductor company originally called S3, Inc. and later called Sonicblue Inc. I held the positions of Chief Technology Officer, Vice President of Systems Integration Products, Senior Vice President of Business Development, and Director of Technology, among others. During my time at SonicBlue, we launched more than 30 new consumer electronics products.

14. I served as a board member and technical advisor at KBGear Inc. from 1999-2001. KBGear Inc. designed and produced digital cameras and music players.

15. I have published more than fifty peer-reviewed papers in computer architecture and computer systems design. I have also chaired IEEE and ACM conferences in microarchitecture and integrated circuit design. I am a named inventor on at least 56 U.S. patents and 30 foreign patents.

16. I have been the invited keynote speaker at the ACM/IEEE International Symposium on Microarchitecture and at the International Conference on Multimedia. I have also been an invited speaker on various aspects of technology or the PC industry at numerous industry events including the Intel Developer's Forum, Microsoft Windows Hardware Engineering Conference,

Microprocessor Forum, Embedded Systems Conference, Comdex, and Consumer Electronics Show as well as at the Harvard Business School and the University of Illinois Law School. I have been interviewed on subjects related to technology and the electronics industry by publications such as the Wall Street Journal, New York Times, LA Times, Time, Newsweek, Forbes, and Fortune as well as CNN, NPR, and the BBC. I have also spoken at dozens of universities including MIT, Stanford, University of Texas, Carnegie Mellon, UCLA, University of Michigan, Rice, and Duke.

### **III. RELEVANT LEGAL STANDARDS**

17. I am not an attorney. For the purposes of this Declaration, I have been informed about certain aspects of the law that are relevant to my opinions and asked to apply the law as stated herein. My understanding of the law is summarized below.

18. I have been informed and understand that claim construction is a matter of law and that the final claim constructions for this proceeding will be determined by the Patent Trial and Appeal Board.

19. I understand that in the context of an *inter partes* review, a claim of an unexpired patent must be construed according to its ordinary and customary meaning as understood by one of ordinary skill in the art.

20. I have been informed and understand that a patent claim is anticipated under 35 U.S.C. § 102, and is therefore invalid, if all of the elements of the claim are disclosed by a single prior art reference. I have been informed and understand that anticipation does not require that a prior art reference expressly disclose each and every claim element using the same terminology as recited by the claims. I understand that a claim is anticipated if each and every element as set forth in the claim is found, either expressly or inherently, in a single prior art reference. For example, I understand that a claim limitation is inherently disclosed if it is not explicitly present in the written description of the prior art, but would necessarily be embodied or met by an apparatus or method as taught by the prior art. Moreover, I understand that anticipation does not require that the prior art use the same terminology recited within the patent claims.

21. I have been informed and understand that a patent claim is obvious under 35 U.S.C. § 103, and therefore invalid, if the claimed subject matter, as a whole, would have been obvious to a person of ordinary skill in the art as of the priority date of the patent based on one or more prior art references and/or the knowledge of one of ordinary skill in the art. I understand that an obviousness analysis must consider (1) the scope and content of the prior art, (2) the differences between the claims and the prior art, (3) the level of ordinary skill in the pertinent art, and (4) secondary considerations, if any, of non-obviousness (such as

unexpected results, commercial success, long-felt but unmet need, failure of others, copying by others, and skepticism of experts).

22. I understand that a prior art reference may be combined with other references to disclose each element of the invention under 35 U.S.C. § 103. I understand that a reference may also be combined with the knowledge of a person of ordinary skill in the art, and that this knowledge may be used to combine multiple references. I further understand that a person of ordinary skill in the art is presumed to know the relevant prior art. I understand that the obviousness analysis may take into account the inferences and creative steps that a person of ordinary skill in the art would employ.

23. In determining whether a prior art reference would have been combined with other prior art or other information known to a person of ordinary skill in the art, I understand that the following principles may be considered:

- a. whether the combinations involve non-analogous art;
- b. whether the combinations are in different fields of endeavor than the inventions in the Patent;
- c. whether the combinations are reasonably pertinent to the problems to which the inventions of the Patent are directed;
- d. whether the combination is of familiar elements according to known methods that yields predictable results;

- e. whether a combination involves the substitution of one known element for another that yields predictable results;
- f. whether the combination involves the use of a known technique to improve similar items or methods in the same way that yields predictable results;
- g. whether the combination involves the application of a known technique to a prior art reference that is ready for improvement, to yield predictable results;
- h. whether the combination is “obvious to try;”
- i. whether the combination involves the known work in one field of endeavor prompting variations of it for use in either the same field or a different one based on design incentives or other market forces, where the variations are predictable to a person of ordinary skill in the art;
- j. whether the combination involves some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill in the art to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention;
- k. whether the combination involves proposed modifications that render the prior art unsatisfactory for its intended use;

- l. whether the combination involves proposed modifications that change the principle of operation of the reference;
- m. whether the combination possesses a reasonable expectation of success; and
- n. whether the combination possesses the requisite degree of predictability at the time the invention was made.

24. I understand that in determining whether a combination of prior art references renders a claim obvious, it is helpful to consider whether there is some teaching, suggestion, or motivation to combine the references and a reasonable expectation of success in doing so. I understand, however, that an express teaching, suggestion, or motivation to combine is not required as long as persons of ordinary skill in the art would have a reason to combine the references in order to obviate the claim.

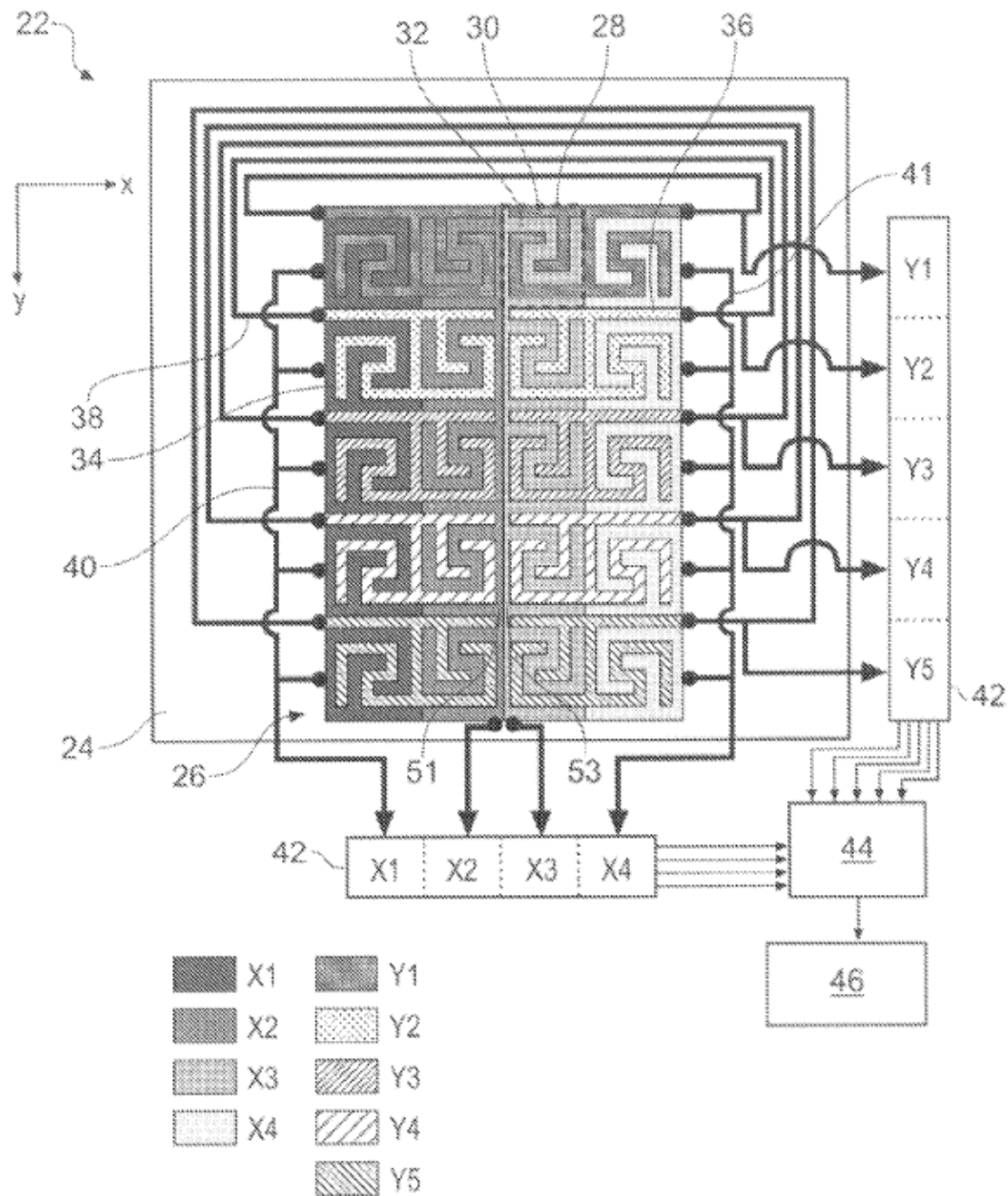
#### **IV. OVERVIEW OF THE '502 PATENT**

##### **A. Overview of the '502 Patent**

25. The '502 Patent issued from U.S. Patent Application No. 11/428,670 ("the '670 Application"), which was filed on July 5, 2006. Ex. 1001 at cover. The '502 Patent claims priority to U.S. Provisional Patent Application No. 60/697,613 ("the '613 Application"), which was filed on July 8, 2005. *Id.* The '502 Patent is directed to a capacitive sensor for determining the position of a touch or contact by

an object along a first (x) and second (y) direction. *See, e.g., id.* at Abstract, 5:37-42. The sensor comprises a plurality of electrodes disposed on the surface of a substrate. *E.g., id.* at 5:42-44, Figs. 3, 7-8. The electrodes define a sensing area in which the position of a finger or other object can be determined. *E.g., id.* at 5:44-47.

26. As shown in Figure 3 below, the electrodes form an array of sensing cells (labeled 28) arranged in rows and columns. *E.g., id.* at 5:58:60, Fig. 3. In this embodiment, each sensing cell includes a column sensing electrode (labeled 32) and a row sensing electrode (labeled 30). *Id.* at 6:8-13, Fig. 3. The column sensing electrodes in each column are electrically coupled together and the row sensing electrodes in each row are electrically coupled together, either by connections within the sensing area or outside the sensing area. *E.g., id.* at 6:29-7:10, Fig. 3. For example, the row sensing electrodes at opposite ends of the rows are connected by wrap-around connections (labeled 38) that lie outside the sensing area. *Id.* at 6:59-7:3, Fig. 3. Similarly, column sensing electrodes in columns X1 and X4 are connected by connections (labeled 40 and 41) that lie outside the sensing area. *Id.* at 7:11-16, Fig. 3.



Ex. 1001, Figure 3

27. The specification explains that the sensing area may include a single layer of sensing electrodes, meaning that the sensing electrodes are disposed on only one side of the substrate. *Id.* at 11:28-32. Both the substrate and the



electrodes may be formed from transparent materials. *E.g., id.* at 3:65-4:2, 5:47-52. As shown in the embodiment depicted in Figure 3 above, the column and row sensing electrodes in each sensing cell may be interleaved with one another in a spiral, interlaced, intertwined, or other pattern such that there exists a portion of a column sensing electrode and a row sensing electrode in each sensing cell. *Id.* at 3:52-55, 11:8-13, Figs. 3, 8.

28. The position sensor also includes a series of capacitive measurement channels coupled to the respective rows and columns of sensing electrodes. *E.g., id.* at 7:59-62, Fig. 3. These capacitive measurement channels (labeled 42) are shown as two separate banks in Figure 3 above. *Id.* at 7:65-8:6, Fig. 3. The specification does not provide any detail concerning the components that form the capacitance measurement channels or the manner in which they measure capacitance in the rows and columns, but generally indicates that the channels generate signals indicative of the capacitive values for each row and column. *E.g., id.* at 7:62-65

29. The signals from the capacitive measurement channels are provided to processing circuitry configured to determine the interpolated position of the capacitive load along the x-direction from the signals associated with the columns and the interpolated position of the capacitive load along the y-direction from the signals associated with the rows. *Id.* at 7:62-65, 8:30-44. The '502 Patent does not

specify how this is achieved, but indicates that the determination of the position of a touch is to be made using otherwise conventional circuitry connected to the sensing elements. *Id.* at 3:28-36. In addition, the '502 Patent explains that all of the rows and columns of the array may be driven in a phase-synchronous manner as taught by Boie and two other U.S. patents. *Id.* at 8:11-20.

**B. Prosecution History**

30. During the prosecution of the '502 Patent, the Examiner issued two office actions. In the first office action dated June 24, 2009, the Examiner rejected Claims 1-4, 6-15, and 19-24 (which ultimately issued as Claims 1-13 and 16-21 of the '502 Patent) as anticipated by U.S. Patent No. 4,550,221 ("Mabusth") and Claims 17 and 18 (which ultimately issued as Claims 14 and 15 of the '502 Patent) as obvious in view of Mabusth and Boie. Ex. 1008 at 104-09.<sup>1</sup> With respect to dependent Claim 17, the Examiner found that "Mabusth does not teach a graphical display wherein the electrodes in the sensing area are disposed over the graphical display to provide a touch screen." *Id.* at 108-09. Similarly, with respect to Claim 18, the Examiner found that "Mabusth does not teach an insulating panel wherein the electrodes in the sensing area are disposed beneath the insulating panel to

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<sup>1</sup> For ease of reference, the pages of Exhibit 1008 have been numbered consecutively from 1 to 209.

provide a keypad.” *Id.* The Examiner explained that it would have been obvious to combine Mabusth with the disclosures of Boie that address both limitations. *Id.*

31. The applicant argued the rejection of Claims 1-13 and 16-21 was improper because Mabusth does not show or teach “electrodes of sensing cells at opposing ends of a row (or column) connected using a wrap-around connection” as recited by independent Claim 1 or “connecting the broken segments together with an electrical conductor, wherein the conductor is made to lie outside of the active sensing region” as recited by independent Claim 20. *Id.* at 85-86. The applicant argued that the rejection of dependent Claims 17 and 18 was improper because those claims depend from Claim 1, which was improperly rejected for the foregoing reason. *Id.*

32. In the second office action dated February 19, 2010, the Examiner repeated the rejection of Claims 1-4, 6-15, and 19-24 as anticipated by Mabusth, and Claims 17 and 18 as obvious in view of Mabusth and Boie for the same reasons cited in the earlier office action. *Id.* at 73-78. The applicant argued the rejection of the claims was improper for the same reasons cited in response to the earlier office action. *Id.* at 59-61. On May 19, 2010, the applicant submitted a supplemental response to the second office action amending independent Claims 20 to recite “connecting a first broken segment at a first end of second end of the one of the at least one row or column using a wrap-around connection lying

outside of the active sensing region.” *Id.* at 38-39. The Examiner issued a notice of allowance on June 18, 2010, and the ’502 Patent issued on October 26, 2010.

*Id.* at 27-30.

## **V. LEVEL OF ORDINARY SKILL IN THE ART**

33. As discussed above, Claims 1-21 of the ’502 Patent are directed to a capacitive position sensor for determining the position of an object within a two-dimensional sensing area. *See, e.g.*, Exhibit 1001 at Abstract, 1:5-7. Accordingly, as of July 2005, a person of ordinary skill in the art (“POSITA”) would have had a bachelor’s degree in electrical engineering, computer science, physics, or the equivalent, plus at least two years of experience in the field of touch sensors or a related field, where additional education could substitute for work experience and vice versa. *See* Section IV.A. As of July 2005, I was at least a person of ordinary skill in the art. *See* Section II; *see also* Ex. 1003.

## **VI. CLAIM CONSTRUCTION**

34. I have been informed that in the context of an *inter partes* review, claim terms are given their plain and ordinary meaning according to the *Phillips* claim construction standard. 83 Fed. Reg. 51340, 51340-44 (Oct. 11, 2018); *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005). To resolve the particular grounds presented in this Petition, however, it is my understanding that Petitioners do not believe any term requires explicit construction. For purposes of this

declaration and the opinions I express herein, I accept this position and assume it to be correct. I may, however, provide further opinions at a later time as additional issues and/or disputes arise. As such, I have applied the plain meaning of each claim term as understood by persons of ordinary skill in the art at the time of the earliest filing date of the '502 Patent.

## **VII. OVERVIEW OF THE INVALIDATING PRIOR ART**

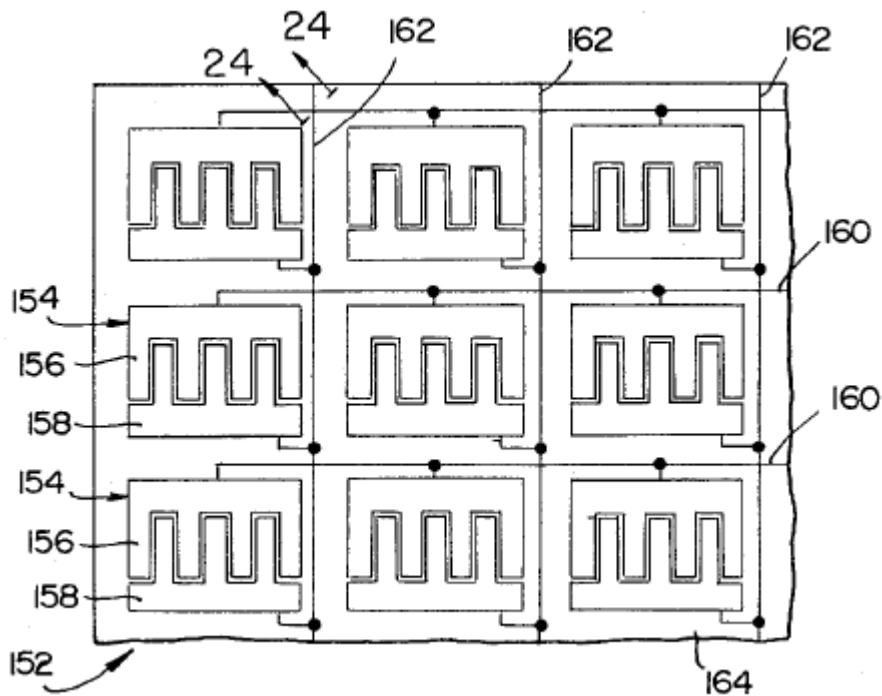
35. I have briefly summarized the prior art references that render Claims 1-21 of the '502 Patent obvious. Neither U.S. Patent No. 3,757,322 ("Barkan") nor U.S. Patent Publication No. 2006/0017701 ("Marten") were before the Examiner during prosecution of the '502 Patent. *See generally* Ex. 1007. The examiner cited Boie for its disclosure of "a graphical display wherein the electrodes in the sensing area are disposed over the graphical display to provide a touch screen" (issued Claim 14) and "an insulating panel wherein the electrodes in the sensing area are disposed beneath the insulating panel to provide a keypad" (issued Claim 15). *Id.* at 108-09; *see also* discussion Section IV.B *supra*. The following grounds do not rely on Boie for its disclosure of those limitations.

### **A. U.S. Patent No. 3,757,322 ("Barkan")**

36. Barkan was filed on February 3, 1971 and issued on September 4, 1973. Ex. 1004 at cover. It is my understanding that Barkan qualifies as prior art under pre-AIA U.S.C. § 102(b). Barkan is directed to a transparent touch actuated

interface that overlies a display to form a keyboard or touch screen. *See, e.g., id.* at Abstract, 4:37-50, 7:43-52, Figs. 5, 9, 23. The touch actuated interface includes a plurality of contact areas deposited on a transparent substrate such as a sheet of glass or plastic. *E.g., id.* at 4:59-62, Figs. 3, 9, 23. The contact areas may comprise thin films of electrically conductive transparent material deposited in a single layer on a surface of the substrate via well-known techniques such as sputtering, stencil deposition, or etching. *E.g., id.* at 4:59-62, 12:47-48, 15:39-61.

37. As shown in Figure 23 below, the contact areas are arranged in columns and rows to form a capacitive sensing area. Each contact area (labeled 154) includes an X contact sub-area (labeled 156) and a Y contact sub-area (labeled 158). *Id.* at 27:1-18-63, Fig. 23. The X contact sub-areas in each row are connected by transparent electrically conductive leads (labeled 160) and the Y column contact sub-areas in each column are similarly connected by transparent electrical conductive leads (labeled 162). *Id.* at 27:52-56, Fig. 23. The leads connecting the contact sub-areas may be thin opaque wires (*i.e.*, free wires) or conductive traces deposited on the substrate or thin opaque wires (*i.e.*, free wires). *E.g., id.* at 19:56-62, 23:3-19, 5:23-28, 13:17-29, Fig. 23.



Ex. 1004, Figure 23

38. Each row and column of contact areas is connected to its own dedicated matrix circuitry that includes a switch and one or more “and gates.” *E.g., id.* at 26:26-59. The matrix circuitry receives signals from the various rows and columns in the sensing area and the touch-activated switches are activated when a touch alters the capacitance of a contact area within a particular row and column associated with the switches. *E.g., id.* at 7:49-52, 26:43-48. After the location of the touch is recognized by the interface through its touch-activated switches and “and gates,” the location recognition is translated via the programming of the machine into the desired input for a utilization mechanism

such as a computer that performs an action or function in response to the touch.

*E.g., id.* at 7:49-52, 11:29-56, 12:47-52, 16:53-61, Fig. 2.

**B. U.S. Patent Publication No. 2006/0007701 (“Marten”)**

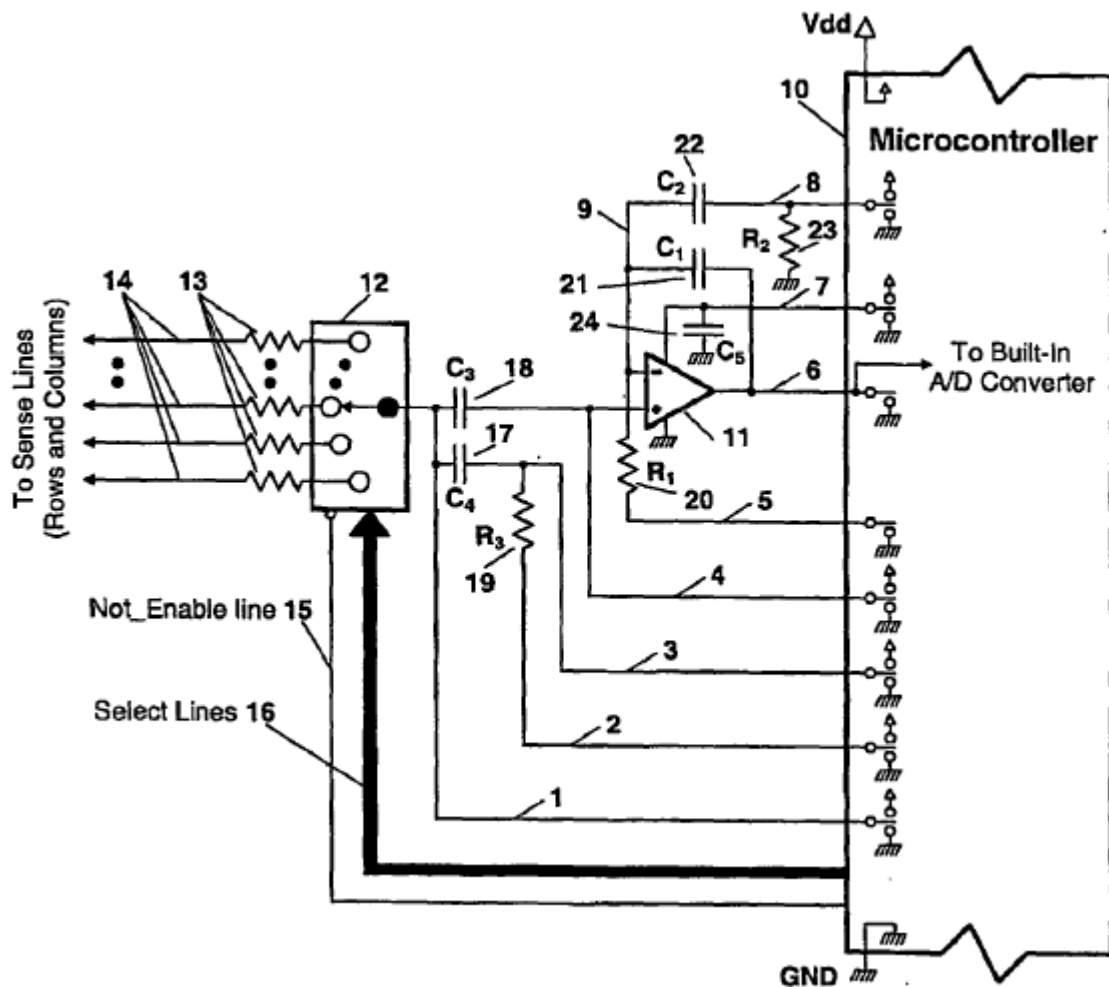
39. Marten was filed as International Patent Application No. PCT/US03/3372 on October 28, 2003 and was published as International Publication No. WO2004/040538 on May 13, 2004 and as U.S. Patent Publication No. 2006/0017701 on January 26, 2006. Ex. 1005 at cover. International Publication No. WO2004/040538 was published in English and designated the United States. It is my understanding that Marten qualifies as prior art under at least pre-AIA 35 U.S.C. § 102(e).

40. Marten is directed to processing circuitry for a capacitive touch pad sensor. *E.g., id.* at Abstract, [0022], [0058]-[0067]. The circuitry utilizes charge transfer to sense capacitance and can be implemented using general purpose “off the shelf” components and a programmable microcontroller. *Id.* Marten explains that this is advantageous, because it makes the processing circuitry resistant to the effects of noise from internal sources such as CPU clocks and memory signals as well external sources such as cellular phones operated in close proximity to the capacitive touch pad sensor, power lines, etc. *Id.* at [0004], [0058].

41. As shown in Figure 1 below, the circuit includes a single voltage source (labeled Vdd) that drives all of the rows and columns of electrodes in the



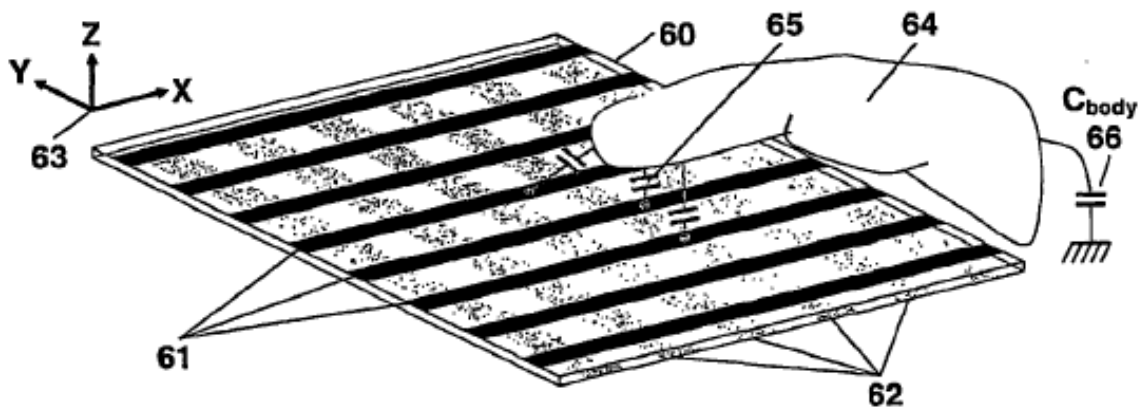
capacitive touch pad sensor. *E.g., id.* at [0058], Figs. 1, 4. The circuit also includes a synchronous detector capable of further suppression of noise and unwanted signals due to their phase difference or non-synchronicity to the drive signal. *Id.* at [0014].



Ex. 1005, Figure 1

42. The processing circuitry can be coupled with a capacitive touch pad such as that shown in Figure 6 below. The touch pad (labeled 60) includes a first

group of electrodes parallel to the X-axis (labeled 61) for determining the Y coordinate of a touch and a second group of electrodes (labeled 62) parallel to the Y-axis for determining the X coordinate of a touch. *E.g., id.* at [0053], [0007]-[0011], Fig. 6. When a person touches the touch panel, the circuitry determines the position of the touch by measuring the changes in capacitance to ground for all of the electrodes in the first and second groups, followed by extrapolation of the position between the electrodes. *Id.* at [0054, [0010], Fig. 6.

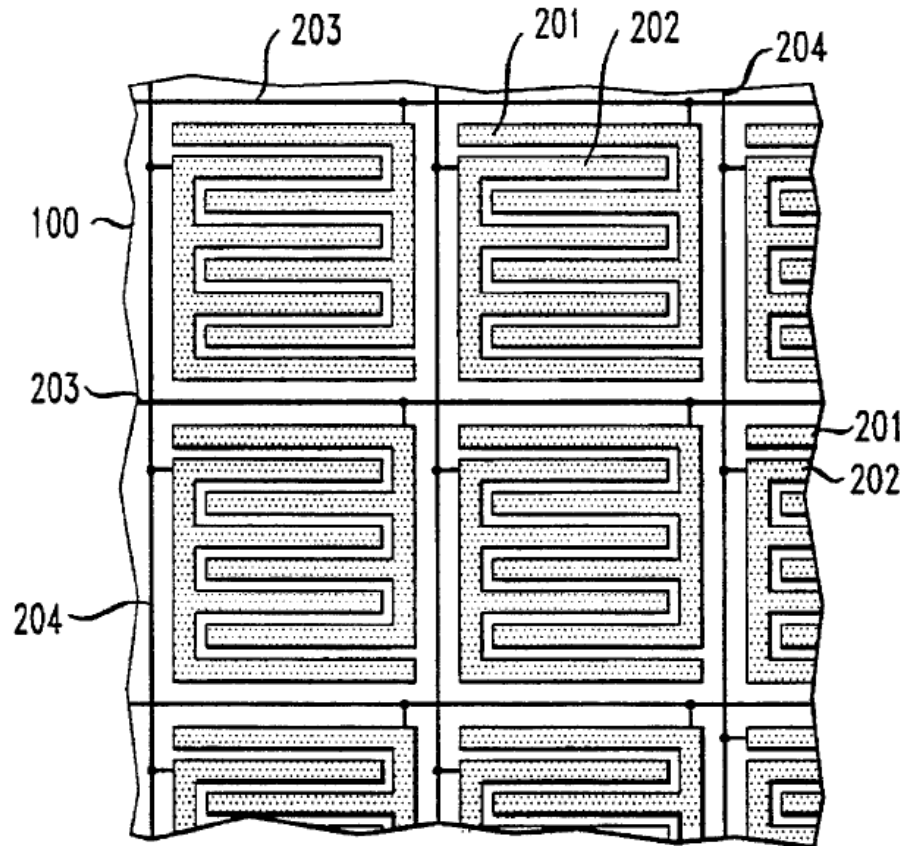


Ex. 1005, Figure 6

**C. U.S. Patent No. 5,463,388 (“Boie”)**

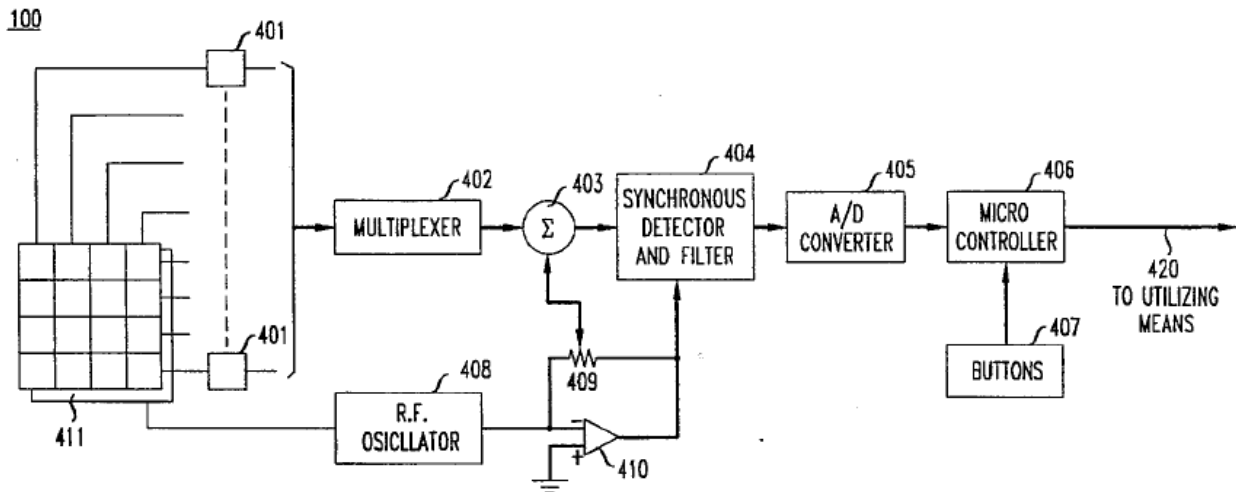
43. Boie was filed on January 29, 1993 and issued on October 31, 1995. Ex. 1006 at cover. I have been informed that Boie qualifies as prior art under pre-AIA 35 U.S.C. § 102(b). Boie is directed to a capacitive sensor with a plurality of electrodes disposed on an insulating surface (i.e., substrate). *E.g., id.* at Abstract, 1:61-2:11. As shown in Figure 2 below, the array of electrodes (labeled 100) is

arranged in a grid of columns and rows and each electrode (labeled 101) may be subdivided into a horizontal element (labeled 201) and a vertical element (labeled 202). *Id.* at 3:13-22, Fig. 2. The horizontal elements in each row are interconnected by leads (labeled 203) and the vertical elements in each column are connected by leads (labeled 204). *Id.* The horizontal and vertical elements within each electrodes may be interdigitated (i.e., interleaved) as shown in Figure 6. *Id.* at 3:22-29, Fig. 2.



Ex. 1006, Figure 2

44. Each column and row of the array is connected to circuitry for measuring capacitance. *E.g., id.* at Abstract. As shown in Figure 4 below, the circuitry includes a single RF oscillator (labeled 408) that drives all of the columns and rows in unison and a synchronous detector and filter (labeled 404). *E.g., id.* at 3:67-4:13, 4:58-66, Fig. 4. The processing circuitry also includes a microcontroller that determines the position of a finger or other object in contact with the touch pad by calculating the centroid of measured capacitance across the rows and columns of electrodes. *E.g., id.* at Abstract, 5:10-49.

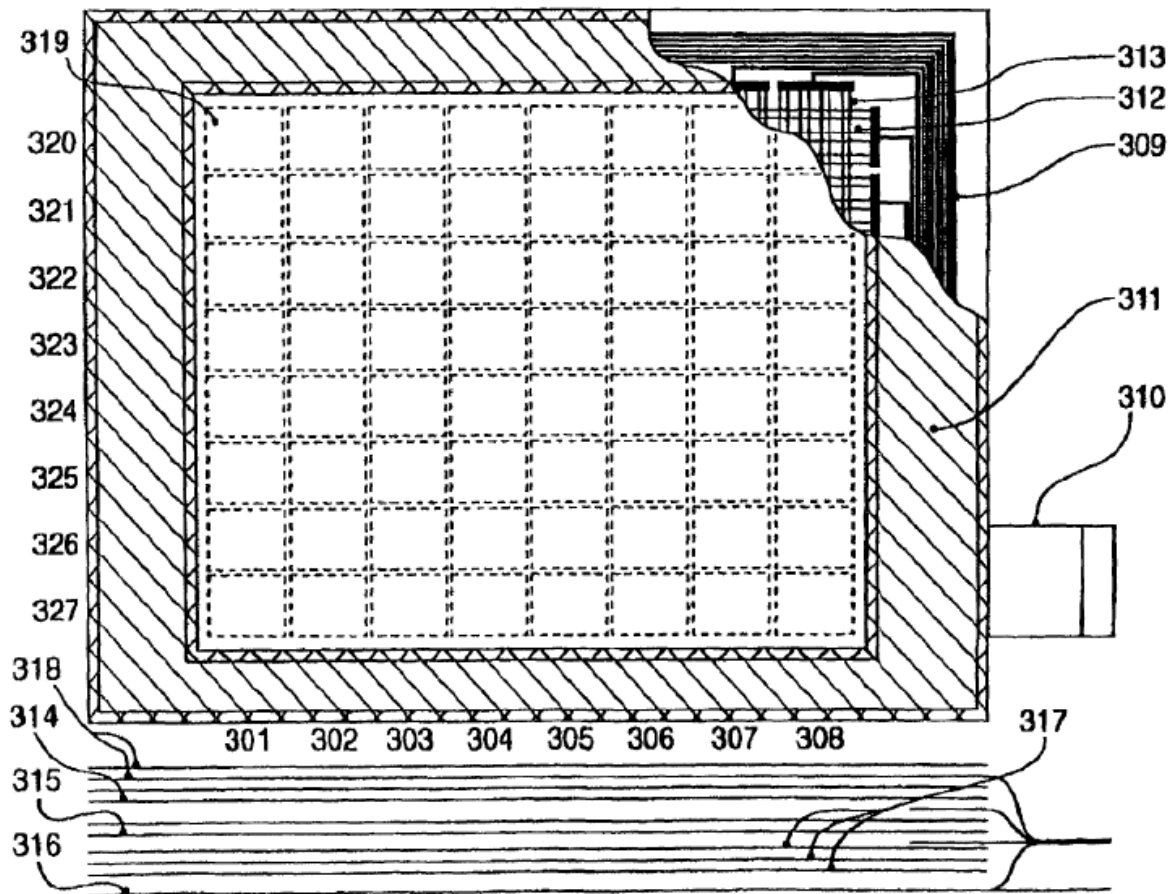


Ex. 1006, Figure 4

**D. U.S. Patent Publication No. 2003/0067451 (“Tagg”)**

45. Tagg was filed as International Patent Application No. PCT/GB95/02678 on November 14, 1995 and was published as U.S. Patent Publication No. 2003/0067451 on April 10, 2003. Ex. 1007 at cover. Tagg qualifies as prior art under pre-AIA 35 U.S.C. § 102(b).

46. Tagg is directed to a touch screen with two sets of orthogonally arranged linear electrodes forming rows and columns. *Id.* at [0201]-[0202], Figs. 23-24. As shown in Figure 23 below, the touch screen includes a row layer (314) and a column layer (315). *Id.* Each layer includes a plurality of parallel linear electrodes comprised of thin strips (312 and 313). *Id.* The opposing ends of the electrodes are coupled via external wires (309) that are routed outside the sensing area of the touch screen. *Id.* The wires, which may be formed from a conductive silver track, are connected to an edge connector and a channel capacitance measuring device (not shown in Figure 23). *Id.*



Ex. 1007, Figure 23

47. The sensing area of the touch screen is defined by an array of capacitive sensor zones (e.g., 319). *Id.* An associated processor can be configured to interpolate the position of a finger in contact with the surface of the touch screen. *Id.* at [0084]-[0085].

**VIII. FIRST GROUND: CLAIMS 1-4 AND 9-18 OF THE '502 PATENT ARE RENDERED OBVIOUS BY BARKAN, EITHER ALONE OR IN COMBINATION WITH TAGG**

48. I have reviewed Barkan and Tagg, and I provide my opinions below as to their applicability to Claims 1-4 and 9-18 of the '502 Patent.

**A. Motivation to Combine**

49. Persons of ordinary skill in the art would have been motivated to combine the disclosures and teaching of Barkan and Tagg as they are directed to common subject matter within the same field. Both references disclose capacitive touch sensors and associated processing circuitry for determining the position of a touch on a touch panel. *See, e.g.*, Ex. 1004 at Abstract; Ex. 1007 at Abstract, [0201]-[0211], Figs. 23-24. In addition, the references disclose common components, including an array of electrodes aligned with the X and Y axes that signal the position of a touch based on changes in capacitance. *See, e.g.*, Ex. 1004 at Abstract, 27:1-63, Fig. 23; Ex. 1007 at Abstract, [0178], [0201]-[0211], Figs. 10, 23-24.

50. To the extent it is not already disclosed by Barkan, it would have been obvious to persons of ordinary skill in the art to incorporate processing elements from Tagg, including a 16 channel capacitance measurement device and a microprocessor that compares signals from the capacitance measurement channels in order to interpolate the position of a finger in contact with the touch screen. *E.g.*, Ex. 1007 at [0084]-[0085], [0201]. Tagg teaches that these functions can be achieved using well-known universal components such as “a small (i.e. low cost) microprocessor).” *E.g.*, Ex. 1007 at [0113]. Accordingly, persons of ordinary skill in the art would have been motivated to incorporate these elements with the touch

sensor of Barkan to achieve a low-cost means of determining the position of a touch with improved accuracy. Persons of ordinary skill in the art would have understood that this would involve the combination of known elements (i.e., a general-purpose microprocessor and a known configuration of electrodes arranged in rows and columns) to yield predictable results.

51. Persons of ordinary skill in the art would have also found it obvious to incorporate external wires connecting electrodes at opposing ends of each column and row of electrodes as taught by Tagg. As persons of ordinary skill in the art would have appreciated, these connections would be beneficial in minimizing RC delay, and would thereby enable the use of lengthier columns and rows of electrodes. Accordingly, persons of ordinary skill in the art would have been motivated to achieve this benefit. Furthermore, because Tagg teaches that the external wires are formed from conductive silver track, a POSITA would have understood that this could be accomplished using known materials and techniques. *See* Ex. 1007 at [0201]. For these reasons, along with those discussed below, a POSITA would have found it obvious to incorporate these elements with the touch interface of Barkan and would have understood how to do so.



**B. Claim 1**

**1. Claim 1, Preamble: “A position sensor comprising”**

52. To the extent the preamble of Claim 1 is limiting, Barkan discloses “[a] transparent touch actuated interface with an interactively related display.” Ex. 1004 at Abstract. Barkan teaches that “the operator responds to [] data presented on the [display] screen in the simplest way imaginable that is, by touching the selected portion of the display [at which point] [t]he location of the touch is recognized by the interface through its touch-activated switches.” *Id.* at 7:43-52.

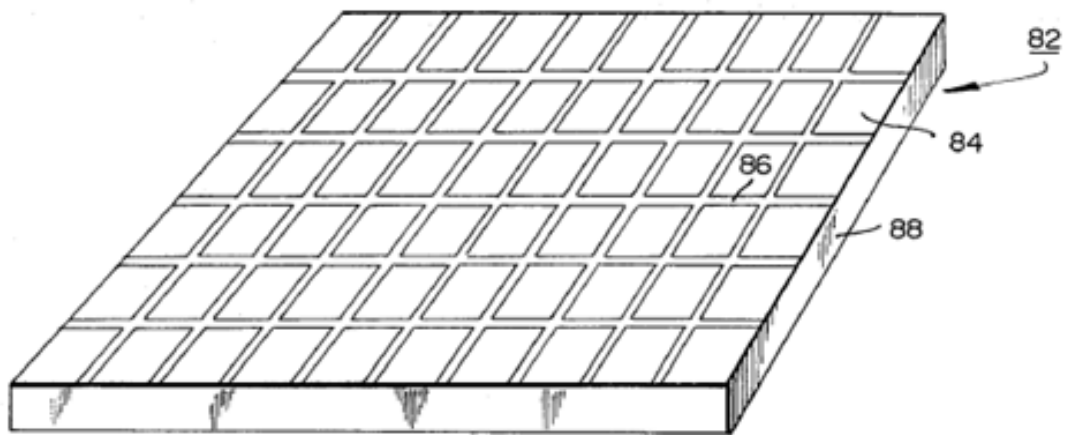
53. Based on the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious the Preamble of Claim 1.

**2. Claim 1, Element A: “a substrate having a surface with an arrangement of electrodes mounted thereon”**

54. Barkan discloses a touch actuated interface that includes “one or more to-be-touched contact areas of electrically conductive transparent material electrically isolated from one another by transparent means.” *Id.* at Abstract. Barkan teaches that “the contact areas may be thin electrically conductive transparent films supported by an electrically non-conductive substrate such as a pane of clear glass or clear plastic.” *Id.* at 4:59-62, Figs. 3, 9, 23. The contact areas may be mounted on the substrate via well-known techniques such as sputtering, stencil deposition, or etching. *Id.* at 15:39-61. As persons of ordinary

skill in the art would have appreciated, the contact areas composed of electrically conductive material are electrodes mounted on the substrate.

55. Barkan further teaches that the contact areas are preferably disposed on a single surface of the substrate. *Id.* at 12:47-48 (“The contact areas preferably are flat and their contact surfaces are coplanar.”). In the exemplary embodiment shown in Figure 9 below, the contact areas (labeled 84) are disposed on the upper surface of a substrate (labeled 88). *Id.* at 18:64-19:15, Figs. 9, 23.



Ex. 1004, Figure 9

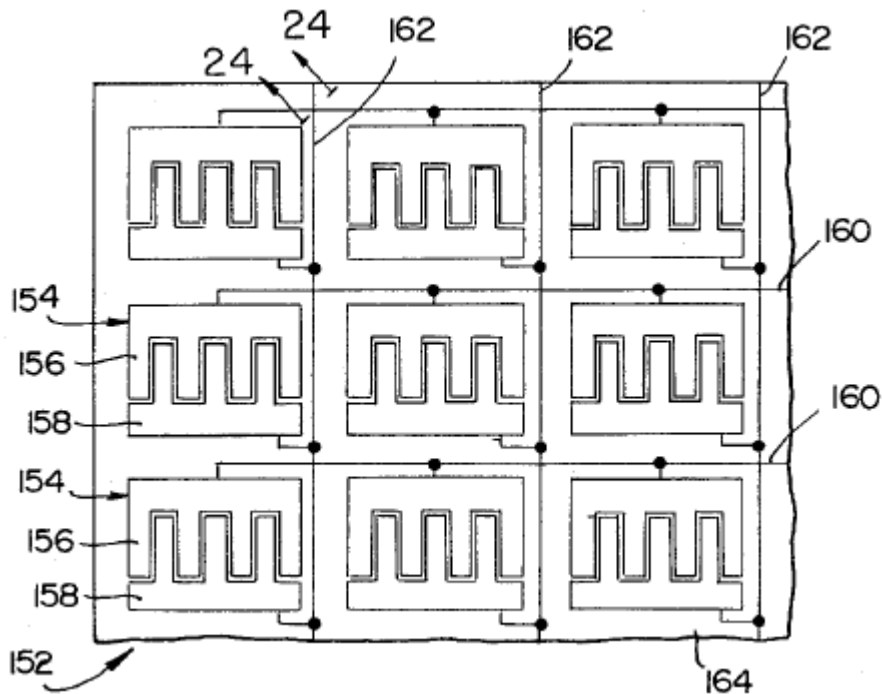
56. Based on these disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Element A of Claim 1.

3. **Claim 1, Element B: “wherein the electrodes define an array of sensing cells arranged in columns and rows to form a capacitive sensing area of the sensor, each sensing cell including a column sensing electrode and a row sensing electrode, the column sensing electrodes of sensing cells in the same column being electrically coupled together and the row sensing electrodes of sensing cells in the same row being electrically coupled together”**

57. Barkan discloses a touch actuated interface with an array of electrically conductive contact areas (i.e., “sensing cells”). Barkan teaches that the contact areas are arranged in columns and rows to form a capacitive sensing area. *Id.* at 26:10-15, 26:26-59, Figs. 3, 5-9, 23; *see also* 12:47-52, 13:46-50 (“The conductive areas are designed to be touched and their associated switch circuits energized thereby, the touch being that of a human finger or an element having a capacitance in the order of that of a human being or an element having a resistance in the order of that of a human finger.”).

58. With reference to Figure 23 below, Barkan further teaches that each contact area (labeled 154) may include an X contact sub-area (labeled 156) and a Y contact sub-area (labeled 158). *Id.* at 27:1-18-63, Fig. 23. In this configuration, “[a]ll of the X contact sub-areas in any given X row are connected by a transparent electrically conductive lead 160, and, similarly, all of the Y column contact subareas in any given Y column are connected by a transparent electrical conductive lead 162.” *Id.* at 27:52-56, Fig. 23. Persons of ordinary skill would

have thus appreciated that the Y contact sub-areas are “column sensing electrodes” and the X contact sub-areas are “row sensing electrodes.”



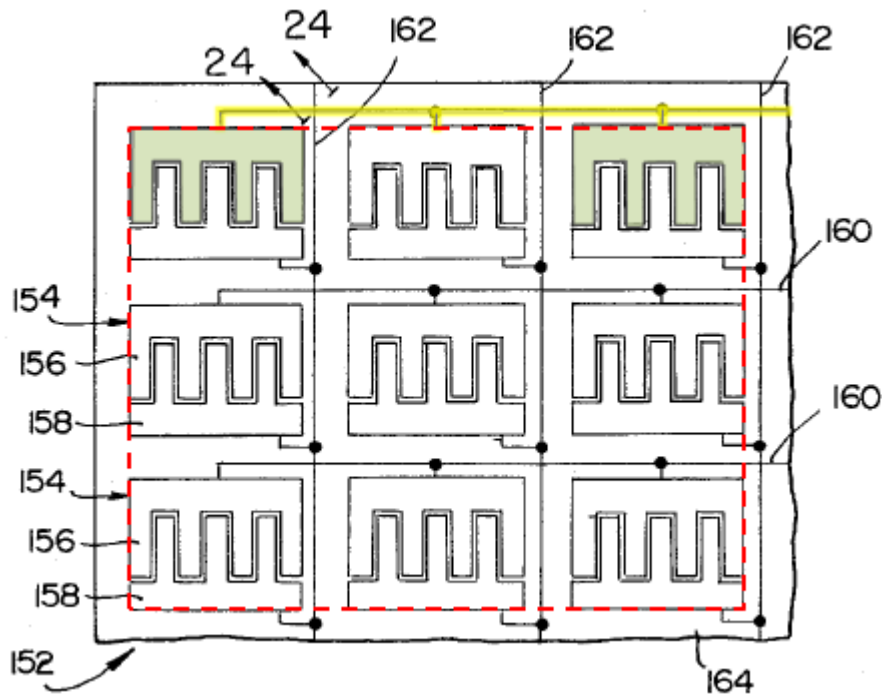
Ex. 1004, Figure 23

59. On the basis of the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Element B of Claim 1.

4. **Claim 1, Element C: “wherein row sensing electrodes of sensing cells at opposing ends of at least one of the rows are electrically coupled to one another by respective row wrap-around connections made outside of the sensing area”**

60. As previously discussed in connection with Element B of Claim 1, Barkan discloses an array of contact areas (i.e., “sensing cells”) wherein each contact area includes an X contact sub-area (i.e., “row sensing electrode”) and a Y

contact sub-area (i.e., “column sensing electrode”). *See, e.g., id.* at 27:1-18, 27:49-56, Fig. 23. Barkan teaches that the X contact sub-areas (labeled 156) in each row are electrically coupled by a lead (labeled 160) as shown in annotated Figure 23 below. *Id.* at 27:52-56, Fig. 23. The X contact sub-areas (highlighted in green) on the left and right ends of the uppermost row are electrically coupled via a lead (highlighted in yellow) that lies outside the sensing area (indicated by a red dashed line) containing the contact areas that sense touch. *Id.*; *see also* Ex. 1001 at 5:44-47 (explaining that “[t]he sensing electrodes 26 define a sensing area within which the position of an object (e.g. a finger or stylus) adjacent the sensor may be determined”).

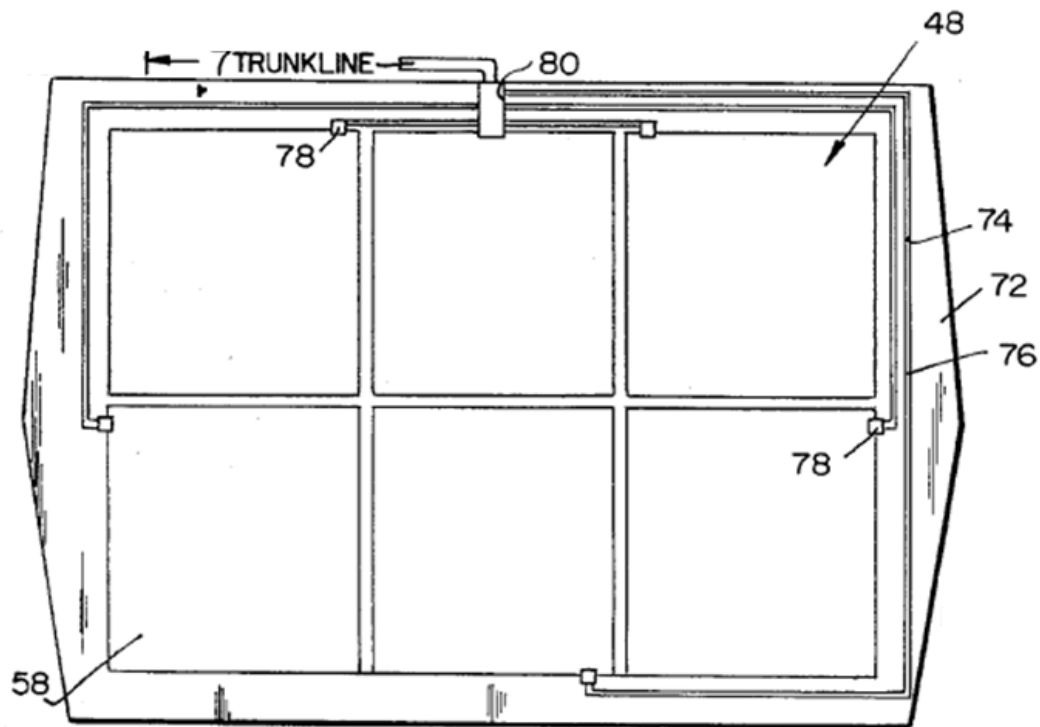


Ex. 1004, Figure 23 (Annotated)

61. Although the right and bottom edges of the illustration in Figure 23 are uneven, indicating that the touch sensor extends to the right and down, the left and top edges are straight and solid, which would indicate to persons of ordinary skill in the art that these are the left and top edges of the touch sensor overlay. Further, while the uneven edge on the right indicates that the touch sensor extends to the right, possibly with additional contact areas (labeled 154), persons of ordinary skill in the art would have understood that any additional contact areas in the top row, including the right-most one, would be connected to the highlighted lead exactly as those pictured in Figure 23 or would be optional. Accordingly, persons of ordinary skill in the art would have understood that the highlighted lead connecting these X contact sub-areas, including those on the X contact sub-areas on the left and right ends of the uppermost row, is a “wrap around connection” as recited in Claims 1 and 17 of the ’502 Patent.

62. Barkan also teaches that the lead connecting the X contact sub-areas in the uppermost row could be positioned even further outside the sensing area. With reference to the embodiment shown in Figure 8 below, Barkan explains that the leads (labeled 74 and 76) connecting the contact areas to the processing circuitry may be routed through a series of channels formed in a supporting frame (labeled 72) surrounding the contact areas (labeled 58). *Id.* at 18:22-49, Fig. 8. In this configuration, the leads run through the channels in the frame to an exit

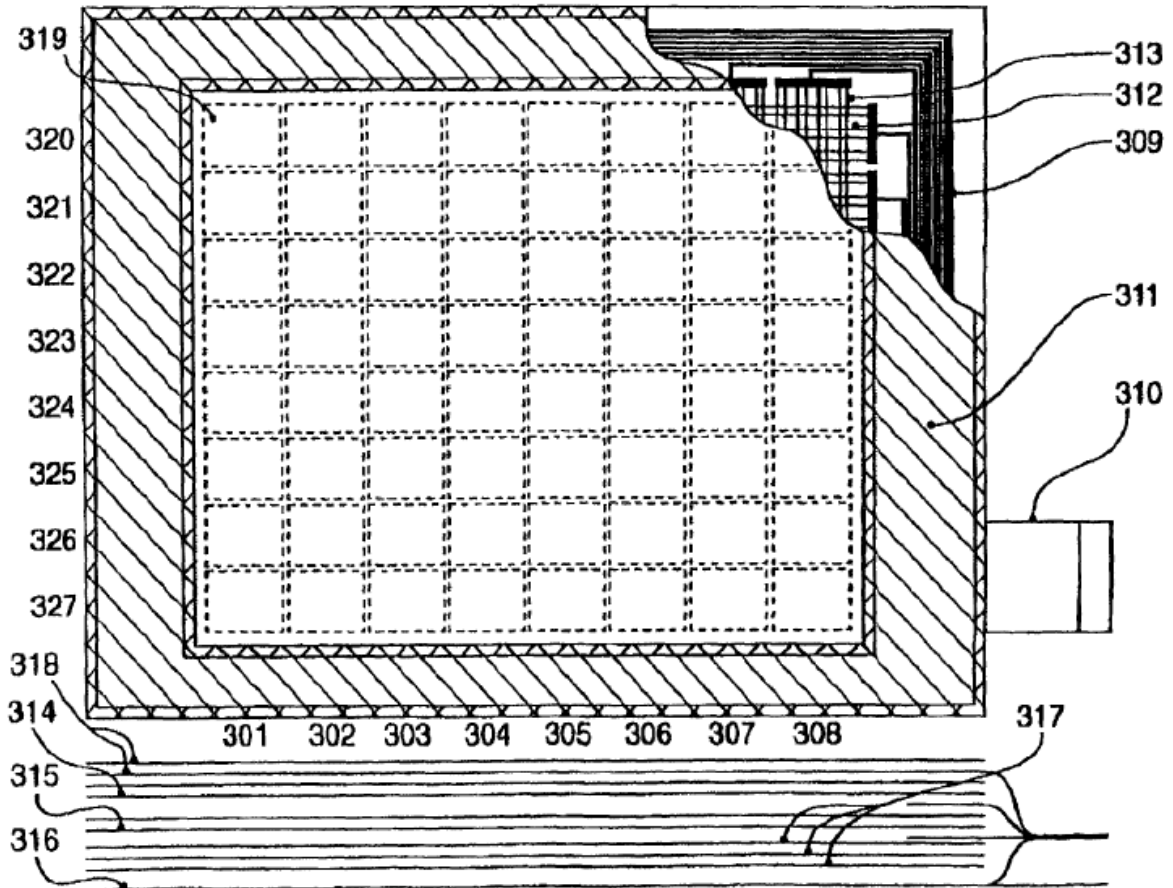
channel (labeled 80) and then to the processing circuitry. *Id.* Persons of ordinary skill in the art would have recognized that the uppermost lead in the embodiment of Figure 23 could likewise be routed through a surrounding frame, which would offer numerous advantages, including enhanced protection of the delicate lead and the avoidance of any visual interference with the underlying display.



Ex. 1004, Figure 8

63. To the extent Barkan does not explicitly disclose “row wrap-around connections made outside the sensing area,” Tagg discloses a touch screen with external wires that connect row sensing electrodes at opposing ends of each row. Ex. 1007 at [0201], Fig. 23. As shown in Figure 23 below, the touch screen includes a row layer (314) and a column layer (315). *Id.* The row layer includes a

plurality of electrodes structured as thin strips (312). *See id.* The opposing ends of the row electrodes are coupled via wires (309) that are routed outside the sensing area under the frame of the touch screen. *See id.*

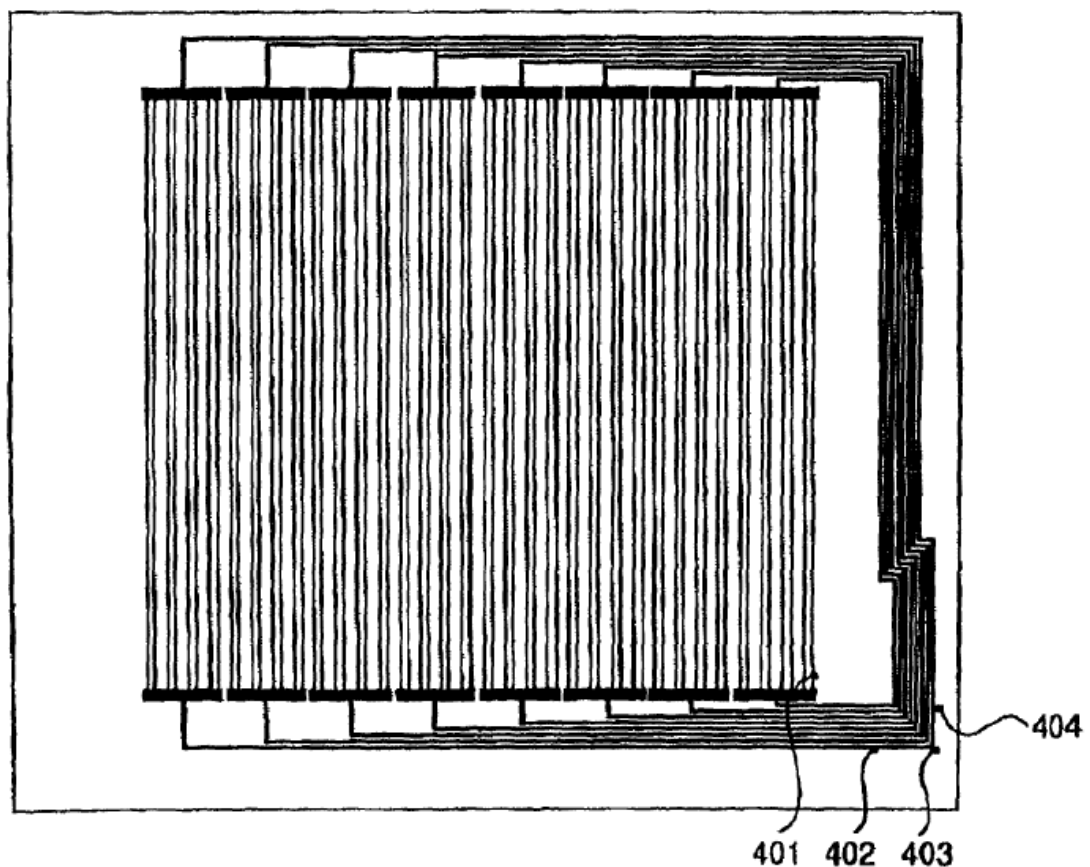


Ex. 1007, Figure 23

64. The wires can be seen more clearly in Figure 24 below, which depicts the column layer alone. *Id.*, [0202], Figure 24. The opposing ends of each column electrode are coupled via the wires shown to the right of the array of column electrodes. *Id.* Although the external wires coupling opposing ends of the row



electrodes are not shown in their entirety in Figure 23, persons of ordinary skill in the art would have understood that those wires would be configured in the same manner as the wires depicted in Figure 24. Accordingly, persons of ordinary skill in the art would have understood that the wires (309) are “row wrap-around areas made outside the sensing area.”



Ex. 1007, Figure 24

65. In view of the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Element C of Claim 1, either alone or in combination with Tagg.

**C. Claim 2**

**1. Claim 2: “The position sensor of 1, wherein the row wrap-around connections comprise a conductive trace deposited on the substrate”**

66. Barkan teaches that the leads may be “deposited films of electrically conductive transparent material” and may be formed via “vacuum evaporation deposition through a stencil.” *See, e.g.*, Ex. 1004 at 19:56-62, Fig. 23. The leads may also be formed with the use of a resist/etching technique. *See, e.g., id.* at 15:53-61. In either case, persons of ordinary skill in the art would have appreciated that the leads would comprise a conductive trace deposited on the substrate.

67. In view of the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Claim 2.

**D. Claim 3**

**1. Claim 3: “The position sensor of 1, wherein the row wrap-around connections comprise free wires connected to the respective row sensing electrodes”**

68. Barkan teaches that “the present invention also contemplates the use of opaque leads such, for instance, as wires.” *See, e.g., id.* at 23:3-19, 5:23-28, 13:17-29 (explaining that “[i]n an alternate form of the invention very thin opaque wire-type leads are used). As discussed in connection with Elements 1B and 1C of

Claim 1, these leads are connected to the X contact sub-areas (i.e., “row electrodes”) in each row of the touch interface. *See, e.g., id.* at 27:52-56, Fig. 23.

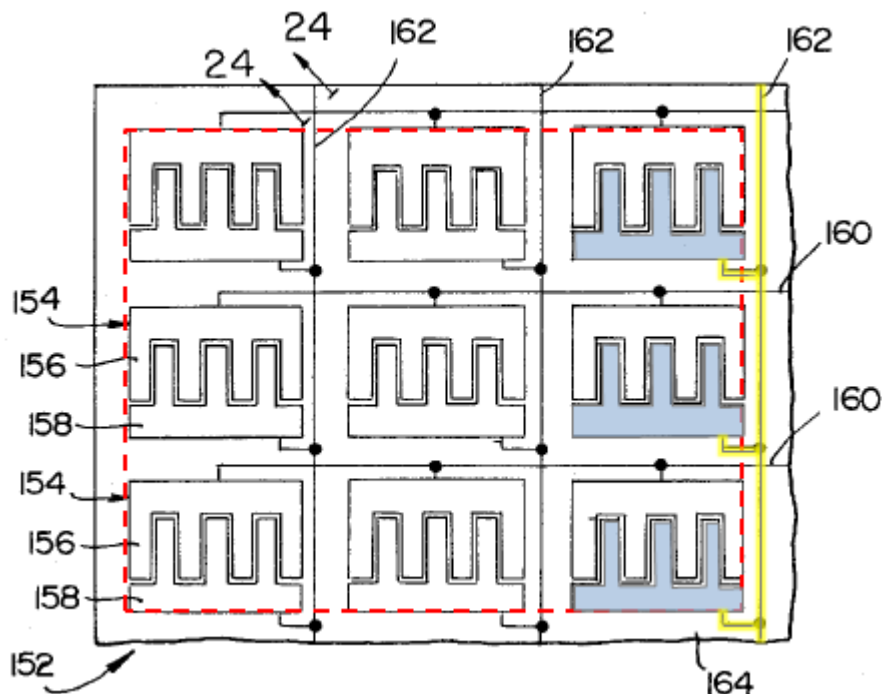
69. In view of the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Claim 3.

**E. Claim 4**

- 1. Claim 4: “The position sensor of 1, wherein the column sensing electrodes of a column of sensing cells at an edge of the sensing area are electrically coupled to one another by column wrap-around connections made outside of the sensing area”**

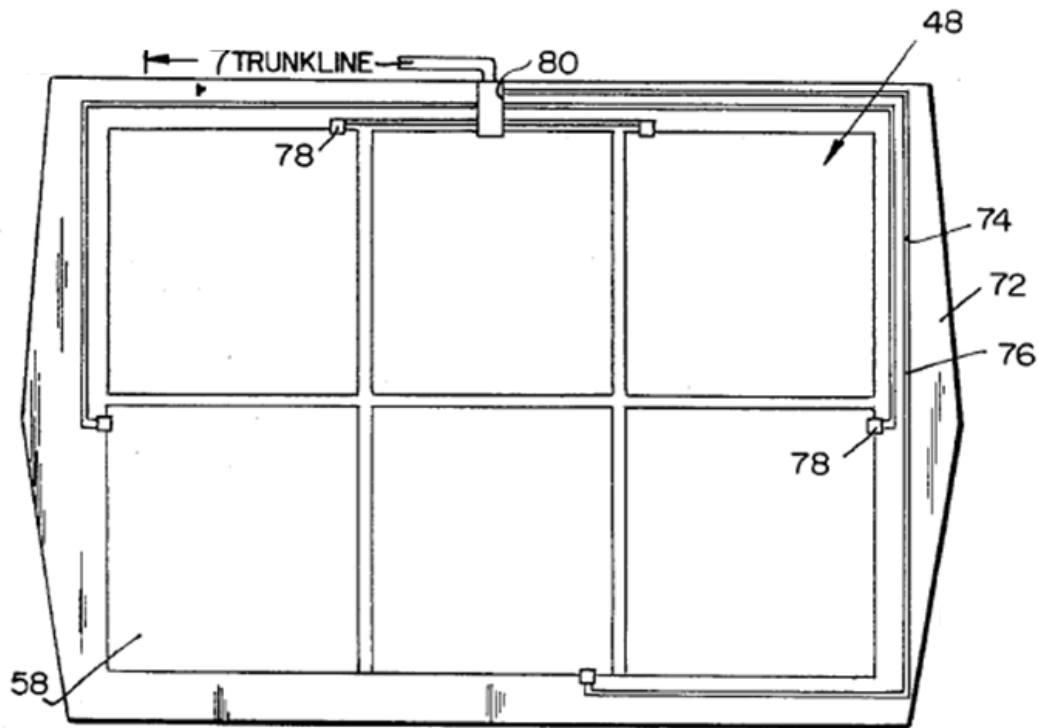
70. As previously discussed in connection with Elements B and C of Claim 1, Barkan discloses an array of contact areas (i.e., “sensing cells”) wherein each contact area includes an X contact sub-area (i.e., “row sensing electrode”) and a Y contact sub-area (i.e., “column sensing electrode”). *See, e.g., id.* at 27:1-18, 27:49-56, Fig. 23. Barkan teaches that the Y contact sub-areas (labeled 158) in each column are electrically coupled by a lead (labeled 162) as shown in annotated Figure 23 below. *Id.* at 27:52-56, Fig. 23. The Y contact sub-areas (highlighted in blue) in the third column from the left are electrically coupled via a lead (highlighted in yellow). *Id.* While the uneven edge on the right of the illustration indicates that the touch sensor extends to the right, possibly with additional contact areas (labeled 154), persons of ordinary skill in the art would have understood that the last column would appear exactly as the right-most one in Figure 23, with a

lead (similar to the one highlighted in yellow below) that lies outside the sensing area containing the contact areas that sense touch. *Id.*; see also Ex. 1001 at 5:44-47 (explaining that “[t]he sensing electrodes 26 define a sensing area within which the position of an object (e.g. a finger or stylus) adjacent the sensor may be determined”). Persons of ordinary skill in the art would have also understood that additional columns are optional in the Barkan disclosure and the system can be implemented exactly as illustrated in Figure 23 with 3 rows and 3 columns. Accordingly, persons of ordinary skill in the art would have understood that the lead connecting these Y contact sub-areas is a “wrap around connection” as recited in Claims 1 and 17 of the ’502 Patent.



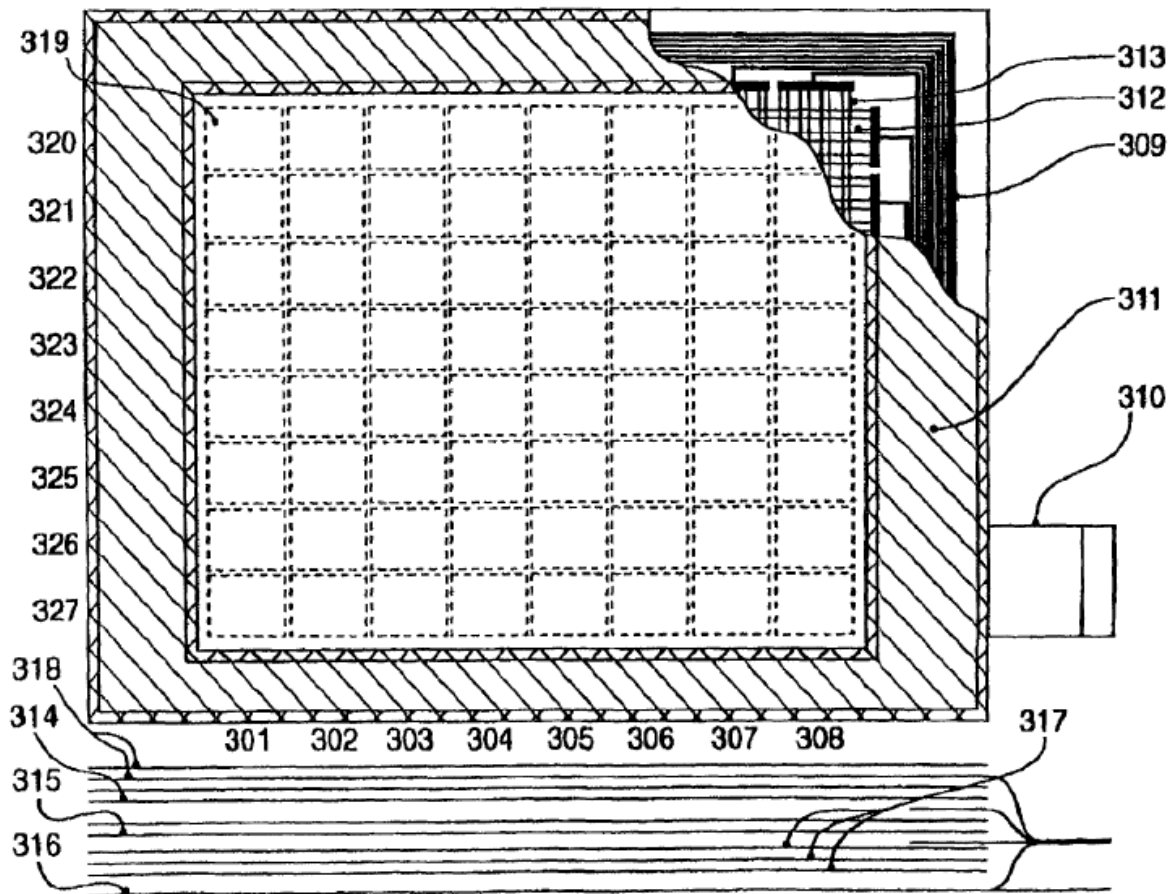
Ex. 1004, Figure 23 (Annotated)

71. Barkan also teaches that the lead connecting the Y contact sub-areas in the right edge column could be positioned even further outside the sensing area. With reference to the embodiment shown in Figure 8 below, Barkan explains that the leads (labeled 74 and 76) connecting the contact areas to the processing circuitry may be routed through a series of channels formed in a supporting frame (labeled 72) surrounding the contact areas (labeled 58). *Id.* at 18:22-49, Fig. 8. In this configuration, the leads run through the channels in the frame to an exit channel (labeled 80) and then to the processing circuitry. *Id.* Persons of ordinary skill in the art would have recognized that the right edge lead in the embodiment of Figure 23 could likewise be routed through a surrounding frame, which would offer numerous advantages, including enhanced protection of the delicate lead and the avoidance of any visual interference with the underlying display.



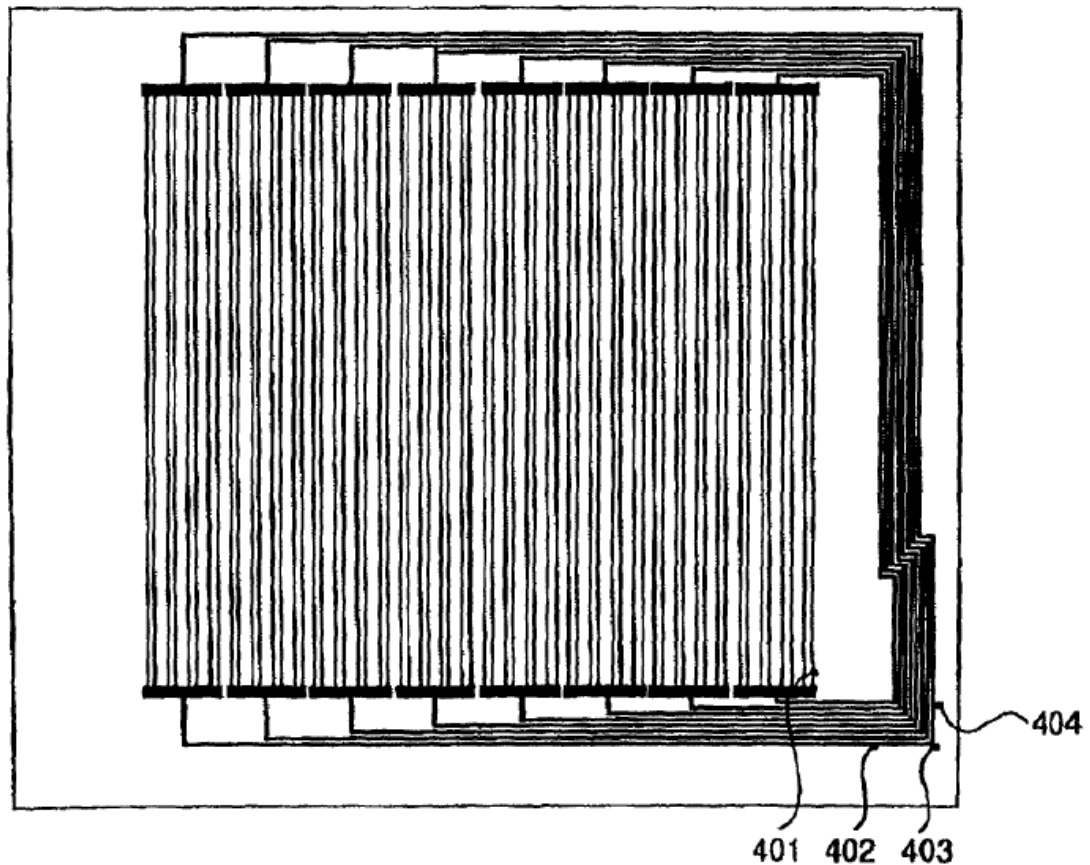
Ex. 1004, Figure 8

72. To the extent Barkan does not explicitly disclose “column wrap-around connections made outside the sensing area,” Tagg discloses a touch screen with external wires that connect column sensing electrodes at opposing ends of each column. Ex. 1007 at [0201], Fig. 23. As shown in Figure 23 below, the touch screen includes a row layer (314) and a column layer (315). *Id.* The column layer includes a plurality electrodes structured as thin strips (313). *See id.* The opposing ends of the column electrodes are coupled via wires (309) that are routed outside the sensing area under the frame of the touch screen. *See id.*



Ex. 1007, Figure 23

73. The wires can be seen more clearly in Figure 24 below, which depicts the column layer alone. *Id.* at [0202], Figure 24. The opposing ends of each column electrode are coupled via the wires shown to the right of the array of column electrodes. *Id.* Accordingly, persons of ordinary skill in the art would have understood that the wires (309) are “column wrap-around connections made outside the sensing area.”



Ex. 1007, Figure 24

74. Based on the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Claim 4, either alone or in combination with Tagg.

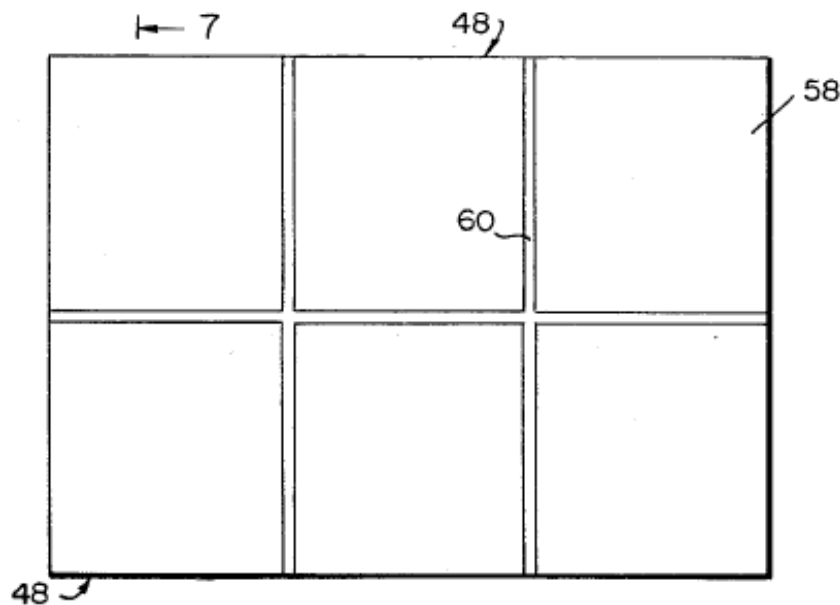
**F. Claim 9**

**1. Claim 9: “The position sensor of 1, wherein the sensing cells are arranged into three columns”**

75. Barkan discloses a touch actuated interface with an array of contact areas (i.e., “sensing cells”) that can be arranged in any number of columns and rows. *See, e.g.*, Ex. 1004 at 5:3-9 (discussing “more sophisticated forms of



matrices such as  $3 \times N$ , up to  $N \times M$ ). For example, the exemplary array depicted in Figure 6 below includes three columns. *See, e.g., id.* at Figs. 6, 23. Persons of ordinary skill would have understood that additional columns are optional in the Barkan disclosure and the system can be implemented exactly as illustrated in Figure 23 with 3 rows and 3 columns.



Ex. 1004, Figure 6

76. In view of the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Claim 9.

**G. Claim 10**

**1. Claim 10: “The position sensor of 1, wherein the sensing cells are arranged into four columns”**

77. Barkan discloses a touch actuated interface with an array of contact areas (i.e., “sensing cells”) that can be arranged in any number of columns and

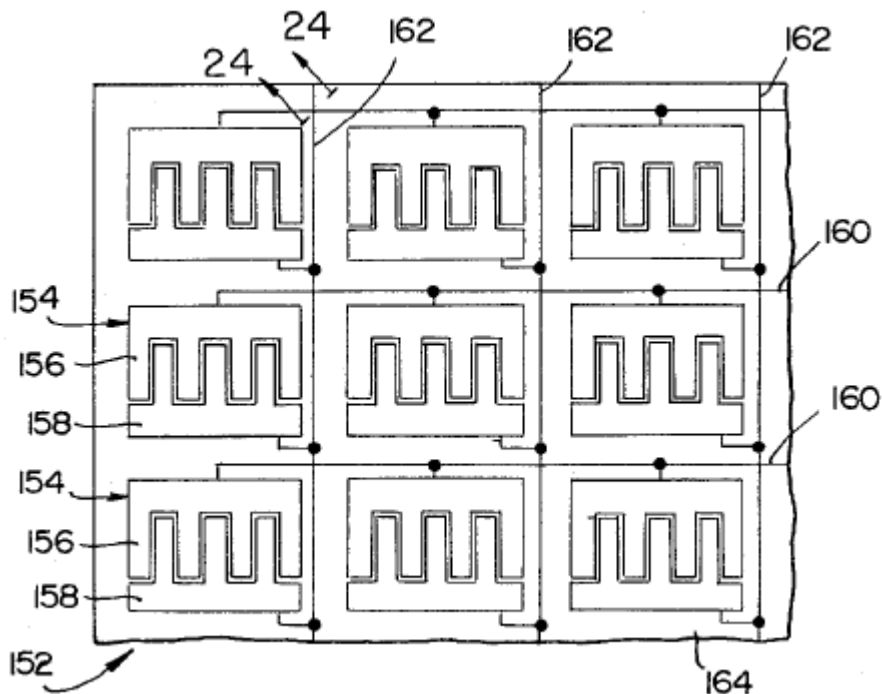
rows. *E.g., id.* at 5:3-9 (discussing “more sophisticated forms of matrices such as  $3 \times N$ , up to  $N \times M$ ”). Indeed, as noted above, the uneven line on the right side of Figure 23 indicates that the touch sensor extends to the right, and may include additional columns of contact areas. Persons of ordinary skill in the art would have thus appreciated that the touch interface could be configured with an array of contact areas having four columns.

78. In view of the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Claim 10.

#### **H. Claim 11**

**1. Claim 11: “The position sensor of 1, wherein the column sensing electrode and the row sensing electrode in each sensing cell are interleaved with one another”**

79. Barkan teaches that the Y contact sub-areas (i.e., “column sensing electrodes”) and X contact sub-areas (i.e., “row sensing electrodes”) in each contact area (i.e., “sensing cell”) “are of such configuration and mutual arrangement that they are interleaved, e.g., interdigitated” as shown in Figure 23 below. *Id.* at 27:22-35, Fig. 23. Barkan further teaches that “each contact area could be in the form of a flat helix, i.e., spiral, and the associated contact sub-area, likewise in the form of a spiral, the turns of which are interleaved with the turns of the first contact sub-area.” *Id.* at 27:31-35.



Ex. 1004, Figure 23

80. Based on the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Claim 11.

**I. Claim 12**

**1. Claim 12: “The position sensor of 1, wherein the substrate is formed from a transparent material”**

81. Barkan teaches that “[i]n a preferred form of the invention the contact areas are discrete thin films supported on the electrically non-conductive *transparent substrate*.” *E.g., id.* at Abstract (emphasis added), 15:53-61, 27:52-63. Barkan further teaches that the substrate may comprise an “electrically non-conductive substrate such as a pane of clear glass or clear plastic.” *Id.* at 4:59-64.

82. In view of the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Claim 12.

**J. Claim 13**

**1. Claim 13: “The position sensor of 1, wherein the electrodes are formed from a transparent electrically conductive material”**

83. Barkan teaches that the contact areas (i.e., “electrodes”) are comprised of “electrically conductive transparent material.” *E.g., id.* at Abstract (discussing “one or more to-be-touched contact areas of electrically conductive transparent material”), 1:8-14. Barkan further teaches that “the contact areas may be thin electrically conductive transparent films.” *E.g., id.* at 4:59-64, 15:39-61 (“The contact areas 58 are electrically conductive and, since they must also be transparent, are, in the described embodiment of the invention, extremely thin.”).

84. In view of the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Claim 13.

**K. Claim 14**

**1. Claim 14: “The position sensor of 13, further comprising a graphical display wherein the electrodes in the sensing area are disposed over the graphical display to provide a touch screen”**

85. Barkan discloses “an interreactive [sic] interface in the form of a transparent overlay on a display surface [that is] is clearly visible through the overlay.” *E.g., id.* at 7:43-46. The “displays can be static or dynamic and can

come from any source known to the visual art.” *E.g., id.* at 28:67-29:5. For example, the overlay could be used with a cathode ray tube display. *Id.* at Abstract, 6:32-39. Barkan further teaches that “the operator responds to [] data presented on the screen in the simplest way imaginable—that is, by touching the selected portion of the display.” *Id.* at 7:46-48. At that point, “[t]he location of the touch is ‘recognized’ by the interface through its touch-activated switches, and this location recognition is translated, via the programming of the machine, into the desired input.” *Id.* at 7:49-52.

86. In one example, “[s]uch an overlay might be used [] to cover a radar display at an airport traffic control center, the positions of the airplanes being indicated by moving spots of light that constitute a visual display and which are disposed immediately beneath the overlay.” *Id.* at 19:15-20. In the event that “a controller at the airport tower wants to place himself in voice communication with a particular airplane, he touches his finger to the overlay at the location whereat the blip of light corresponding to the airplane is positioned,” and the system will activate a voice channel to that airplane. *Id.* at 19:20-28.

87. Based on the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Claim 14.

**L. Claim 15**

- 1. Claim 15: “The position sensor of 1, further comprising an insulating panel wherein the electrodes in the sensing area are disposed beneath the insulating panel to provide a keypad”**

88. Barkan discloses “[a] transparent touch actuated interface with an interactively related display, in which the display is substantially fully covered by a solid state overlay, *e.g., a keyboard*, composed of one or more to-be-touched contact areas.” *E.g., id.* at Abstract (emphasis added), 4:39-42 (“By way of analogy, the overlay may be considered to be a transparent fixed keyboard, i.e., a transparent keyboard without movable parts.”). Barkan teaches that “for the sake of protecting the contact areas against humidity, chemical deterioration or soil, the exposed surface of the overlay may be covered with a very thin layer of a clear electrically non-conductive material.” *Id.* at 5:49-53.

89. Based on the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Claim 15.

**M. Claim 16**

- 1. Claim 16: “A device comprising the position sensor of 1”**

90. As previously discussed, Barkan discloses “an interreactive [sic] interface in the form of a transparent overlay on a display surface.” *E.g., id.* at 7:43-46, 1:8-24. Barkan teaches that “[t]he interface is adapted to be connected to a utilization mechanism including a broad range of electrical devices such as

computers, teaching machines, read-outs, illuminating means to light up a selected portion or portions of the display, audio/visual apparatuses and playboard means.”

*E.g., id.* at Abstract. For example, the interface may be coupled with a wide variety of devices, including election machines, television surveillance systems, vending machines, and visual display toys. *E.g., id.* at 3:41-4:22. In each instance, the overlay of the touch actuated interface would be integrally combined with a display on the device.

91. Based on the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Claim 16.

**N. Claim 17**

**1. Claim 17, Preamble: “A method comprising”**

92. To the extent the Preamble of Claim 17 is limiting, Barkan discloses a method for depositing a single layer of electrically conductive contact areas on a substrate to form an overlay of a touch actuated interface. *See, e.g., id.* at Abstract; *see also* discussion Sections VIII.A-VIII.D. As previously discussed in connection with Claims 1-2, 4, and 12, Barkan teaches that the contact areas are connected by leads and that both the leads and the contact areas may be formed from conductive materials such as chromium, tin oxide, or zinc oxide deposited via well-known techniques such as sputtering or vacuum evaporation procedures, deposition

through a stencil, or etching. *E.g.*, Ex. 1004 at 15:39-61, 15:53-61; *see also* discussion Sections VIII.A-VIII.B, VIII.D, VIII.H.

93. In view of the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious the Preamble of Claim 17.

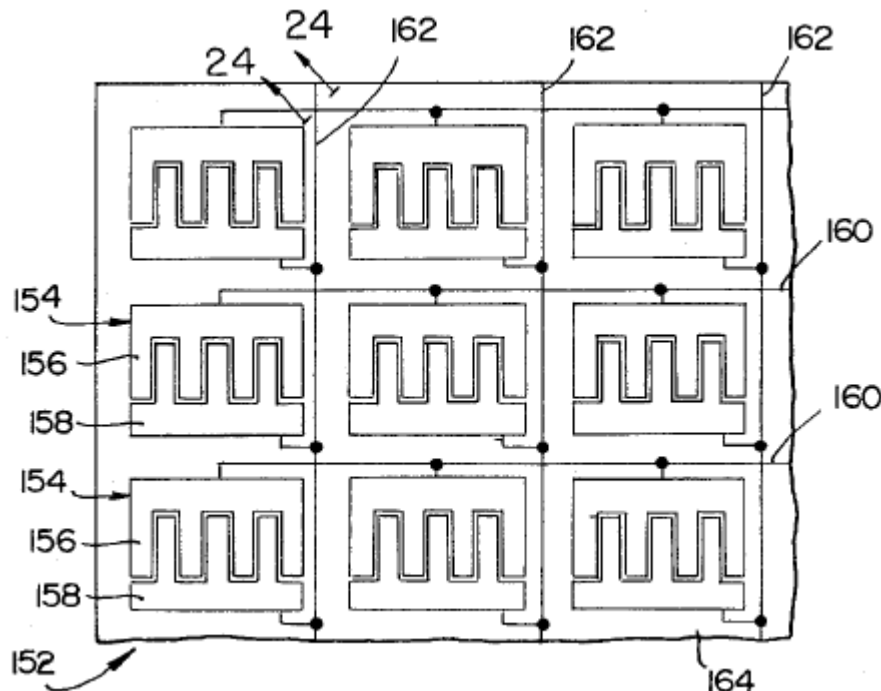
2. **Claim 17, Element A: “depositing a single layer of patterned conductive material on a substrate to form an active sensing region of a capacitive sensor, the pattern comprising rows and columns of electrodes connected to individual ones of capacitive sensing channels, and wherein at least one row or column is broken into a plurality of segments within the active sensing region”**

94. As previously discussed in connection with Claims 1 and 12, Barkan teaches that a single layer of patterned electrically conductive transparent films may be deposited on the surface of a substrate to form an array of contact areas (i.e., “electrodes”) arranged in rows and columns. *See* discussion Sections VIII.A, VIII.H. Barkan teaches that the contact areas are preferably disposed on a single surface of the substrate, and may be formed from conductive materials such as chromium, tin oxide, or zinc oxide deposited via well-known techniques such as sputtering or vacuum evaporation procedures, deposition through a stencil, or etching. *E.g.*, *id.* at 12:47-48 (“The contact areas preferably are flat and their contact surfaces are coplanar.”), 15:39-61, Fig. 23; *see also* discussion Sections VIII.A-VIII.B, VIII.D, VIII.H.



95. As shown in Figure 23 below, the contact areas (labeled 154) are arranged in a grid with columns and rows. *E.g.*, Ex. 1002 at Fig. 23. Each contact sub area includes an X contact sub-area (labeled 156) and a Y contact sub-area (labeled 158), with the X contact sub-areas in each row connected by an X lead (labeled 160) and the Y contact sub-areas in each column connected by a Y lead (labeled 162). *Id.* at 27:1-63, Fig. 23; *see also* discussion Section VIII.A.3.

Because the X and Y contact areas are deposited in a single layer, it is necessary to prevent short circuiting where the leads cross. *Id.*, 12:47-48, 27:52-28:13, Figs. 23-24. For that purpose, thin layers of insulating material may be deposited over the leads in the spaces between the X and Y contact sub-areas. *Id.*



Ex. 1004, Figure 23

96. Barkan teaches that this configuration can be used with a “well known X, Y matrix technique” in which “each X row and each Y column is associated with a different switch” along with other logic circuitry dedicated to each row and column. Ex. 1004 at 26:22-59; 26:64-27:2 (explaining that the configuration shown in Figure 23 is suitable for an “X, Y matrix technique”). To illustrate, Barkan explains that “one of the X switches would have as an antenna therefor all of the contact areas in a given X row, another X switch would have associated therewith as an antenna all of the contact areas in another X row, and, similarly, one Y switch would have associated therewith as an antenna all of the contact areas in a given Y column, etc.” *Id.* at 26:30-36.

97. The contact areas in each row and column are connected to the dedicated X, Y matrix circuitry via the X and Y leads. The matrix circuitry is energized when a contact area in a particular column and row is touched. *Id.* at 26:43-48 (“[I]f a contact area in the second X row and fourth Y column were touched, the 2 X switch and the 4 Y switch would be energized and the outputs from these two switches would control an and gate for an output corresponding to the 2 X/4 Y contact area.”). Accordingly, persons of ordinary skill in the art would have understood that each row and column is connected via an X or Y lead to its own individual matrix circuitry (i.e., “sensing channel”).

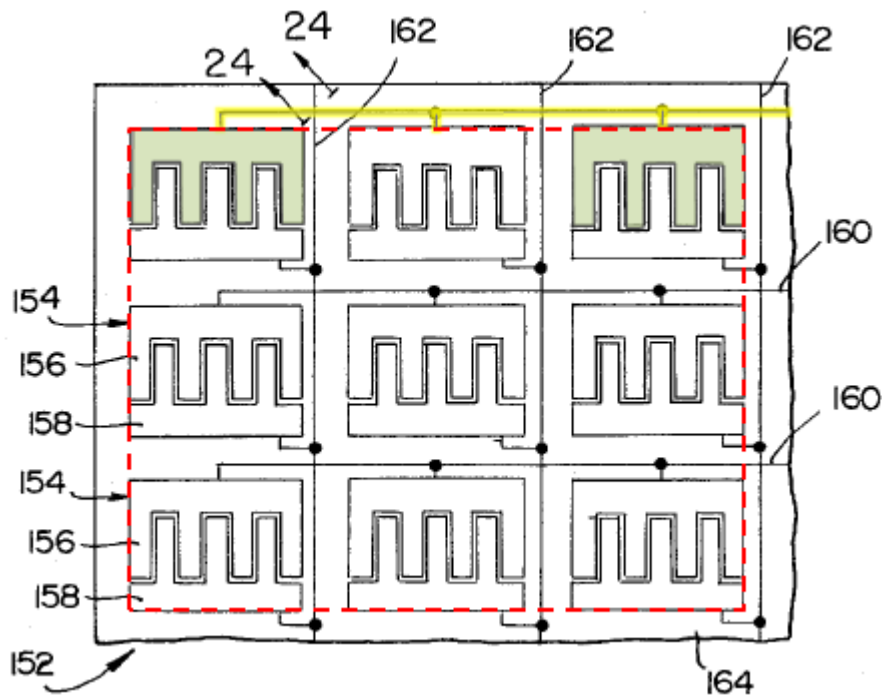
98. As shown in Figure 23 above, and as previously discussed in connection with Element B of Claim 1, each row and column is broken into a plurality of discrete X contact sub-areas and Y contact sub-areas. Persons of ordinary skill in the art would recognize, for example, that the top row of X contact sub-areas and the right-most column of Y contact sub-areas, which are discrete electrodes not electrically connected within the sensing area, are electrodes “broken into a plurality of segments” as recited by Claim 17 of the ’502 Patent. *See id.* Fig. 23, 27:5-6, *see also* discussion Section VIII.A.3 *supra*.

99. In view of the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Element A of Claim 17.

3. **Claim 17, Element B: “connecting a first broken segment at a first end of one of the at least one row or column to a second broken segment at a second end of the one of the at least one row or column using a wrap-around connection lying outside of the active sensing region, the plurality of segments including the first broken segment and the second broken segment”**

100. As previously discussed in connection with Element C of Claim 1 and Claim 4, Barkan discloses leads lying outside the sensing area that connect the individual X contact sub-areas (i.e., “broken segments”) in a row and the individual Y contact sub-areas (i.e., “broken segments”) in a column. *See* Ex. 1004 at 27:52-56, Fig. 23; *see also* discussion Sections VIII.A.4 and VIII.D. For

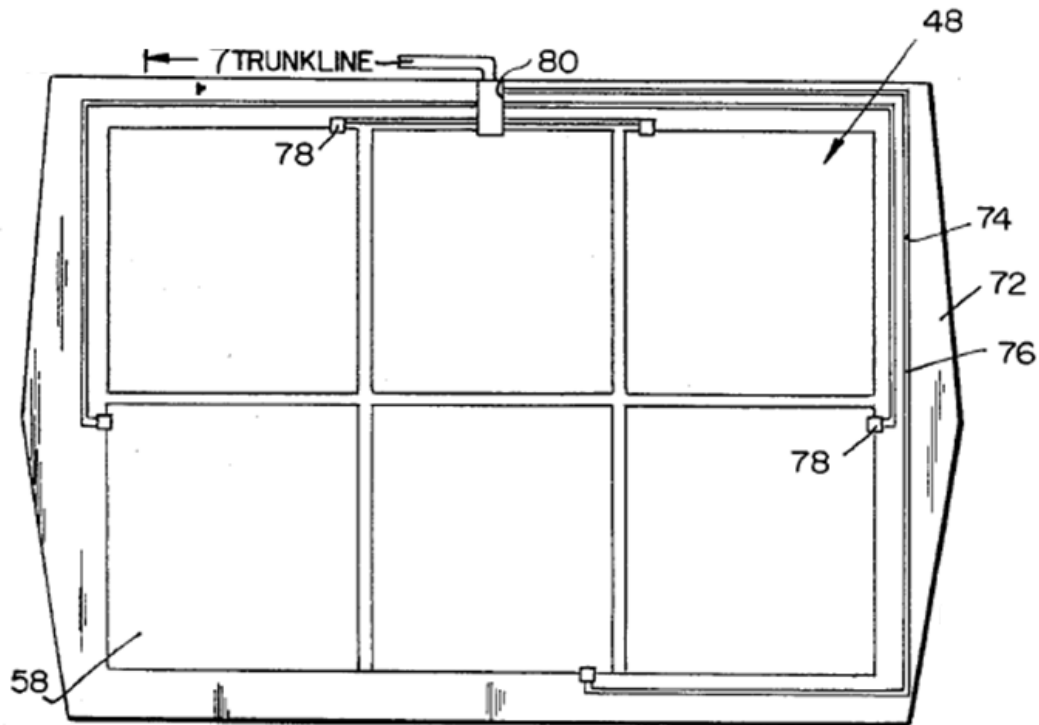
example, as shown in annotated Figure 23 below, the X contact sub-areas (highlighted in green) on the left and right ends of the uppermost row are connected via a lead (highlighted in yellow) that lies outside the sensing area (bounded by a red dashed line) containing the contact areas that sense touch. *Id.*; *see also* Ex. 1001 at 5:44-47 (explaining that “[t]he sensing electrodes 26 define a sensing area within which the position of an object (e.g. a finger or stylus) adjacent the sensor may be determined”). As discussed in connection with Element C of Claim 1, while the uneven edge on the right indicates that the touch sensor extends to the right, possibly with additional contact areas (labeled 154), persons of ordinary skill in the art would have understood that any additional contact areas in the top row, including the right-most one, would be connected to the highlighted lead exactly as those pictured in Figure 23. Thus, persons of ordinary skill in the art would have understood that this lead is a “wrap around connection” connecting “a first broken segment at a first end” of the uppermost row with “a second broken segment at a second end” of the uppermost row. *Id.*



Ex. 1004, Figure 23 (Annotated)

101. Barkan also teaches that the lead connecting the X contact sub-areas in the uppermost row and the lead connecting the Y contact sub-areas in the right edge column could be positioned even further outside the sensing area. With reference to the embodiment shown in Figure 8 below, Barkan explains that the leads (labeled 74 and 76) connecting the contact areas to the processing circuitry may be routed through a series of channels formed in a supporting frame (labeled 72) surrounding the contact areas (labeled 58). *Id.* at 18:22-49, Fig. 8. In this configuration, the leads would run through the channels in the frame to an exit channel (labeled 80) and then to the processing circuitry. *Id.* Persons of ordinary skill in the art would have recognized that the uppermost lead and the right edge

lead in the embodiment of Figure 23 could likewise be routed through a surrounding frame, which would offer numerous advantages, including enhanced protection of the delicate lead and the avoidance of any visual interference with the underlying display.



Ex. 1004, Figure 8

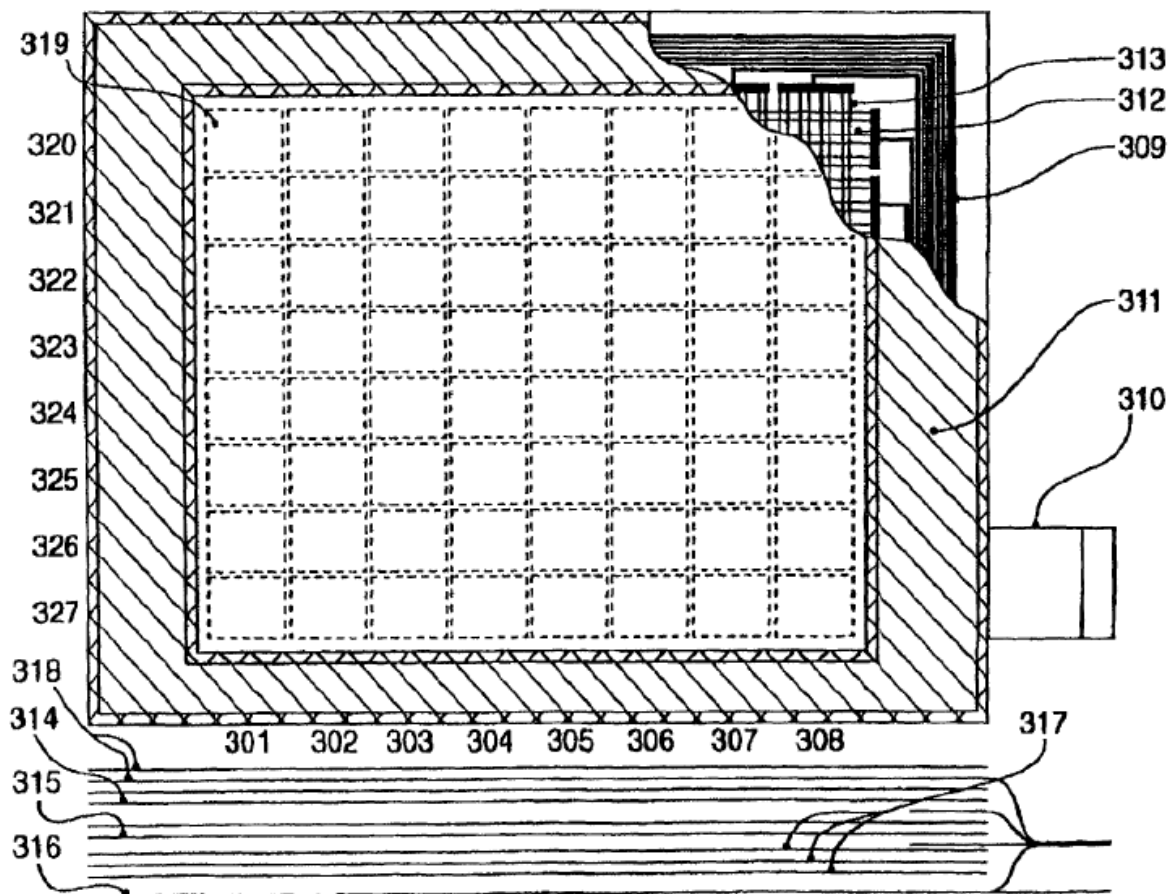
102. In view of the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Element B of Claim 17.

**4. Claim 17, Element C: “connecting the rows and columns to individual sensing channels of a multi-channel capacitive sensor circuit having multiple outputs representing amplitudes of capacitance on the rows and columns”**

103. As previously discussed in connection with Element A of Claim 17, and as shown in Figure 23 below, Barkan teaches that each row and column is connected via a lead to its own dedicated “matrix circuitry,” which includes a switch and one or more “and gates.” *E.g.*, Ex. 1004 at 26:26-59; *see also* discussion Section VIII.A.2. Barkan further teaches that “[t]he associated circuitry is such that any contact area will, upon touching a human finger or an element having a capacitance in the order of that of a human being, actuate the associated switch, and, through that, a utilization mechanism.” *E.g.*, Ex. 1004 at 12:47-52, 16:53-61. Thus, persons of ordinary skill in the art would have recognized that the circuitry associated with each row and column comprises a sensing channel that receives and outputs signals representing amplitudes of capacitance in response to a touch that alters the capacitance of a contact area associated with a row and a column. *See, e.g., id.* at 26:43-48.

104. Tagg teaches a similar configuration of orthogonally arranged rows and columns of electrodes that are coupled to a plurality of capacitance measurement channels. Ex. 1007 at [0178], [0201]. With reference to Figure 23 below, Tagg explains that the eight rows (320-327) and eight columns (301-308) of

electrodes are connected to a “16 channel capacitance measuring device.” *Id.* at [0201]. Accordingly, a POSITA would have understood that each row and column is connected to a capacitance measurement channel of the capacitance measuring device. A POSITA would have found it obvious to incorporate a similar capacitance measuring device to measure the capacitance of each row and column of electrodes taught by Barkan for the reasons discussed in Section VIII.A.



Ex. 1007, Figure 23



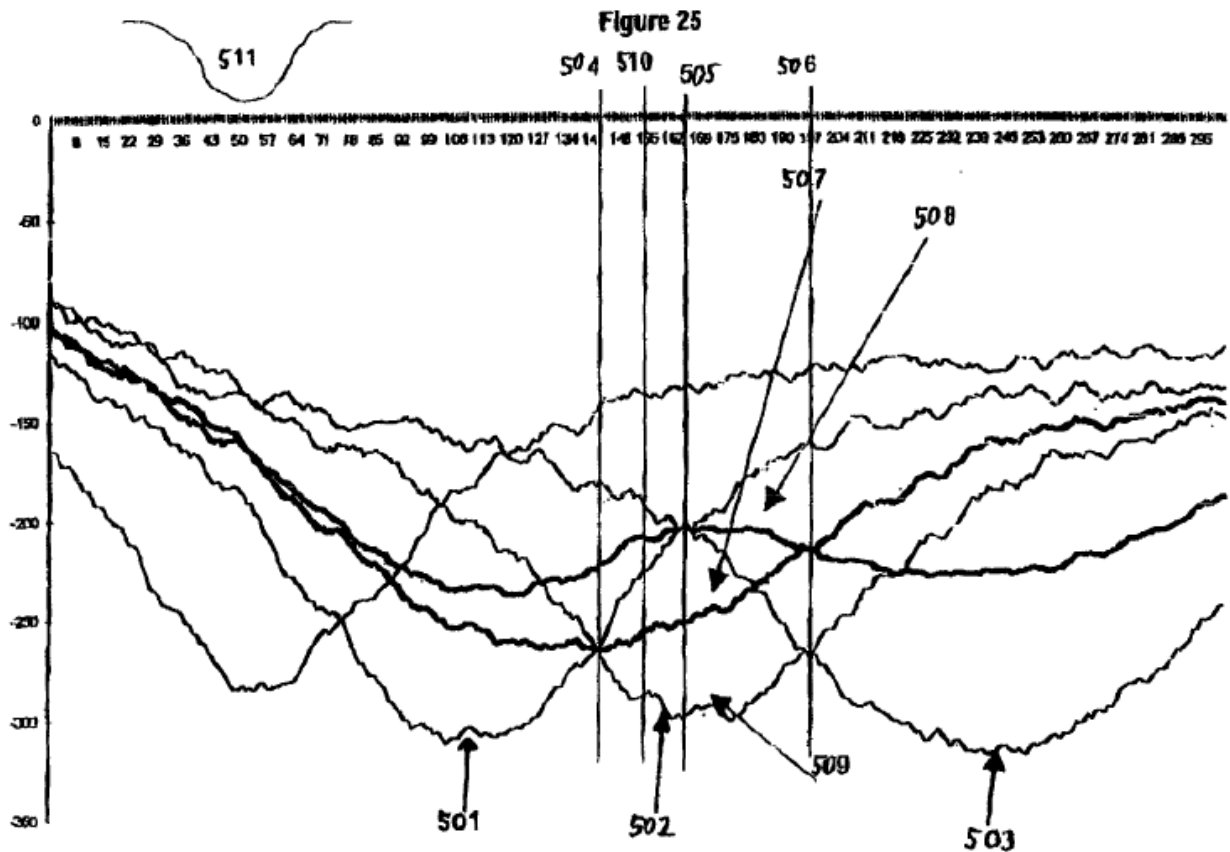
105. In view of the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Element C of Claim 17, either alone or in combination with Tagg.

**5. Claim 17, Element D: “providing a processor operable to process the multiple outputs to determine a XY coordinate position of an object adjacent the active sensing region”**

106. Barkan teaches that the matrix circuitry receives signals from the rows and columns of contact areas and determines the X, Y coordinate position of a touch within the active sensing region. *E.g., id.* at 26:43-48 (“To elucidate further, if a contact area in the second X row and fourth Y column were touched, the 2 X switch and the 4 Y switch would be energized and the outputs from these two switches would control an and gate for an output corresponding to the 2 X/4 Y contact area.”). Barkan further teaches that “[t]he location of the touch is recognized by the interface through its touch-activated switches, and this location recognition is translated, via the programming of the machine, into the desired input.” *Id.* at 7:49-52. Thus, as persons of ordinary skill in the art would have appreciated, the matrix circuitry that includes switches and “and gates” comprises a processor that determines the position of a touch. Furthermore, the interface of Barkan is “adapted to be connected to a utilization mechanism including a broad range of electrical devices such as computers,” which persons of ordinary skill in

the art would recognize as a further processor programmed to process signals from the array of contact areas. *See, e.g., id.* at Abstract, 7:49-52.

107. Tagg also teaches a microprocessor that can interpolate the position of a touch by comparing signals from the columns and rows of electrodes in a touch screen. *E.g.* Ex. 1007 at [0084]-[0085], [0203]-[0211], Fig. 25. For example, Figure 25 below shows the capacitance measured from a series of column electrodes as a finger is moved across the screen from left to right. *Id.* at [0203], Fig. 25. The measured capacitance of each column increases as the finger approaches, then peaks when the finger passes over it, and finally decreases as the finger moves away, forming bell curves. *Id.* A microprocessor can interpolate the position of a touch by comparing these signals at a fixed point in time. *Id.* at [0203]-[0211], Fig. 25. To the extent this limitation is not explicitly disclosed by Barkan, persons of ordinary skill in the art would have been motivated to incorporate the foregoing processing elements of Tagg for the reasons discussed in Section VIII.A.



Ex. 1007, Figure 25

108. Based on the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Element D of Claim 17, either alone or in combination with Tagg.

**O. Claim 18**

- 1. Claim 18: “The method of 17, wherein the processor is operable to compensate for position distortion introduced by the physical geometry of the patterned conductive, material”**

109. Barkan teaches that the touch interface can be configured with contact areas and contact sub-areas of various sizes and shapes. *E.g.*, Ex. 1004 at 8:46-54,

27:26-35. Barkan further teaches that accuracy is a key benefit of the touch interface. Additionally, Barkan provides that “[t]he location of the touch is recognized by the interface through its touch-activated switches, and this location recognition is translated, via the programming of the machine, into the desired input.” *Id.* at 7:49-52, Abstract (explaining that the interface is “adapted to be connected to a utilization mechanism including a broad range of electrical devices such as computers”). Persons of ordinary skill in the art would have understood that this “recognition” and “translation” would necessarily involve compensating for any position distortion introduced by the physical geometry of the patterned conductive, material.

110. To the extent Barkan does not explicitly or inherently disclosed this limitation, persons of ordinary skill in the art would have found it obvious to modify the programming of the interface or the associated computerized utilization mechanism to compensate for any position distortion introduced by the physical geometry of the contact areas, which could be patterned in various sizes and shapes. *See, e.g., id.* at 27:26-35. Persons of ordinary skill in the art would have been motivated to do so in order to ensure accurate touch location that Barkan touts as a key benefit of the touch interface. *See, e.g., id.* at 8:46-54. Persons of ordinary skill in the art would have further recognized that this could be accomplished using well-known circuit components and programming.

111. Indeed, the '502 Patent acknowledges that “the determination of the position of a touch [can] be made using otherwise conventional circuitry connected to the sensing elements. Ex. 1001 at 3:34-36, 9:19-23 (“The signals provided by the capacitance measurement channels have been processed according to conventional techniques, e.g. background capacitance removal, touch threshold detection, normalization and filtering have been performed as desired.”). Accordingly, to the extent Barkan does not otherwise disclose compensation for position distortion, persons of ordinary skill in the art would have recognized that it could be incorporated by applying well-known elements and techniques to a similar item to achieve the benefits taught by Barkan.

112. In view of the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Claim 18.

**IX. SECOND GROUND: CLAIMS 5-7 AND 20 OF THE '502 PATENT ARE RENDERED OBVIOUS BY BARKAN, EITHER ALONE OR IN COMBINATION WITH MARTEN OR TAGG**

113. I have reviewed Barkan, Marten, and Tagg, and I provide my opinions below as to their applicability to Claims 5-7 and 20 of the '502 Patent.

**A. Motivation to Combine**

114. To the extent it is not already disclosed by Barkan, it would have been obvious to persons of ordinary skill to incorporate processing elements from Marten, including capacitance measurement channels comprising a charge transfer

circuit (Claims 5 and 7) and processing circuitry that compares signals from the rows and columns of the sensor and interpolates the position of a touch (Claims 6 and 20). *See* discussion Section IX. Persons of ordinary skill in the art would have been motivated to consult these references as they both disclose capacitive touch sensors and associated processing circuitry for determining the position of a touch on a touch panel. *See, e.g.*, Ex. 1004 at Abstract; Ex. 1005 at Abstract, [0053]-[0054]; *see also* discussion Sections VII.A, VII.B, VIII. IX. Furthermore, the references disclose common components, including an array of electrodes aligned with the X and Y axes and processing circuitry that utilizes switches for controlling and sensing the flow of current through the rows and columns of electrodes. *See, e.g.*, Ex. 1004 at Abstract, 27:1-63, Fig. 23; Ex. 1005 at Abstract, [0053]-[0054]; *see also* discussion Sections VII.A, VII.B, VIII. IX.

115. Persons of ordinary skill in the art would have been motivated to incorporate the processing elements from Marten to improve the noise resistance and accuracy of the touch interface taught by Barkan. Marten teaches that by utilizing the disclosed charge transfer circuit, processing speed can be improved and “the whole circuit can be made quite resistant to the effects of noise currents following [sic] into [the] capacitor.” *E.g.*, Ex. 1005 at Abstract, [0066], [0059], [0094]. Similarly, persons of ordinary skill in the art would have appreciated that the speed and accuracy of the interface could be improved by configuring the

processor to determine the position of a touch by comparing and interpolating the signals from the rows and columns of touch sensing contact areas (i.e., electrodes).

116. Persons of ordinary skill in the art would have appreciated that this could be achieved by combining the well-known and conventional components and techniques taught by Marten to a similar device to yield predictable results. Indeed, the '502 Patent acknowledges that the claimed processing features and steps can be implemented using conventional processing circuitry and techniques. *E.g.*, Ex. 1001 at 3:34-36 (teaching that “the determination of the position of a touch [can] be made using otherwise conventional circuitry connected to the sensing elements”), 9:19-23 (teaching that “the signals provided by the capacitance measurement channels [are] processed according to conventional techniques”), 9:32-37 (“The determination of the position of point P along the x-direction is thus made by comparing the signals from the different columns of column sensing electrodes, and in particular by determining the interpolation or centroid of the signal values. This can be done using conventional processing techniques.”).

117. Marten likewise teaches that the charge transfer circuit for processing touch signals from the capacitive touch pad “utilizes [] general purpose ‘off the shelf’ components and [a] programmable microcontroller (element providing flexibility for changes and adjustments without incurring the high costs of a custom IC design)”). Ex. 1005 at Abstract, [0025]. Persons of ordinary skill in the

art would have thus understood that like the processing components and techniques disclosed by the '502 Patent, the processing components and techniques taught by Marten are not customized for a specific touch sensor, and could have been incorporated with the interface of Barkan to yield predictable results and improved performance. For these reasons, along with those discussed below, persons of ordinary skill in the art would have been motivated to incorporate the processing elements and techniques taught by Marten with the interface of Barkan and would have understood how to do so.

**B. Claim 5**

- 1. Claim 5: “The position sensor of 1, further comprising a plurality of capacitance measurement channels connected to respective ones of the rows and columns of sensing electrodes, wherein each measurement channel is operable to generate a signal indicative of a capacitance between its associated column or row of sensing electrodes and a system ground”**

118. As previously discussed in connection with Elements A and C of Claim 17, Barkan teaches that each row of X contact sub-areas (i.e., “row sensing electrodes”) and each row of Y contact sub-areas (i.e., “column sensing electrodes”) is connected to its own dedicated matrix circuitry (i.e., “capacitance measurement channels”) that includes a capacitive switch and one or more “and gates.” *E.g.*, Ex. 1004 at 26:26-59; *see also* discussion Sections VIII.M.2 and VIII.M.4. As previously discussed in connection with Element D of Claim 17,

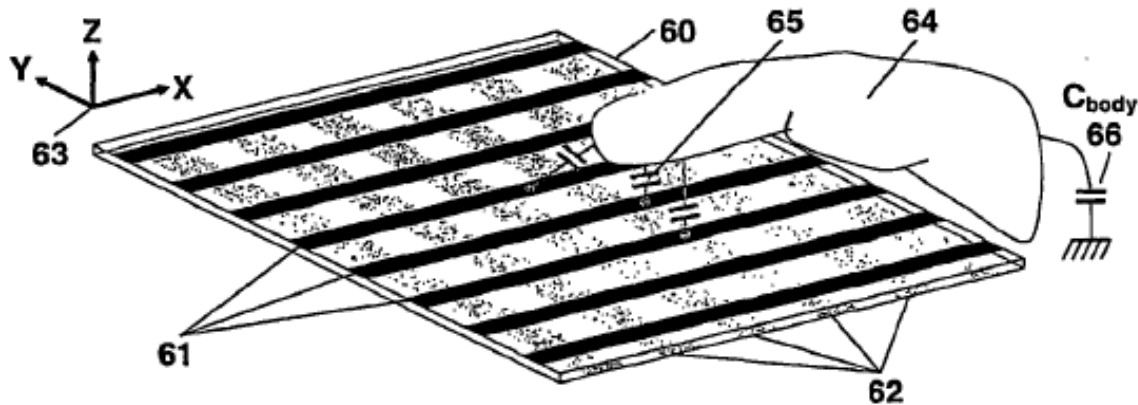


Barkan teaches that the switches associated with a row and a column will output signals to the “and gates” when a contact area in that row and column is touched. *E.g., id.* at 12:48-52, 26:43-48 (“To elucidate further, if a contact area in the second X row and fourth Y column were touched, the 2 X switch and the 4 Y switch would be energized and the outputs from these two switches would control an and gate for an output corresponding to the 2 X/4 Y contact area.”).

119. As persons of ordinary skill in the art would have recognized, these switches would be energized in response to a touch that would alter the capacitance between their associated row and column electrodes and a system ground. Accordingly, persons of ordinary skill in the art would have also understood that the signals output by the switches would be indicative of a capacitance between the row and column electrodes and a system ground.

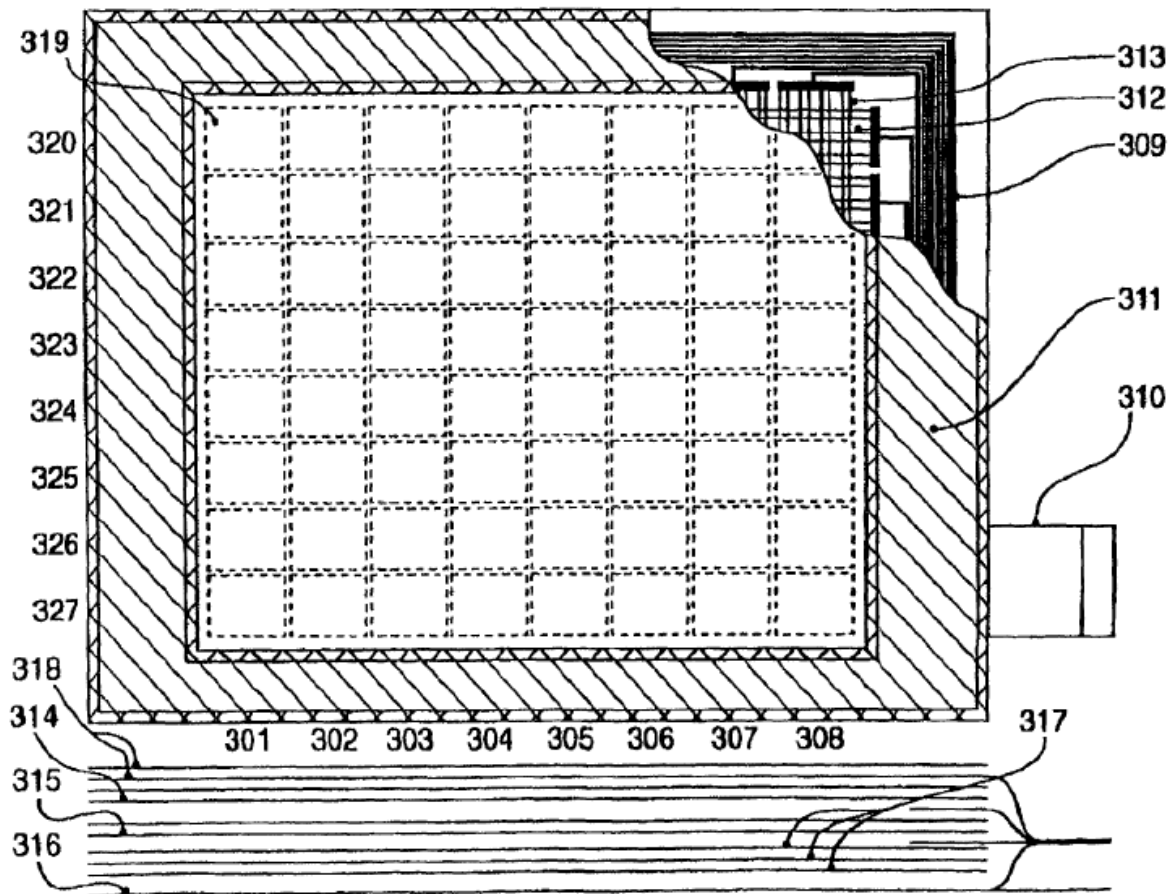
120. To the extent Barkan does not explicitly or inherently disclose this limitation, Marten discloses a similar capacitive touch pad and associated circuitry that determines the X and Y coordinates of a touch. *E.g., Ex. 1005* at [0007]-[0010], [0013], [0053]. With reference to Figure 6 below, Marten teaches that “[t]he position [of a touch by a grounded human] is determined by measurement of the changes of the capacitances to ground for all the electrodes (belonging to both group 61 and 62), followed by extrapolation of the position between the electrodes.” *E.g., id.* at [0054]. Persons of ordinary skill in the art would have

thus understood that the row and column electrodes in groups 61 and 62 are coupled to a plurality of capacitance measurement channels that generate signals indicative of the changes in capacitance to ground for the electrodes.



Ex. 1005, Figure 6

121. Tagg teaches a similar configuration of orthogonally arranged rows and columns of electrodes that are coupled to a plurality of capacitance measurement channels. Ex. 1007 at [0178], [0201]. With reference to Figure 23 below, Tagg explains that the eight rows (320-327) and eight columns (301-308) of electrodes are connected to a “16 channel capacitance measuring device.” *Id.* at [0201]. Accordingly, persons of ordinary skill in the art would have understood that each row and column is connected to a capacitance measurement channel of the capacitance measuring device.

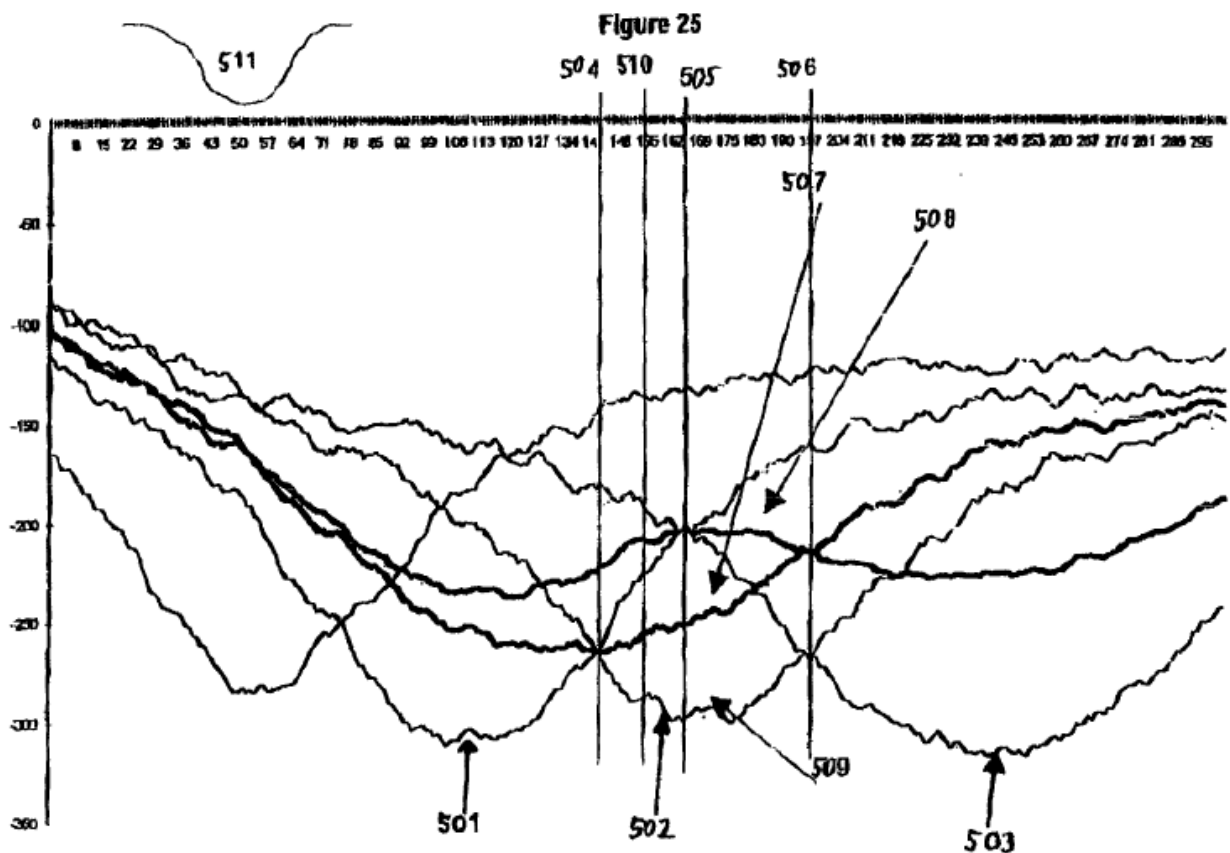


Ex. 1007, Figure 23

122. Tagg further teaches that the measurement channels associated with the rows and columns of electrodes output signals indicative of the capacitance of each row and column that can be used to interpolate the position of a touch. Ex. 1007 at [0203]-[0211], Fig. 25. For example, Figure 25 below shows the capacitance measured from a series of column electrodes as a finger is moved across the screen from left to right. *Id.* at [0203], Fig. 25. The measured capacitance of each column increases as the finger approaches, then peaks when

the finger passes over it, and finally decreases as the finger moves away, forming bell curves. *Id.* A microprocessor can interpolate the position of a touch by comparing these signals at a fixed point in time. *Id.* at [0203]-[0211], Fig. 25.

Persons of ordinary skill in the art would have thus understood that the plurality of capacitive measurement channels generate signals indicative of the capacitance between their associate rows and columns of electrodes and a system ground. To the extent this limitation is not explicitly disclosed by Barkan, persons of ordinary skill in the art would have been motivated to incorporate the foregoing processing elements of Tagg for the reasons discussed in Section VIII.A.



Ex. 1007, Figure 25

123. In view of the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Claim 5, either alone or in combination with Marten or Tagg.

**C. Claim 6**

1. **Claim 6: “The position sensor of 5, further comprising a processor operable to determine the position of the object in the sensing area along a first direction by comparing signals from the different columns with each other and along a second direction by comparing signals from the different rows with each other”**

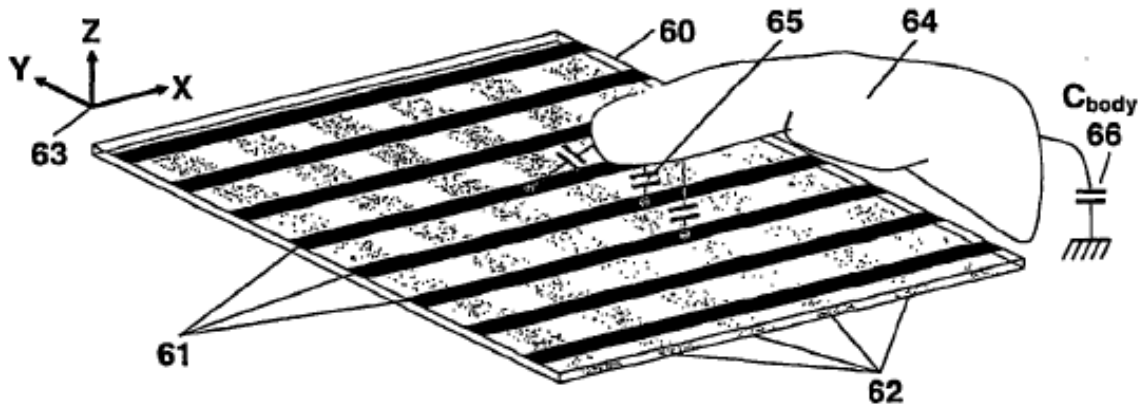
124. As previously discussed in connection with Elements A and D of Claim 17 and Claim 5, Barkan discloses matrix circuitry that receives signals from the various rows and columns of contact areas and determines the X, Y coordinate position of a touch within the in the active sensing region. *E.g., id.* at 26:43-48 (“To elucidate further, if a contact area in the second X row and fourth Y column were touched, the 2 X switch and the 4 Y switch would be energized and the outputs from these two switches would control an and gate for an output corresponding to the 2 X/4 Y contact area.”). Barkan further teaches that “[t]he location of the touch is recognized by the interface through its touch-activated switches, and this location recognition is translated, via the programming of the machine, into the desired input.” *Id.* at 7:49-52. Persons of ordinary skill in the art

would have recognized that this involves a comparison of the different signals from the columns and rows to distinguish those that have energized their associated matrix circuitry from those that have not.

125. As persons of ordinary skill in the art would have appreciated, the matrix circuitry and “the programming of the machine” that translates the signals from the switches comprise a processor that can determine the position of a touch. Ex. 1004, 7:49-52. Furthermore, the interface of Barkan is “adapted to be connected to a utilization mechanism including a broad range of electrical devices such as computers,” which persons of ordinary skill in the art would have recognized as an additional processor programmed to process signals from the array of contact areas and determine the position of a touch. *See, e.g.*, Ex. 1004, Abstract, 7:49-52.

126. To the extent Barkan does not explicitly or inherently disclose this limitation, it would be rendered obvious by Marten. Marten teaches a capacitive touch pad with a first group of electrodes parallel to the X-axis for determining the Y coordinate of a touch and a second group of electrodes parallel to the Y-axis for determining the X coordinate of a touch. *E.g.*, Ex. 1005 at [0053], [0007]-[0008], Fig. 6. As shown in Figure 6 below, Marten teaches that “the capacitances 65 between the digit 64 and electrodes belonging to group 61 (as illustrated in FIG. 6) allow for the determination of the position of the digit's tip 64 in the Y-axis [and]

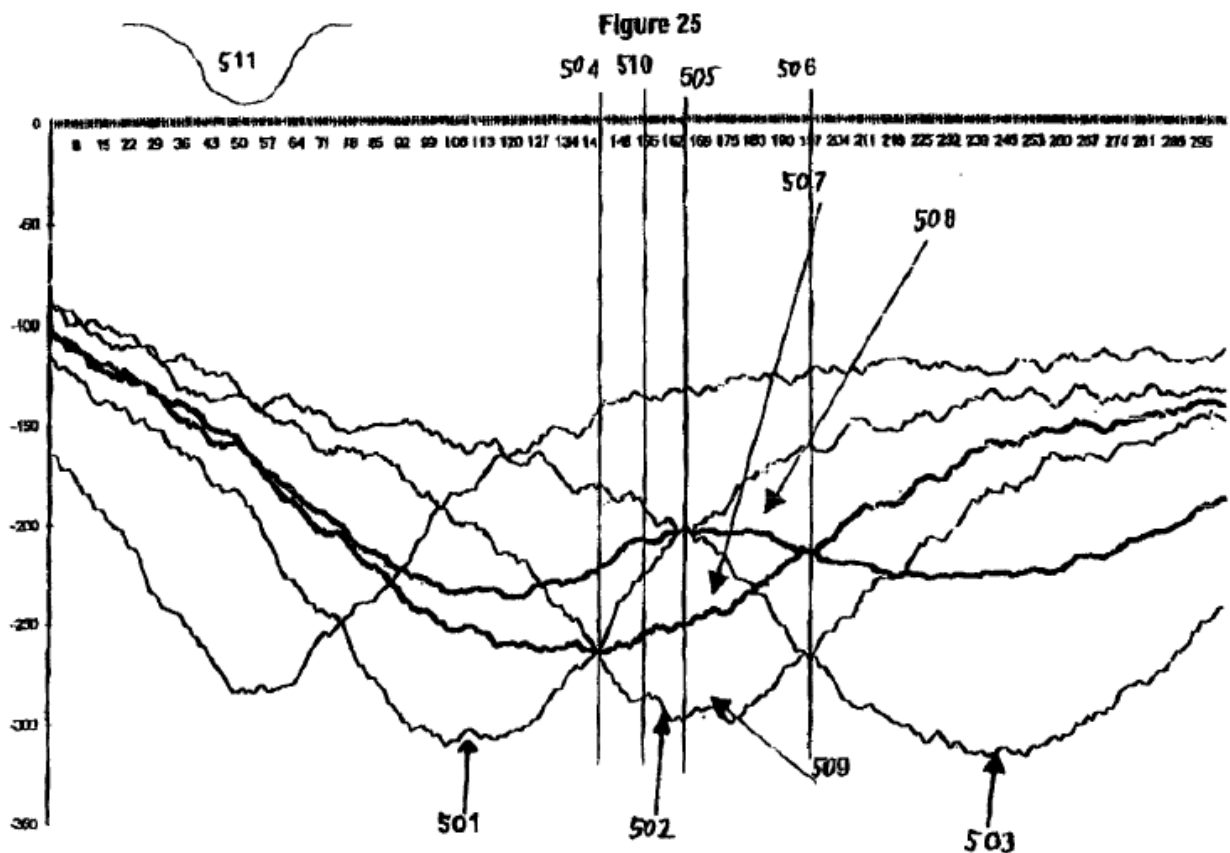
[t]he capacitances between the digit 64 and group of electrodes 62 (not shown for clarity) allow the determination of the position in the X-axis.” *Id.* Marten further teaches that “[t]he position is determined by measurement of the changes of the capacitances to ground for all the electrodes (belonging to both group 61 and 62), followed by extrapolation of the position between the electrodes.” *Id.* at [0054], [0010]. Persons of ordinary skill in the art would understand that this involves a comparison of the signals from the different rows and columns to determine which row and column exhibited the greatest change in capacitance from the touch and thereby extrapolate the position of the touch.



Ex. 1005, Figure 6

127. Tagg also teaches a microprocessor that can interpolate the position of a touch by comparing signals from the columns and rows of electrodes in a touch screen. *E.g.* Ex. 1007 at [0084]-[0085], [0203]-[0211], Fig. 25. For example, Figure 25 below shows the capacitance measured from a series of column

electrodes as a finger is moved across the screen from left to right. *Id.* at [0203], Fig. 25. The measured capacitance of each column increases as the finger approaches, then peaks when the finger passes over it, and finally decreases as the finger moves away, forming bell curves. *Id.* A microprocessor can interpolate the position of a touch by comparing these signals at a fixed point in time. *Id.* at [0203]-[0211], Fig. 25. To the extent this limitation is not explicitly disclosed by Barkan, persons of ordinary skill in the art would have been motivated to incorporate the foregoing processing elements of Tagg for the reasons discussed in Section VIII.A.





Ex. 1007, Figure 25

128. In view of the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Claim 6, either alone or in combination with Marten or Tagg.

**D. Claim 7**

**1. Claim 7: “The position sensor of 5, wherein the capacitance measurement channels comprise a charge transfer circuit”**

129. As previously discussed in connection with Claims 5 and 17, Barkan discloses matrix circuitry associated with each row and column that includes switches and “and gates” that are activated when the contact areas (i.e., “sensing electrodes”) in their associated columns and rows are touched by a finger. *E.g.*, Ex. 1004 at 12:47-52 (“The associated circuitry is such that any contact area will, upon touching a human finger of an element having a capacitance in the order of that of a human being, actuate the associated switch, and, through that, a utilization mechanism.”), 26:43-48. In keeping with basic principles of capacitance, persons of ordinary skill in the art would have appreciated that the switches would be actuated in response to some amount of the stored charge in the capacitive contact areas being transferred through the human finger upon contact. Thus, persons of ordinary skill in the art would have understood that the capacitive touch interface includes a charge transfer circuit.

130. This is consistent with the '502 Patent, which does not provide any description of the structure or function of a charge transfer circuit, and instead merely mentions that “[p]referably, the sensing channels 42 are multiple in-phase charge-transfer sensors of the type described in U.S. Pat. No. 5,730,165 or U.S. Pat. No. 6,466,036.” Ex. 1001 at 8:16-18. To the extent Barkan does not explicitly or inherently disclose a charge transfer circuit, however, Marten discloses “[a] Circuit (in FIG. 1) and an Algorithm for Data Acquisition from Capacitive Touch Pad Sensor [that] employs charge transfer to sense capacitance.” *E.g.*, Ex. 1005 at Abstract, [0059]-[0060].

131. Based on the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Claim 7, either alone or in combination with Marten.

**E. Claim 20**

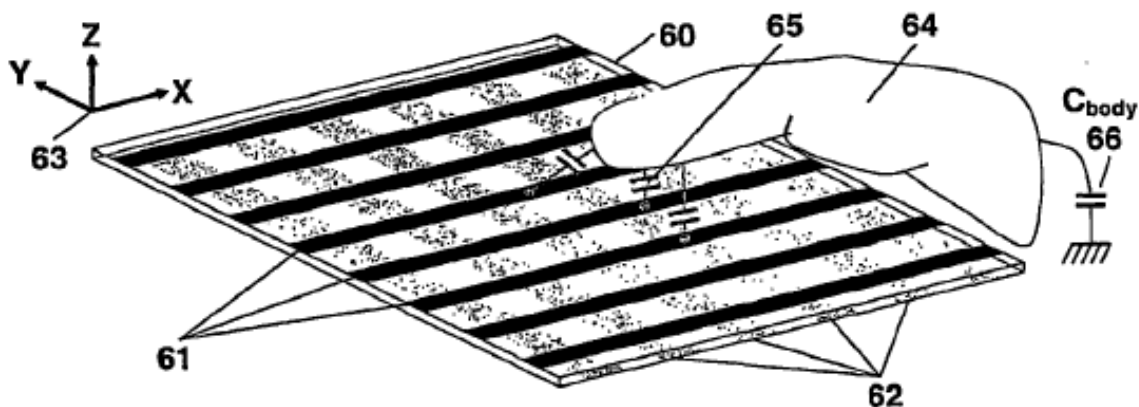
**1. Claim 20: “The method of 17, wherein the processor is operable to calculate an interpolation of the signals across rows and an interpolation of the signals across columns”**

132. As previously discussed in connection with Elements A and D of Claim 17 and Claims 5 and 6, Barkan discloses matrix circuitry that receives signals from the various rows and columns of contact areas and determines the X, Y coordinate position of a touch within the in the active sensing region. *E.g.*, *id.* at 26:43-48 (“To elucidate further, if a contact area in the second X row and fourth Y

column were touched, the 2 X switch and the 4 Y switch would be energized and the outputs from these two switches would control an and gate for an output corresponding to the 2 X/4 Y contact area.”). Barkan further teaches that “[t]he location of the touch is recognized by the interface through its touch-activated switches, and this location recognition is translated, via the programming of the machine, into the desired input.” *Id.* at 7:49-52. Persons of ordinary skill in the art would have recognized that this involves a comparison and interpolation of the different signals from the columns and rows to distinguish those that have energized their associated matrix circuitry from those that have not and to determine a final position of the touch.

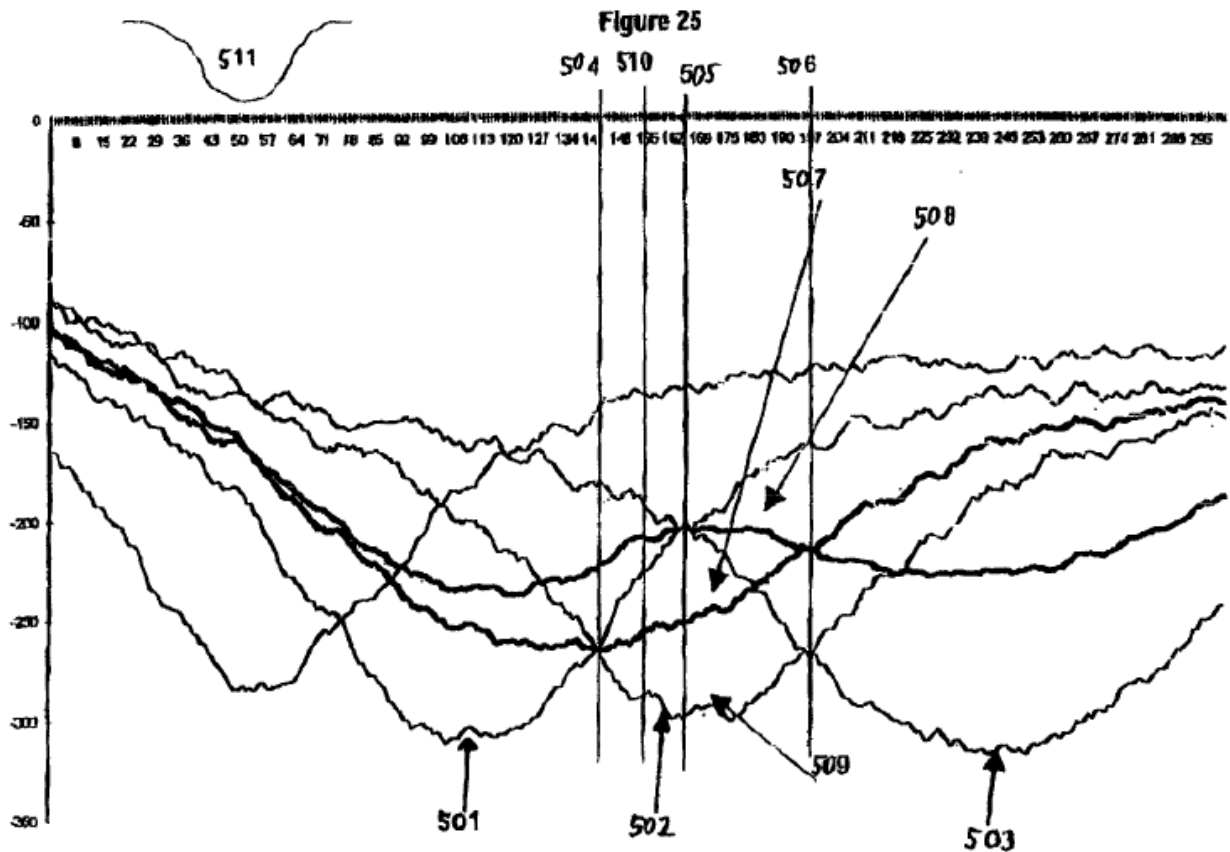
133. To the extent Barkan does not explicitly or inherently disclose this limitation, it would be rendered obvious by Marten. Marten teaches a capacitive touch pad with a first group of electrodes parallel to the X-axis for determining the Y coordinate of a touch and a second group of electrodes parallel to the Y-axis for determining the X coordinate of a touch. *E.g.*, Ex. 1005 at [0053], [0007]-[0008], Fig. 6. As shown in Figure 6 below, Marten teaches that “the capacitances 65 between the digit 64 and electrodes belonging to group 61 (as illustrated in FIG. 6) allow for the determination of the position of the digit's tip 64 in the Y-axis [and] [t]he capacitances between the digit 64 and group of electrodes 62 (not shown for clarity) allow the determination of the position in the X-axis.” *Id.* Marten further

teaches that “[t]he position is determined by measurement of the changes of the capacitances to ground for all the electrodes (belonging to both group 61 and 62), followed by extrapolation of the position between the electrodes.” *Id.* at [0054], [0010]. Persons of ordinary skill in the art would understand that this extrapolation (i.e., “interpolation”) involves a comparison of the signals across the rows and columns to determine the coordinates where the greatest change in capacitance from the touch is exhibited. A POSITA would have thus recognized that this extrapolation process is functionally identical to the interpolation recited in Claim 20 of the ’502 Patent. *See* Ex. 1001, 8:32-41 (explaining that “[t]he interpolated position of the capacitive load along the x-direction is determined from the signals from the capacitance measurement channels associated with the columns of column sensing electrodes and the interpolated position of the capacitive load along the y-direction is determined from the signals from the capacitance measurement channels associated with the rows of row sensing electrodes.”)



Ex. 1005, Figure 6

134. Tagg also teaches a microprocessor that can interpolate the position of a touch by comparing signals from the columns and rows of electrodes in a touch screen. *E.g.* Ex. 1007 at [0084]-[0085], [0203]-[0211], Fig. 25. For example, Figure 25 below shows the capacitance measured from a series of column electrodes as a finger is moved across the screen from left to right. *Id.* at [0203], Fig. 25. The measured capacitance of each column increases as the finger approaches, then peaks when the finger passes over it, and finally decreases as the finger moves away, forming bell curves. *Id.* A microprocessor can interpolate the position of a touch by comparing these signals at a fixed point in time. *Id.* at [0203]-[0211], Fig. To the extent this limitation is not explicitly disclosed by Barkan, persons of ordinary skill in the art would have been motivated to incorporate the foregoing processing elements of Tagg for the reasons discussed in Section VIII.A.



Ex. 1007, Figure 25

135. Based on the foregoing disclosures, persons of ordinary skill in the art would have understood that Barkan discloses or renders obvious Claim 7, either alone or in combination with Marten or Tagg.

**X. THIRD GROUND: CLAIMS 8 AND 21 OF THE '502 PATENT ARE RENDERED OBVIOUS BY BARKAN IN COMBINATION WITH MARTEN OR WITH MARTEN AND BOIE**

136. I have reviewed Barkan, Marten, and Boie, and I provide my opinions below as to their applicability to Claims 8 and 21 of the '502 Patent.

**A. Motivation to Combine**

137. It would have been obvious to persons of ordinary skill in the art to incorporate processor elements from Marten or Boie that drive the sensing electrodes of the touch pad in a substantially phase synchronous manner (Claims 18 and 21). Like Barkan and Marten, Boie is directed to capacitive touch sensors and associated processing circuitry for determining the position of a touch on a touch panel. *See, e.g.*, Ex. 1004 at Abstract; Ex. 1005 at Abstract, [0053]-[0054]; Ex. 1006 at Abstract, Figs. 2-4; *see also* discussion Sections VII.A-VII.C, VIII., IX. Barkan and Boie disclose highly similar touch sensor configurations with interleaved row and column electrodes deposited in a grid on a substrate and connected within each column and row by leads. *See, e.g.*, Ex. 1004 at Fig. 23; Ex. 1006 at Fig. 2; *see also* discussion Sections VII.A, VII.C, VIII., X.

138. As previously discussed in connection with Claims 1-4 and 9-18, persons of ordinary skill in the art would have been motivated to combine the processing elements and techniques taught by Marten with the interface of Barkan. *See* discussion Section VIII.A *supra*. Marten teaches that by driving the electrodes in a phase synchronous manner and using a synchronous detector, the processing circuitry is “capable of suppression of noise and unwanted signals due to their phase difference or non-synchronicity to the excitation signal.” *E.g.*, Ex. 1005 at [0014]. Boie teaches the same benefit can be achieved by using a phase

synchronous drive signal. *E.g.*, Ex. 1006 at 4:58-61 (“The effects of electrode-to-electrode capacitances, wiring capacitances and other extraneous capacitances are minimized by driving all electrodes and guard plane 411 in unison with the same RF signal from RF oscillator”). Accordingly, persons of ordinary skill in the art would have been motivated to incorporate the single voltage source taught by Marten or the single oscillator taught by Boie to improve the noise resistance of the interface disclosed by Barkan. *See* discussion Section IX.A *supra*.

139. As discussed in detail in connection with Claims 1-4 and 9-18, both the '502 Patent and Marten teach that the processing circuitry recited in the challenged claims and the processing circuitry disclosed by Marten is conventional circuitry that utilizes well-known techniques to perform the claimed functions. *E.g.*, Ex. 1001 at 3:34-36 (teaching that “the determination of the position of a touch [can] be made using otherwise conventional circuitry connected to the sensing elements”), 9:19-23 (teaching that “the signals provided by the capacitance measurement channels [are] processed according to conventional techniques”), 9:32-37 (“The determination of the position of point P along the x-direction is thus made by comparing the signals from the different columns of column sensing electrodes, and in particular by determining the interpolation or centroid of the signal values. This can be done using conventional processing techniques.”); *see also* discussion Section IX.A *supra*. The '502 Patent further explains that the



circuitry taught by Boie can be used to provide a phase synchronous drive signal.

Ex. 1001 at 3:40-47, 8:11-16.

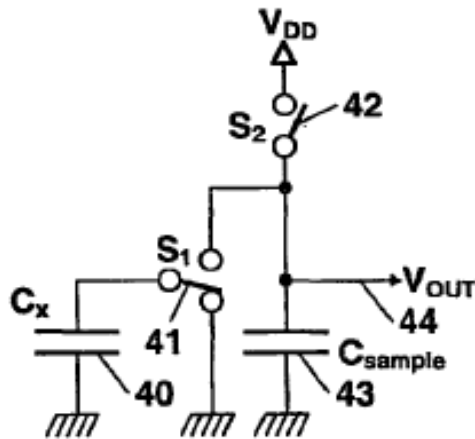
140. Persons of ordinary skill in the art would have thus understood that the well-known and conventional processing components and techniques taught by Marten and Boie are not customized for a specific touch sensor, and could have been incorporated with the interface of Barkan to yield predictable results and drive the electrodes in a substantially phase synchronous manner. This could be achieved by simply driving the electrodes with a single signal from a single oscillator or other voltage source as taught by Marten and Boie. For these reasons, along with those discussed below, persons of ordinary skill in the art would have been motivated to incorporate the processing elements and techniques taught by Marten or Boie with the interface of Barkan and would have understood how to do so.

**B. Claims 8 and 21**

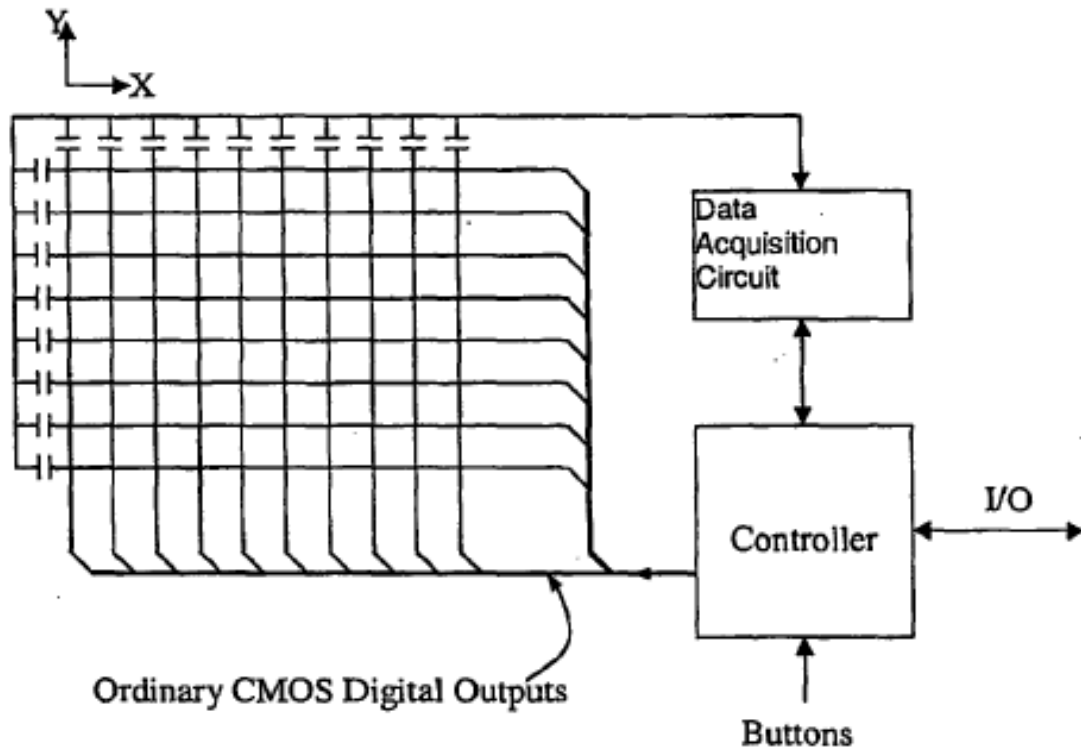
1. **Claim 8: “The position sensor of 5, wherein the capacitance measurement channels are configured to drive a plurality of sensing electrodes substantially synchronously in phase with one another”**  
**Claim 21: “The method of 17, wherein the capacitive sensing channels employ driving signals which are substantially phase-synchronous with respect to one another”**

141. As discussed above, Claim 5 is disclosed or rendered obvious by Barkan, alone or in combination with Marten, and Claim 17 is disclosed or rendered obvious by Barkan (Section VII.A.13 above).

142. Marten teaches that “[t]he extraction of the useful signal is typically carried with a synchronous detector, capable of suppression of noise and unwanted signals due to their phase difference or non-synchronicity to the excitation signal.” *E.g.*, Ex. 1005 at [0014]. In addition, the exemplary processing circuits shown in Figures 1 and 4 include a single voltage source (labeled Vdd in Figure 4 below). *Id.* at Figs. 1, 4; *see also* Figs. 11 and 12 (showing an embodiment in which all rows and columns are driven by a common controller with a voltage source). Accordingly, persons of ordinary skill in the art would have appreciated that the processing circuitry of Marten is configured to drive the plurality of electrodes substantially synchronously in phase with one another.



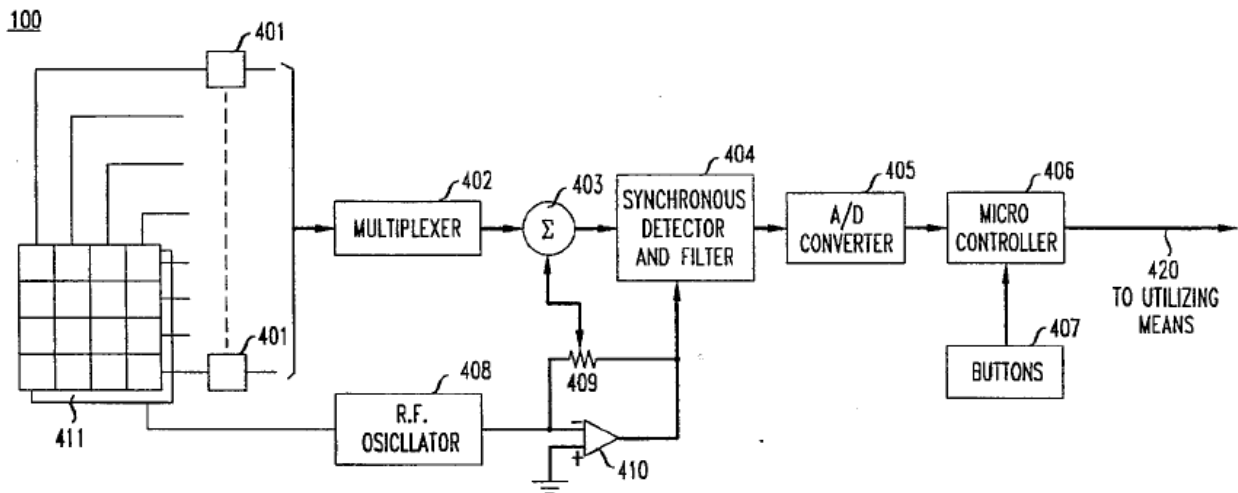
Ex. 1005, Figure 4



Ex. 1005, Figure 11

143. Alternatively, the '502 Patent acknowledges the method used to drive a plurality of sensing electrodes substantially synchronously in phase with one

another was disclosed in the admitted prior art such as Boie, which “drive[s] all the rows and columns with a single oscillator simultaneously.” Ex. 1001 at 8:11-16, 8:16-20 (explaining that “the sensing channels [may be] multiple in-phase charge-transfer sensors of the type described in U.S. Pat. No. 5,730,165 or U.S. Pat. No. 6,466,036”). With reference to Figure 4 below, Boie teaches the use of a synchronous detector (labeled 404) and a single RF oscillator that drives the rows and columns of the capacitive sensor (labeled 400) in unison with the same RF signal. *E.g.*, Ex. 1006 at 3:64-4:2, 4:58-61, Fig. 4. Persons of ordinary skill in the art would have appreciated that Boie discloses a single voltage source for driving the rows and columns of electrodes substantially synchronously in phase with one another.



Ex. 1006, Figure 4

144. Based on the foregoing disclosures, persons of ordinary skill in the art would have understood that the combined disclosures and teaching of Barkan with Marten or Boie render obvious Claims 8 and 21.

**XI. FOURTH GROUND: CLAIM 19 OF THE '502 PATENT IS RENDERED OBVIOUS BY BARKAN IN COMBINATION WITH BOIE**

145. I have reviewed Barkan and Boie, and I provide my opinions below as to their applicability to Claim 19 of the '502 Patent.

**A. Motivation to Combine**

146. As previously discussed, in connection with Claims 8 and 21, it would have been obvious to persons of ordinary skill to incorporate processing elements taught by Boie, including elements or programming that calculate a centroid of touch signals across the rows and columns of the touch pad. *See* discussion Section X.A *supra*. Boie teaches that the processing circuitry and methods it discloses can be utilized with various touch sensor types and configurations. *E.g.*, Ex. 1006 at 2:42-47, 3:37-38, 7:26-44, Figs. 2-4.

147. Persons of ordinary skill in the art would have thus understood that the versatile and conventional processing techniques taught by Boie could have been incorporated with the interface of Barkan to yield predictable results and calculate a centroid of capacitance across the rows and columns of the touch sensor. This could be achieved by simply modifying the programming of the

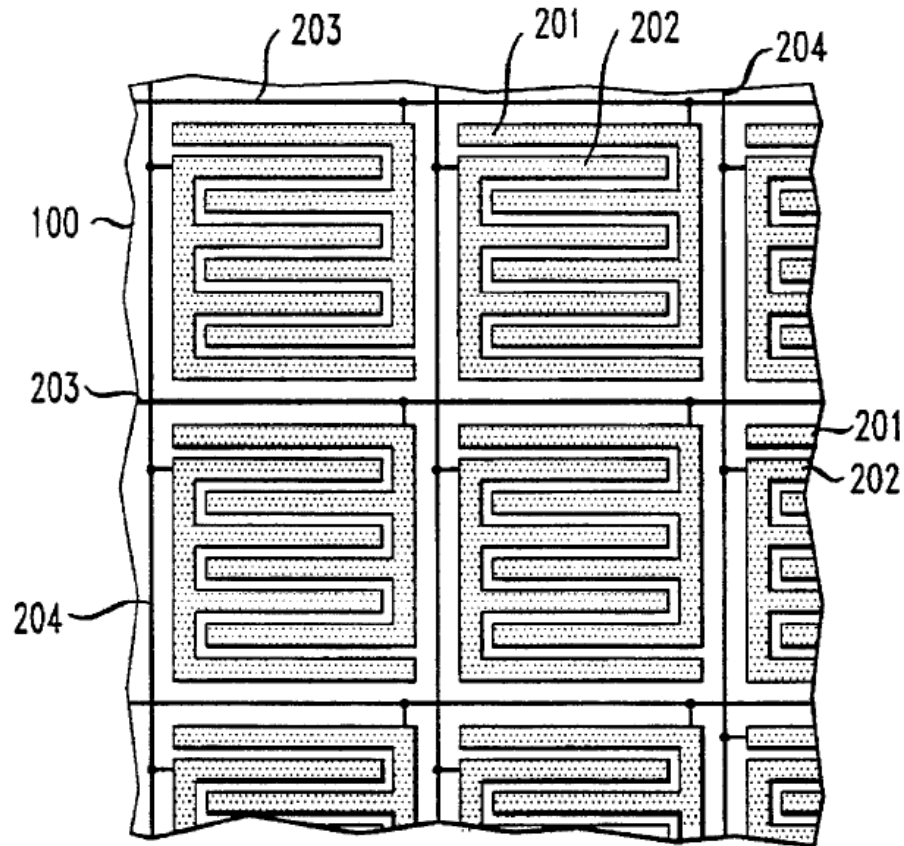
processor in the interface or the utilization mechanism of Barkan to perform a simple calculation of the centroid of capacitance based on signals from the rows and columns of electrodes. This would have been within the knowledge and skills of persons of ordinary skill in the art well before July 2005. For these reasons, along with those discussed below, persons of ordinary skill in the art would have been motivated to incorporate the processing elements and techniques taught by Boie with the interface of Barkan and would have understood how to do so.

**B. Claim 19**

**1. Claim 19: “The method of 17, wherein the processor is operable to calculate a centroid of the signals across rows and a centroid of the signals across columns”**

148. As previously discussed, Claim 17 is disclosed or rendered obvious by Barkan. Like Barkan and Marten, Boie discloses a capacitive sensor with a plurality of electrodes that can be divided into separate horizontal and vertical elements connected in columns and rows as shown in Figure 2 below. *E.g.*, Ex. 1006 at 1:61-2:5, 3:9-22, Fig. 2. Boie teaches that in this configuration, the capacitances are measured separately for each column and row and the x and y coordinates of the centroid of capacitance are determined in a microcontroller. *E.g.*, *id.* at 1:61-2:5, 3:9-15, 5:10-49 (explaining the method and calculation for determining the centroid of capacitance “[f]or applications in which the electrodes

of array 100 are connected in rows and columns, as shown in FIG. 2 and FIG. 3”),  
Figs. 2, 6.



Ex. 1006, Figure 2

149. Based on the foregoing disclosures, persons of ordinary skill in the art would have understood that the combined disclosures and teaching of Barkan and Boie render obvious Claim 19.

## **XII. SECONDARY CONSIDERATIONS**

150. I have considered and evaluated the impact of secondary indicia of non-obviousness. With respect to the claims at issue and the prior art discussed

herein, none of these secondary indicia impact my opinion one way or another in terms of the obviousness of these claims in light of the art discussed.


### **XIII. CONCLUSION**

151. For the foregoing reasons, it is my opinion that (1) all elements of Claims 1-4 and 9-18 are rendered obvious by Barkan, either alone or in combination with Tagg; (2) all elements of Claims 5-7 and 20 are rendered obvious by Barkan, either alone or in combination with Tagg or Marten; (3) all elements of Claims 8 and 21 are rendered obvious by Barkan in combination with Marten or with Marten and Boie; and (4) all elements of Claim 19 are rendered obvious by Barkan in combination with Boie.



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

Date: December 12, 2019

  
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Dr. Andrew Wolfe