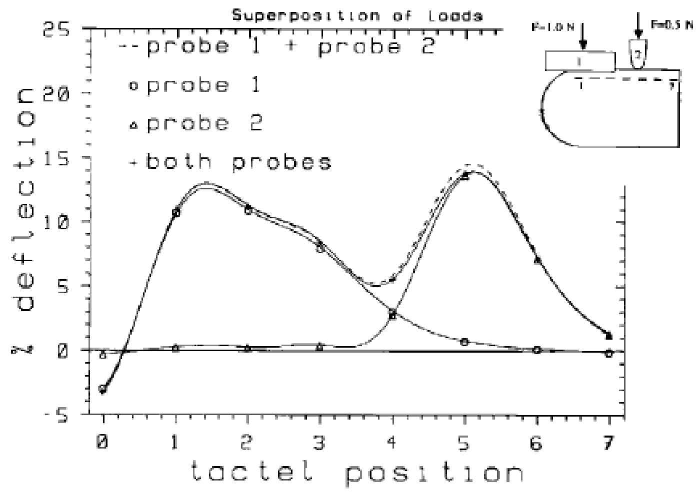
EXHIBIT G

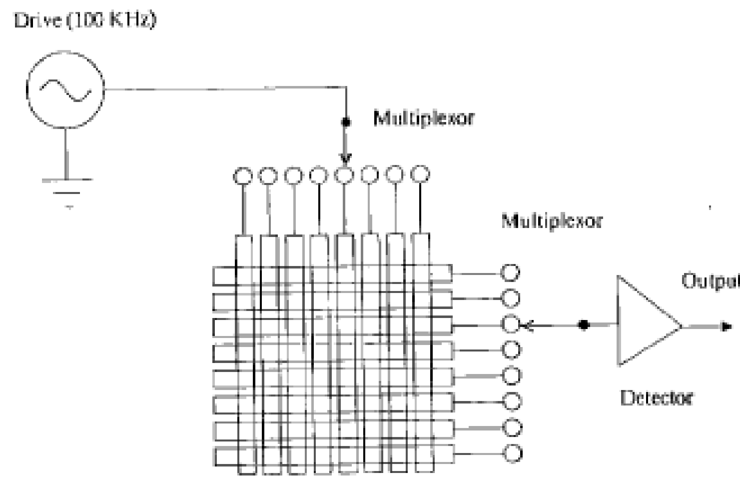
APPENDIX E

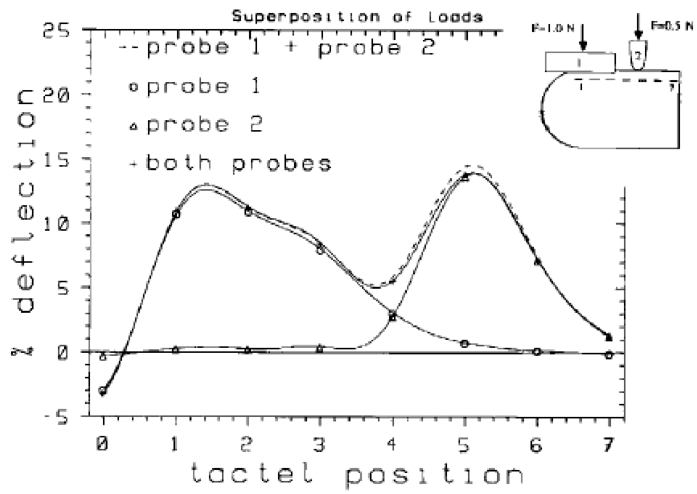
Appendix E: Tactile Sensing Mechanisms Invalidates the Asserted Claims of the ’352 Patent
Tactile Sensing Mechanisms (the “Fearing 1990 Reference”) Anticipates and/or Renders Obvious Claims 1, 7, 10, 18, 21[1]

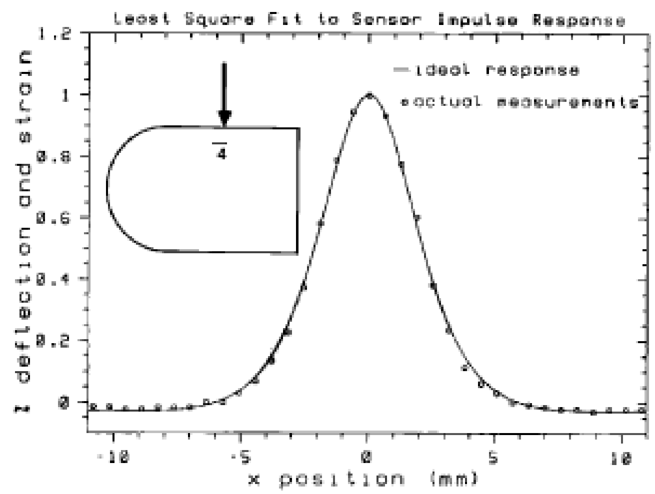
Claim Language	Disclosure
1. A method for detecting the operative coupling of multiple fingers to a touch sensor involving the steps of	The Fearing 1990 Reference discloses a method for detecting the operative coupling of multiple objects (fingers are objects) to a touch sensor. Specifically, the Fearing 1990 Reference discloses a capacitive touch sensor capable of sensing multiple contacts. *See* Fearing 1990 Reference at APEL0007543: “This article addresses tactile finger design issues, the transduction mechanism, and determination of contact and magnitude using linear filtering techniques.” *See* Fearing 1990 Reference at APEL0007543: “A tactile sensor array was packaged in a molded rubber finger tip for the Stanford/JPL hand as shown in Figure 1. There are 7 X 12 tactile elements (tactels) on the cylindrical portion and 1 X 12 elements underneath the hemispherical tip for a total of 8 X 12 capacitive sensing elements. Only an 8 X 8 subset (7 X 8 on cylinder and 1 X 8 under the tip) is externally connected to the interface electronics. The sensor density has been increased from previously reported work (Fearing 1987a) to reduce aliasing and is now adequate for local contact determination.” *See* Fearing 1990 Reference at APEL0007548: “Figure 9 shows interpolated strain profiles for two probes applied independently and jointly. The sum of the individual strain profiles corresponds well to the

[1] The citations to specific pages are made for exemplary purposes only. The entire reference, and not just the cited pages, disclose the elements of the asserted claims as set forth herein.

Claim Language	Disclosure
	joint strain profile. Thus superposition seems to be a valid assumption, at least with forces less than 100 grams or so.” *See* Fearing 1990 Reference at Fig. 9 at APEL0007549:  *See* Fearing 1990 Reference at APEL0007544: “As shown in Figure 2, capacitors are formed at the intersection of rows and columns of conductive strips. As in the method used by Siegel (1986), the capacitance at a junction is measured by the amplitude of the output voltage for a selected row and column. Unused rows and columns are switched to ground potential to improve shielding and reduce cross-talk. The 8X8 array was originally scanned at 15 Hz, but the rate was reduced to 7 Hz for improved noise performance. This low scanning speed could be increased, but since the analysis has been done for static forces only, it has not been a limitation.”

Claim Language	Disclosure
	See Fearing 1990 Reference at Fig. 2 at APEL0007544: 
scanning the touch sensor to (a) identify a first maxima in a signal corresponding to a first finger, (b) identify a minima following the first maxima, (c) identify a second maxima in a signal corresponding to a second finger following said minima, and **<u>Apple's and Elan's construction:</u>** ***"scanning the touch sensor":*** measuring the values generated by a touch sensor to detect operative coupling and determining the corresponding positions at which the measurements are made	The Fearing 1990 Reference discloses scanning the touch sensor to identify a first maxima in a signal corresponding to a first finger, identify a minima following the first maxima, and identify a second maxima in a signal corresponding to a second finger following the minima under Elan's constructions but not under Apple's and the Staff's constructions. Namely, the Fearing 1990 Reference does not disclose the temporal order required by Apple's and the Staff's constructions. However, one of ordinary skill in the art would have recognized that the Fearing 1990 Reference could be combine with either the Mehta Thesis or the '661 Application to adapt the Fearing 1990 Reference to include the temporal requirement. The Fearing 1990 Reference discloses that a straight line profile of the touch sensor is generated. *See* Fearing 1990 Reference at Fig. 9 at APEL0007549:

Claim Language	Disclosure
<u>Staff’s construction:</u> ***“scanning the touch sensor”:*** obtaining the values generated by a touch sensor to detect operative coupling **<u>Apple’s construction:</u>** ***“identify”:*** recognize a value to be **<u>Staff’s construction:</u>** ***“identify”:*** to ascertain the origin, nature or definitive characteristics of **<u>Apple’s and Staff’s constructions:</u>** ***“identify a first maxima in a signal corresponding to a first finger”:*** identify a first peak value in a finger profile taken on a straight line obtained from scanning the touch sensor ***“identify a minima following the first maxima”:*** identify the lowest value in the finger profile taken on said straight line that occurs after the first peak value and before another peak value is identified	 *See* Fearing 1990 Reference at Fig. 16 at APEL0007552:

Claim Language	Disclosure
"identify a second maxima in a signal corresponding to the second finger following said minima": after identifying the lowest value in the finger profile taken on said straight line, identify a second peak value in the finger profile taken on said straight line **<u>Elan's constructions:</u>** ***"identify":*** establish the identity of; to ascertain the origin, nature or definitive characteristics of ***"identify a first maxima in a signal corresponding to a first finger":*** identify a first peak value in a finger profile taken on a straight line obtained from scanning the touch sensor ***"identify a minima following the first maxima":*** identify the lowest value in the finger profile taken on a straight line that occurs after the first peak value ***"identify a second maxima in a signal corresponding to the second finger following said minima":***	 The Fearing 1990 Reference further discloses that the location of the contact is localized to the maxima. *See* Fearing 1990 Reference at APEL0007557: "Localization of a line force could in principle be done by solving for location, angle of force, and magnitude of force from the strain equations at three sensors as was proposed in Fearing and Hollerbach (1985). A more general approach when there is no tangential force at the surface and the applied pressure is an even, single maximum function, is to find the peak strain by interpolation." Points that satisfy the following conditions are maxima, while points that only satisfy the first derivative condition, but not the second derivative condition, are minima.

Claim Language	Disclosure
identify a second peak value in the finger profile taken on a straight line following the minimum.	*See* Fearing 1990 Reference at APEL0007558: The conditions for a maximum of a surface are: $$\frac{\partial f}{\partial x} = 0, \quad \frac{\partial f}{\partial y} = 0, \quad \frac{\partial^2 f}{\partial x^2} < 0, \quad \text{and} \quad \frac{\partial^2 f}{\partial y^2} < 0. \quad (52)$$ *See* Fearing 1990 Reference at APEL0007548: "If the sensor behaves as a linear space invariant system, there are many powerful techniques from linear system theory that can be used to analyze it. If the sensor response is linear and obeys the principle of superposition, the linear space invariant assumption will hold. Figure 9 shows interpolated strain profiles for two probes applied independently and jointly. The sum of the individual strain profiles corresponds well to the joint strain profile. Thus superposition seems to be a valid assumption, at least with forces less than 100 grams or so." The parties' construction for "scanning the touch sensor" requires "measuring the values generated by a touch sensor to detect operative coupling and determining the corresponding positions at which the measurements are made." The Fearing 1990 Reference discloses a touch sensor that is scanned to measure values to detect the coupling of fingers to the touchpad and their respective positions. Accordingly, the Fearing 1990 Reference discloses this limitation consistent with parties' construction. *See* Fearing 1990 Reference at APEL0007544: "As shown in Figure 2, capacitors are formed at the intersection of rows and columns of conductive strips. As in the method used by Siegel (1986), the capacitance at a junction is measured by the amplitude of the output voltage for a selected row and column. Unused rows and columns are switched to

Claim Language	Disclosure
	ground potential to improve shielding and reduce cross-talk. The 8X8 array was originally scanned at 15 Hz, but the rate was reduced to 7 Hz for improved noise performance. This low scanning speed could be increased, but since the analysis has been done for static forces only, it has not been a limitation." The Staff's construction for "scanning the touch sensor" requires "obtaining the values generated by a touch sensor to detect operative coupling." The Fearing 1990 Reference discloses a touch sensor that is scanned to measure values to detect the coupling of fingers to the touchpad. Accordingly, the Fearing 1990 Reference discloses this limitation consistent with the Staff's construction. *See* Fearing 1990 Reference at APEL0007544: "As shown in Figure 2, capacitors are formed at the intersection of rows and columns of conductive strips. As in the method used by Siegel (1986), the capacitance at a junction is measured by the amplitude of the output voltage for a selected row and column. Unused rows and columns are switched to ground potential to improve shielding and reduce cross-talk. The 8X8 array was originally scanned at 15 Hz, but the rate was reduced to 7 Hz for improved noise performance. This low scanning speed could be increased, but since the analysis has been done for static forces only, it has not been a limitation." Apple's construction for "identify" requires "recognize a value to be." The Fearing 1990 Reference discloses a logic process, described above, that determines which points are the extrema (using the first order differential) and further identifies which points are the maxima (using the second order differential). Points that satisfy the first order differential condition but not the second differential order condition are minima. Points that satisfy both conditions are maxima. Accordingly, the Fearing 1990 Reference discloses this limitation consistent with

Claim Language	Disclosure
	Apple’s construction. *See* Fearing 1990 Reference at APEL0007557: “Localization of a line force could in principle be done by solving for location, angle of force, and magnitude of force from the strain equations at three sensors as was proposed in Fearing and Hollerbach (1985). A more general approach when there is no tangential force at the surface and the applied pressure is an even, single maximum function, is to find the peak strain by interpolation.” *See* Fearing 1990 Reference at APEL0007558: The conditions for a maximum of a surface are: $$\frac{\partial f}{\partial x} = 0, \quad \frac{\partial f}{\partial y} = 0, \quad \frac{\partial^2 f}{\partial x^2} < 0, \quad \text{and} \quad \frac{\partial^2 f}{\partial y^2} < 0. \quad (52)$$ *See* Fearing 1990 Reference at APEL0007548: “If the sensor behaves as a linear space invariant system, there are many powerful techniques from linear system theory that can be used to analyze it. If the sensor response is linear and obeys the principle of superposition, the linear space invariant assumption will hold. Figure 9 shows interpolated strain profiles for two probes applied independently and jointly. The sum of the individual strain profiles corresponds well to the joint strain profile. Thus superposition seems to be a valid assumption, at least with forces less than 100 grams or so.” The Staff's and Elan’s constructions for “identify” require at least “to ascertain the origin, nature or definitive characteristics of.” The Fearing 1990 Reference discloses a logic process, described above, that analyzes the finger profile to

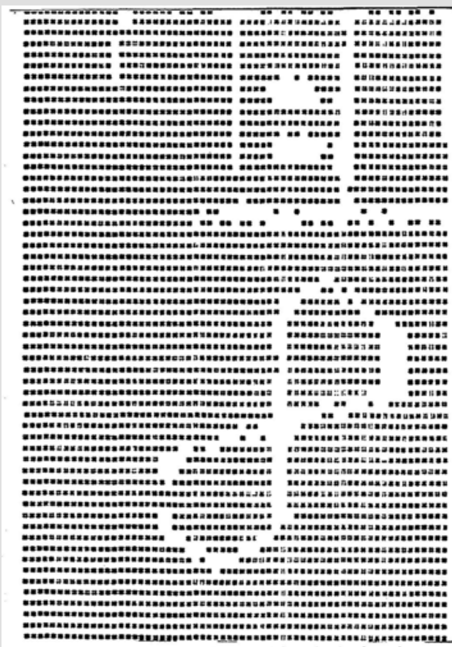
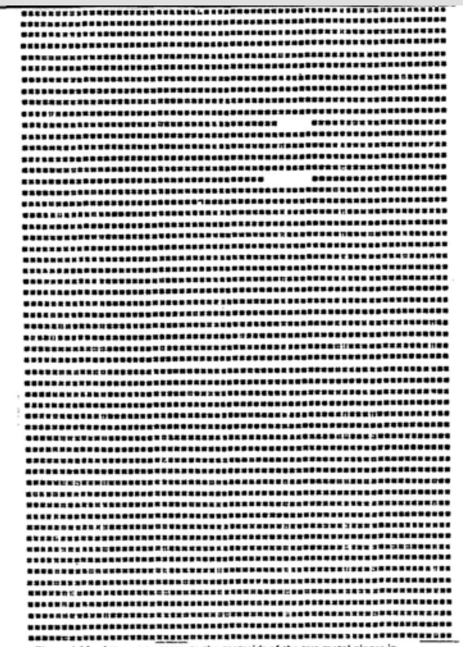
Claim Language	Disclosure
	ascertain whether the signal profile contains maxima and minima. Accordingly, the Fearing 1990 Reference discloses this limitation consistent with the Staff's construction. Apple's and the Staff's construction for "identify a first maxima in a signal corresponding to a first finger" requires "identify a first peak value in a finger profile taken on a straight line obtained from scanning the touch sensor." As described above, the Fearing 1990 Reference discloses a touch sensor that identifies a first maxima using a first and second order differential. *See* Fearing 1990 Reference at APEL0007557: "Localization of a line force could in principle be done by solving for location, angle of force, and magnitude of force from the strain equations at three sensors as was proposed in Fearing and Hollerbach (1985). A more general approach when there is no tangential force at the surface and the applied pressure is an even, single maximum function, is to find the peak strain by interpolation." *See* Fearing 1990 Reference at APEL0007558: The conditions for a maximum of a surface are: $$\frac{\partial f}{\partial x} = 0, \quad \frac{\partial f}{\partial y} = 0, \quad \frac{\partial^2 f}{\partial x^2} < 0, \quad \text{and} \quad \frac{\partial^2 f}{\partial y^2} < 0. \quad (52)$$ *See* Fearing 1990 Reference at APEL0007548: "If the sensor behaves as a linear space invariant system, there are many powerful techniques from linear system theory that can be used to analyze it. If the sensor response is linear and obeys the principle of superposition, the linear space invariant assumption will hold. Figure 9 shows interpolated strain profiles for two

Claim Language	Disclosure
	probes applied independently and jointly. The sum of the individual strain profiles corresponds well to the joint strain profile. Thus superposition seems to be a valid assumption, at least with forces less than 100 grams or so.” Apple's and the Staff's construction for “identify a minima following the first maxima” requires “identify the lowest value in the finger profile taken on said straight line that occurs after the first peak value and before another peak value is identified.” While the Fearing 1990 Reference identifies the minima, it does not explicitly state that the minima is identified after first identifying the first maxima. Accordingly, the Fearing 1990 Reference <u>does not</u> disclose this limitation under Apple and the Staff’s construction. It would have been obvious, however, to combine the Fearing 1990 Reference with any of the references below to adapt the Fearing 1990 Reference to operate in the required manner. Apple's and the Staff's construction for “identify a second maxima in a signal corresponding to the second finger following said minima” requires “after identifying the lowest value in the finger profile taken on said straight line, identify a second peak value in the finger profile taken on said straight line.” As with the previous limitation, the Fearing 1990 Reference discloses identifying a second maxima, but does not explicitly state that the second maxima is identified after identifying the minima. Accordingly, the Fearing 1990 Reference <u>does not</u> disclose this limitation under Apple and the Staff’s construction. It would have been obvious, however, to combine the Fearing 1990 Reference with any of the references below to adapt the Fearing 1990 Reference to operate in the required manner. Elan construes “identify a first maxima in a signal corresponding to a first finger” to mean “identify a first peak value in a finger profile taken on a straight line obtained from scanning the touch sensor”; “identify a minima following the first maxima” to mean “identify the lowest value in the finger profile taken on a

Claim Language	Disclosure
	straight line that occurs after the first peak value”; and “identify a second maxima in a signal corresponding to the second finger following said minima” to mean “identify a second peak value in the finger profile taken on a straight line following the minimum.” Under these constructions, the Fearing 1990 Reference discloses the identification steps. Specifically, the Fearing 1990 Reference discloses that the touch contacts are localized to the peak values of the force on the touch pad. *See* Fearing 1990 Reference at APEL0007557: “Localization of a line force could in principle be done by solving for location, angle of force, and magnitude of force from the strain equations at three sensors as was proposed in Fearing and Hollerbach (1985). A more general approach when there is no tangential force at the surface and the applied pressure is an even, single maximum function, is to find the peak strain by interpolation.” *See* Fearing 1990 Reference at APEL0007558: The conditions for a maximum of a surface are: $\frac{\partial f}{\partial x} = 0, \quad \frac{\partial f}{\partial y} = 0, \quad \frac{\partial^2 f}{\partial x^2} < 0, \quad \text{and} \quad \frac{\partial^2 f}{\partial y^2} < 0. \quad (52)$ *See* Fearing 1990 Reference at APEL0007548: “If the sensor behaves as a linear space invariant system, there are many powerful techniques from linear system theory that can be used to analyze it. If the sensor response is linear and obeys the principle of superposition, the linear space invariant assumption will hold. Figure 9 shows interpolated strain profiles for two probes applied independently and jointly. The sum of the individual strain profiles corresponds well to the joint strain profile. Thus superposition

Claim Language	Disclosure
	seems to be a valid assumption, at least with forces less than 100 grams or so." The above equations also solve for the minima. The first derivative solves for all the extrema (maxima and minima), and the second derivative determines which extrema are maxima and which are minima. Extrema satisfying the condition of the equation are maxima and the rest are minima. Accordingly, under Elan's constructions, the Fearing 1990 reference discloses these limitations.
	The Mehta Thesis discloses scanning the touch sensor to identify a first maxima in a signal corresponding to a first finger, identify a minima following the first maxima, and identify a second maxima in a signal corresponding to a second finger following the minima under Apple's and the Staff's constructions. More specifically, the Mehta Thesis discloses a touch sensor that operates in the following manner. First, a digitized picture of the touch surface is created. The digitized image includes the outline of the key overlay and, if multiple fingers are present, blobs representing fingers. The digitized image is binary, meaning the image only includes values that are minima, "0s", and maxima, "1s." *See* Mehta Thesis at APEL0006843: "The first task at hand is that of picture digitization. A binary digitizer has been implemented; however the decision threshold is set by software. Three binary thresholding techniques were considered. They are detailed in 5.1. After setting the threshold, the image processor is directed to digitize a frame. On completion, the picture buffer contains a digitized image of the scene. This would contain outlines of the keys, and possibly, blobs corresponding to fingers pressed on the overlay." *See* Mehta Thesis at APEL0006822: "However, in the present application, image processing occurs only on 'binary images' - that is, outlines on an overlay are allowed to be only black or white. Even if available, greyscale

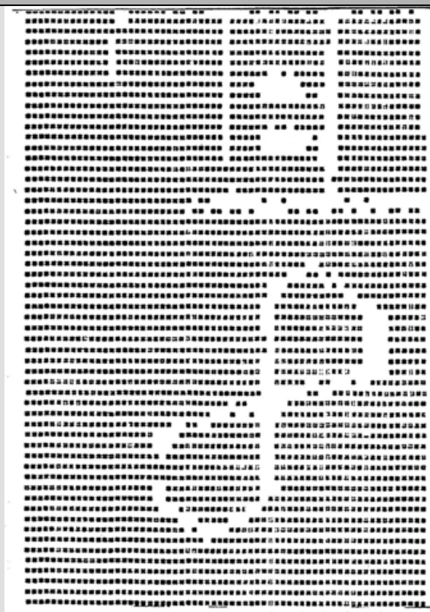
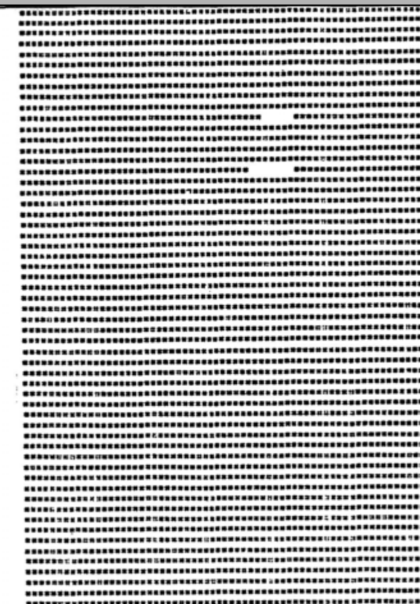
Claim Language	Disclosure
	images would have to be converted into binary images by setting all pixels darker than predetermined threshold to black and the rest to white." Second, the background image (i.e., the image of overlay) is subtracted from the digitized image, leaving only blobs corresponding to fingers. *See* Mehta Thesis at APEL0006843: "The image is subtracted from one containing only outlines of keys that was taken immediately after 'power-up'. The result is a picture containing only blobs corresponding to fingers." Third, each finger blob is reduced (a process called "thinning") to a single representative point. The thinning process checks the frame buffer for horizontal lines. These horizontal lines are maxima within the digitized data set. Accordingly, the thinning process scans the frame buffer for a maximum. When a horizontal line is encountered, the horizontal line is reduced (i.e., thinned) to a single point. This is accomplished by replacing the horizontal line with a single pixel at the centroid of the horizontal line. Implicit in this is that the thinning process must recognize when the horizontal line concludes, i.e., transitions from the maxima to a minima. Accordingly, the thinning process identifies a minima following the maxima. In the case where another finger is present on the input device on the same X or Y axis, the thinning process will encounter another set of horizontal lines corresponding to the second finger. In other words, the scanning processing encounters a second maxima following the minima. *See* Mehta Thesis at APEL0006846: "The thinning process is similar to noise reduction, and has been combined with it. The frame buffer is scanned to check for horizontal lines. When encountered, they are replaced by single pixels at the centre of the line. Hence a blob, which is essentially a set of horizontal lines, is reduced to an approximately vertical line. This line is further reduced to a single centroid point by another pass over the raster, this time checking for vertical lines. Hence, on exit from this

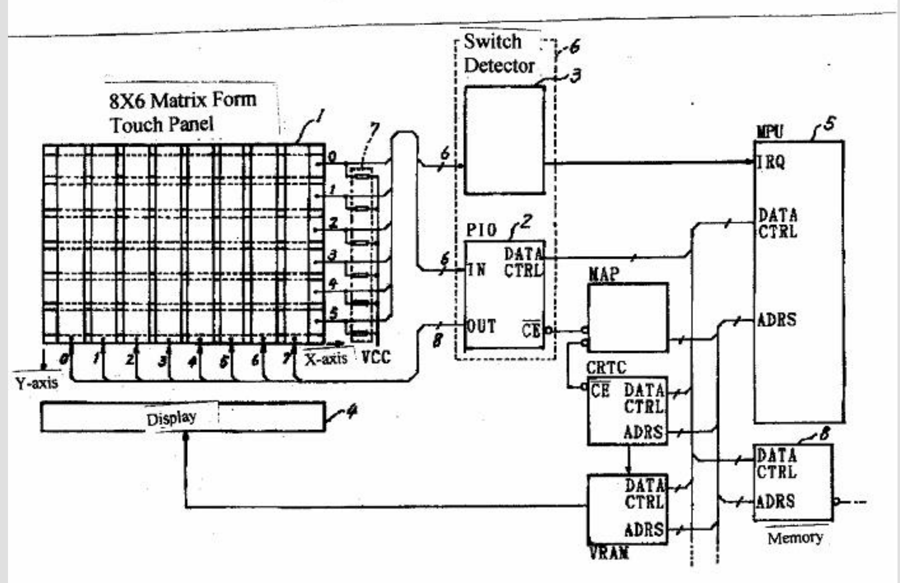
Claim Language	Disclosure
	process, all blobs on the raster are thinned down to single pixels close to, or exactly on, their centroids. This 'centroid' information is stored in a CG file for subsequent use by the tracking and code output subroutines." *See* Mehta Thesis at Figs. 6.15-6.16 at APEL0006862 depicting two contact points:  Figure 6.15 - Overlay image taken with two metal pieces placed on the overlay and separated from each other. This separation will be deemed acceptable if the centroids of the two pieces can be computed successfully.  Figure 6.16 - Attempt to compute the centroids of the two metal pieces in Figure 6.15. As can be seen, the two shadows were successfully reduced to two separated lines. The midpoints of these lines are the centroids of the two shadows. The Apple's construction for "scanning the touch sensor" requires "measuring the values generated by a touch sensor to detect operative coupling and determining the corresponding positions at which the measurements are made." The Mehta Thesis discloses that a video camera takes a snapshot of the surface and the output

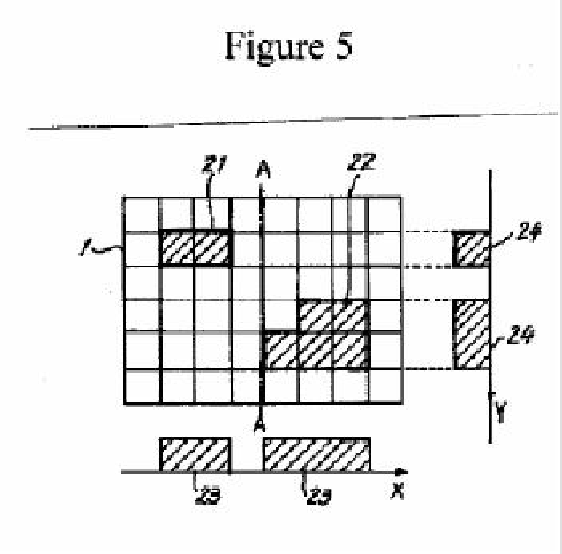
Claim Language	Disclosure
	is fed into an analog-to-digital converter which creates a digital image of the scene as viewed by the camera. This digital image is a set of values generated by the touch sensor to detect the operative coupling and position of fingers or other objects. Accordingly, the Mehta Thesis discloses scanning the touch sensor consistent with Apple's construction. *See* Mehta Thesis at APEL0006822: "The TV Camera video output is fed into an analog-to-digital converter in the attached computer which creates a digital image of the scene as viewed by the camera. Assuming standard video rates, the active view time per line is about 53 microseconds. It is also assumed that the outline resolution of the interface is about 2 mm., and the overlay is 50 cm. long x 20 cm. wide. Under these conditions, the number of points sampled per line (called pixels) must be 500 mm./2 mm. = 250. The time per pixel equals is /us/250 = 212 ns. This implies that the conversion rate of the A/D converter must be 1/212 ns. or about 5 megasamples per second. Commercial 'Flash' converters capable of digitizing analog signals at speeds of 5 megasamples per second are prohibitively expensive. The reason is that they are designed to resolve the analog signal into 4-8 bits of digital data per pixel, which requires extensive hardware. However, in the present application, image processing occurs only on 'binary images' - that is, outlines on an overlay are allowed to be only black or white. Even if available, greyscale images would have to be converted into binary images by setting all pixels darker than predetermined threshold to black and the rest to white." *See* Mehta Thesis at APEL0006843: "The image is subtracted from one containing only outlines of keys that was taken immediately after 'power-up'. The result is a picture containing only blobs corresponding to fingers." The Staff's construction for "scanning the touch sensor" requires "obtaining the values generated by a touch sensor to detect operative coupling." As explained

Claim Language	Disclosure
	above, the Mehta Thesis discloses that a video camera takes a snapshot of the surface and the output is fed into an analog-to-digital converter which creates a digital image of the scene as viewed by the camera. This digital image is a set of values generated by the touch sensor to detect the operative coupling of fingers or other objects. Accordingly, the Mehta Thesis discloses scanning the touch sensor consistent with the Staff's construction. Apple's construction for "identify" requires "recognize a value to be." The Mehta Thesis discloses that the thinning process scans for horizontal lines in the digitized image. In other words, the thinning process evaluates each pixel and recognizes whether a pixel represents a maxima or not. Accordingly, the Mehta Thesis discloses "identify" consistent with Apple's construction. The Staff's construction for "identify" requires "to ascertain the origin, nature or definitive characteristics of." The Mehta Thesis discloses that the thinning process scans for horizontal lines in the digitized image. In other words, the thinning process evaluates each pixel to ascertain whether the pixel is a maxima or a minima. Accordingly, the Mehta Thesis discloses "identify" consistent with the Staff's construction. Apple's and the Staff's construction for "identify a first maxima in a signal corresponding to a first finger" requires "identify a first peak value in a finger profile taken on a straight line obtained from scanning the touch sensor." Apple's and the Staff's construction for "identify a minima following the first maxima" requires "identify the lowest value in the finger profile taken on said straight line that occurs after the first peak value and before another peak value is identified." Apple's and the Staff's construction for "identify a second maxima in a signal corresponding to the second finger following said minima" requires "after identifying the lowest value in the finger profile taken on said straight line, identify a second peak value in the finger profile taken on said straight line." The Mehta Thesis discloses a thinning process that traverses each row of pixels

Claim Language	Disclosure
	searching for horizontal lines (the process also occurs vertically). When a horizontal line is encountered (i.e., a series of maxima is identified), it is reduce to a single pixel. Implicit in this is the recognition of where the horizontal line ends. In other words, the thinning process first identifies the horizontal line (i.e., maxima) and then subsequently identifies where the horizontal line ends, which is signified by the presence of a minimum. After identifying a first horizontal line (i.e., a first maxima) and a minima following that first horizontal line (i.e., where the horizontal line terminates), the thinning process continues searching for any other horizontal lines (i.e. additional maxima). Accordingly, when two fingers are present on the same axis (i.e., finger profile), a first maxima will be identified in the profile, followed by a minima, and then a second maxima. Therefore, the Mehta Thesis discloses max/min/max terms consistent with Apple's and the Staff's construction. *See* Mehta Thesis at Figs. 6.15-6.16 at APEL0006862 depicting two contact points:

Claim Language	Disclosure
	 Figure 6.15 - Overlay image taken with two metal pieces placed on the overlay and separated from each other. This separation will be deemed acceptable if the centroids of the two pieces can be computed successfully.  Figure 6.16 - Attempt to compute the centroids of the two metal pieces in Figure 6.15. As can be seen, the two shadows were successfully reduced to two separated lines. The midpoints of these lines are the centroids of the two shadows. *See* Mehta Thesis at APEL0006846: “The thinning process is similar to noise reduction, and has been combined with it. The frame buffer is scanned to check for horizontal lines. When encountered, they are replaced by single pixels at the centre of the line. Hence a blob, which is essentially a set of horizontal lines, is reduced to an approximately vertical line. This line is further reduced to a single centroid point by another pass over the raster, this time checking for vertical lines. Hence, on exit from this process, all blobs on the raster are thinned down to single pixels close to, or exactly on, their centroids. This ‘centroid’ information is stored in a CG file for subsequent use by the tracking and code output subroutines.”

Claim Language	Disclosure
	The ‘661 Application discloses scanning the touch sensor to identify a first maxima in a signal corresponding to a first finger, identify a minima following the first maxima, and identify a second maxima in a signal corresponding to a second finger following the minima under Apple’s and the Staff’s constructions. Specifically, the ‘661 Application discloses that when a “switch” is contacted, a switch detector transmits an interrupt to a microprocessor. At this point, each line is scanned along the X direction and the Y direction. *See* ‘661 Application at Fig. 1 at APEL0059803: Figure 1  *See* ‘661 Application at APEL0059793: “By scanning all the lines along the x-axis and by reading a y-axis line every time, in such a manner, data

Claim Language	Disclosure
	for all intersections in negative logic relative to ON-switches are obtained." The data is then projected onto the X and Y axes creating two finger profiles taken on straight lines (X and Y). *See* '661 Application at Fig. 5 at APEL0059803:  *See* '661 Application at APEL0059793: "If it is determined by the empty data judgment part (11) that there are some data, [the flow] jumps to an x-axis projection data maker (11), coordinate data are projected on the x-axis as shown in Figure 5, and x-axis projection data (23) are obtained." Once the finger profiles are derived, logic determines the number of fingers by identifying the number of maxima in the profile. Specifically, the logic looks for a first maxima ("1"), followed by a minima ("0"), followed by a second maxima ("1"). In the case where there are three or more fingers, the logic is capable of

Claim Language	Disclosure
	identifying these additional fingers. Applying the logic to the x axis of Figure 5, a "1" is seen for the maxima 23 in the signal. Maxima 23 corresponds to finger 21 on touch pad 1. The logic then looks for a minima following maxima 23, which is where the signal drops to "0." The logic then looks for another "1," which in Figure 5 is the maxima at 25 that corresponds to finger 22 on touch pad 1. *See* '661 Application at APEL0059793: "First, when considered in positive logic, a determination as to a division is carried out, first, by finding a point where a change occurs from a '1' to '0' which is at the end of the first data group and, then, by finding a point where a change occurs from '0' to '1' which is at the beginning of the second data group. The point of division is set at the above-stated point of change from '0' to '1.'" Apple's construction for "scanning the touch sensor" requires "measuring the values generated by a touch sensor to detect operative coupling and determining the corresponding positions at which the measurements are made." The '661 Application discloses that a touch pad is scanned to measure values to detect the coupling of fingers to the touchpad and their respective positions. Accordingly, the '661 Application discloses this limitation consistent with Apple's construction. *See* '661 Application at APEL0059793: "By scanning all the lines along the x-axis and by reading a y-axis line every time, in such a manner, data for all intersections in negative logic relative to ON-switches are obtained." The Staff's construction for "scanning the touch sensor" requires "obtaining the values generated by a touch sensor to detect operative coupling." The '661 Application discloses that the touch pad is scanned to measure values to detect the coupling of fingers to the touchpad. Accordingly, the '661 Application discloses this limitation consistent with the Staff's construction. *See* '661 Application at APEL0059793: "By scanning all the lines along the x-axis and by reading a y-axis line every time, in such a manner, data

Claim Language	Disclosure
	for all intersections in negative logic relative to ON-switches are obtained." Apple's construction for "identify" requires "recognize a value to be." The '661 Application discloses a logic process, described above, that recognizes that "1s" correspond to maxima in the data set and "0s" correspond to minima. Accordingly, the '661 Application discloses this limitation consistent with Apple's construction. *See* '661 Application at APEL0059793: "First, when considered in positive logic, a determination as to a division is carried out, first, by finding a point where a change occurs from a '1' to '0' which is at the end of the first data group and, then, by finding a point where a change occurs from '0' to '1' which is at the beginning of the second data group. The point of division is set at the above-stated point of change from '0' to '1.'" The Staff's construction for "identify" requires "to ascertain the origin, nature or definitive characteristics of." The '661 Application discloses a logic process, described above, that analyzes the finger profile to ascertain whether the signal profile contains maxima ("1s") and minima ("0s"). Accordingly, the '661 Application discloses this limitation consistent with the Staff's construction. *See* '661 Application at APEL0059793: "First, when considered in positive logic, a determination as to a division is carried out, first, by finding a point where a change occurs from a '1' to '0' which is at the end of the first data group and, then, by finding a point where a change occurs from '0' to '1' which is at the beginning of the second data group. The point of division is set at the above-stated point of change from '0' to '1.'" Apple's and the Staff's construction for "identify a first maxima in a signal corresponding to a first finger" requires "identify a first peak value in a finger profile taken on a straight line obtained from scanning the touch sensor." Apple's and the Staff's construction for "identify a minima following the first maxima"

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	requires “identify the lowest value in the finger profile taken on said straight line that occurs after the first peak value and before another peak value is identified.” Apple's and the Staff's construction for “identify a second maxima in a signal corresponding to the second finger following said minima” requires “after identifying the lowest value in the finger profile taken on said straight line, identify a second peak value in the finger profile taken on said straight line.” As described above, the ‘661 Application discloses that the touch sensor is scanned to create a finger profile taken on a straight line. Logic then identifies a first “1” (i.e., maxima) in the profile. The logic then looks for a “0” (i.e., minima) following the first “1” (i.e., first maxima), but before identifying the second “1” (i.e., second maxima) that corresponds to the second finger. Subsequently, the logic identifies a second “1” (i.e., second maxima) in the signal. Accordingly, the ‘661 Application discloses this limitation consistent with Apple’s and the Staff’s construction. *See* ‘661 Application at Fig. 5 at APEL0059803:

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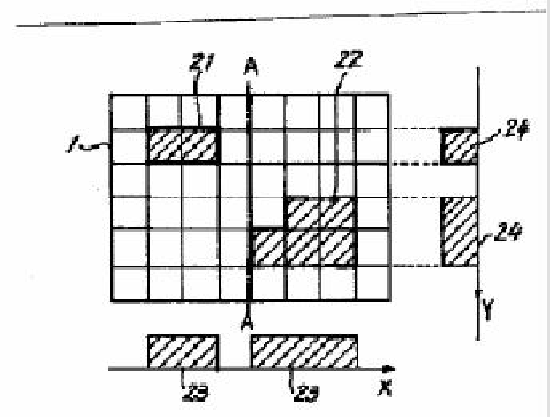
	Figure 5  *See* '661 Application at APEL0059793: "First, when considered in positive logic, a determination as to a division is carried out, first, by finding a point where a change occurs from a '1' to '0' which is at the end of the first data group and, then, by finding a point where a change occurs from '0' to '1' which is at the beginning of the second data group. The point of division is set at the above-stated point of change from '0' to '1.'"
providing an indication of the simultaneous presence of two fingers in response to identification of said first and second maxima. **<u>Apple's and Staff's constructions:</u>** ***"in response to":***	The Fearing 1990 Reference discloses that an indication of the presence of two objects is provided in response to the identification of said first and second maxima under the parties' and the Staff's constructions. Specifically, the Fearing 1990 Reference discloses that the extrema, and in particular the maxima, are identified using the following equation. *See* Fearing 1990 Reference at APEL0007557: "Localization of a line force could in principle be done by solving for location, angle of force, and

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after and in reaction to **<u>Elan's constructions:</u>** ***"in response to":*** plain meaning	magnitude of force from the strain equations at three sensors as was proposed in Fearing and Hollerbach (1985). A more general approach when there is no tangential force at the surface and the applied pressure is an even, single maximum function, is to find the peak strain by interpolation." *See* Fearing 1990 Reference at APEL0007558: The conditions for a maximum of a surface are: $$\frac{\partial f}{\partial x} = 0, \quad \frac{\partial f}{\partial y} = 0, \quad \frac{\partial^2 f}{\partial x^2} < 0, \quad \text{and} \quad \frac{\partial^2 f}{\partial y^2} < 0. \quad (52)$$ *See* Fearing 1990 Reference at APEL0007548: "If the sensor behaves as a linear space invariant system, there are many powerful techniques from linear system theory that can be used to analyze it. If the sensor response is linear and obeys the principle of superposition, the linear space invariant assumption will hold. Figure 9 shows interpolated strain profiles for two probes applied independently and jointly. The sum of the individual strain profiles corresponds well to the joint strain profile. Thus superposition seems to be a valid assumption, at least with forces less than 100 grams or so." As disclosed in Fearing 1990 Reference, the number of maxima corresponds directly to the number of objects on the touch sensor. Accordingly, the solution to the equations (i.e., which points are the maxima), is the indication of the presence of two contacts on the touch sensor (in the case where there are just two contacts). Apple's and the Staff's construction for "in response to" requires "after and in reaction to." The Fearing 1990 Reference discloses that if it is determined that

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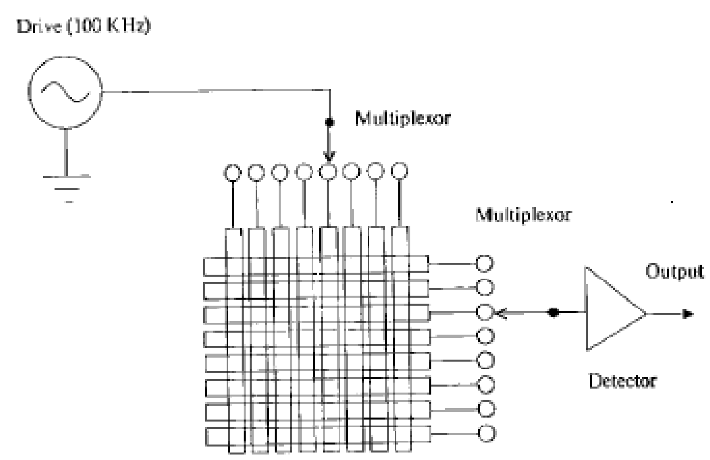
	there are two maxima, there are considered to be two objects. Accordingly, the Fearing 1990 Reference discloses this limitation consistent with Apple's and the Staff's construction. Elan contends that the construction for "in response to" is the plain meaning. I understand the plain meaning of "in response to" to be the construction set forth by Apple and the Staff.
6. The method of claim 1 wherein said touch sensor includes a plurality of lines, said maxima being a largest local variation in a signal value on one of said lines due to capacitive coupling of a finger.	The Fearing 1990 Reference discloses a capacitive touch pad with a plurality of lines, the maxima being a largest local variation in a signal value on one of said lines due to capacitive coupling resulting from an object. *See* Fearing 1990 Reference at Fig. 2 at APEL0007544:  *See* Fearing 1990 Reference at APEL0007544: "As shown in Figure 2, capacitors are formed at the intersection of rows and columns of

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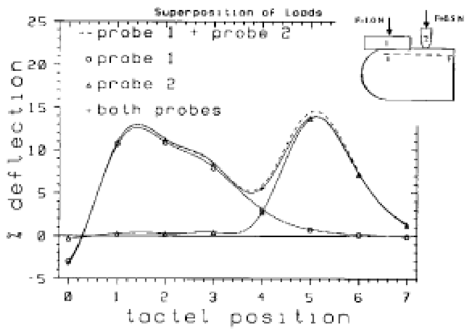
	conductive strips. As in the method used by Siegel (1986), the capacitance at a junction is measured by the amplitude of the output voltage for a selected row and column.” The Fearing 1990 Reference further discloses that the maxima is the largest local variation in a signal value on one of said lines due to capacitive coupling of a contact object. *See* Fearing 1990 Reference at Fig. 9 at APEL0007549:  *See* Fearing 1990 Reference at APEL0007544: “As shown in Figure 2, capacitors are formed at the intersection of rows and columns of conductive strips. As in the method used by Siegel (1986), the capacitance at a junction is measured by the amplitude of the output voltage for a selected row and column.” *See* Fearing 1990 Reference at APEL0007545: $$\frac{V_S - V_o}{V_S} = \frac{\frac{C_S}{C_L} - \frac{C_{So}}{C_L}}{\frac{C_S}{C_L}} = 1 - \frac{\frac{1}{d_o}}{\frac{1}{d_o - \Delta d}} = \frac{\Delta d}{d_o}, \quad (4)$$

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7. The method of claim 6 wherein said maxima are peaks.	The Fearing 1990 Reference discloses that the maxima identified in the profile are peaks. *See* Fearing 1990 Reference at APEL0007557: “Localization of a line force could in principle be done by solving for location, angle of force, and magnitude of force from the strain equations at three sensors as was proposed in Fearing and Hollerbach (1985). A more general approach when there is no tangential force at the surface and the applied pressure is an even, single maximum function, is to find the peak strain by interpolation.” *See* Fearing 1990 Reference at APEL0007558: The conditions for a maximum of a surface are: $\frac{\partial f}{\partial x} = 0, \quad \frac{\partial f}{\partial y} = 0, \quad \frac{\partial^2 f}{\partial x^2} < 0, \quad \text{and} \quad \frac{\partial^2 f}{\partial y^2} < 0. \quad (52)$ *See* Fearing 1990 Reference at APEL0007548: “If the sensor behaves as a linear space invariant system, there are many powerful techniques from linear system theory that can be used to analyze it. If the sensor response is linear and obeys the principle of superposition, the linear space invariant assumption will hold. Figure 9 shows interpolated strain profiles for two probes applied independently and jointly. The sum of the individual strain profiles corresponds well to the joint strain profile. Thus superposition seems to be a valid assumption, at least with forces less than 100 grams or so.” *See* Fearing 1990 Reference at Fig. 9 at APEL0007549:

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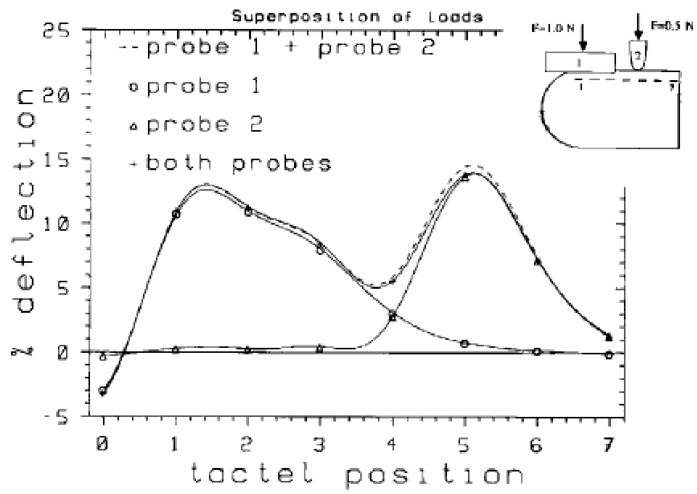
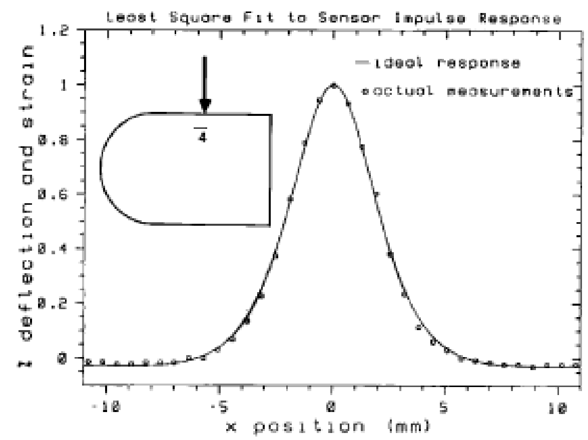
	 *See* Fearing 1990 Reference at Fig. 16 at APEL0007552:

Claim Language	Disclosure
	
10. The method of claim 1 further comprising the step of: detecting a distance between said first and second maxima.	The Fearing 1990 Reference does not disclose that the distance between the first and second maximum is detected. However, it would have been obvious to one of ordinary skill in the art for the reasons discussed in my report to combine the Fearing 1990 Reference with the Mehta Thesis.
	The Mehta Thesis discloses that the distance between the first and second maximum is detected. Specifically, the Mehta Thesis discloses that several tests were run that considered the distance between touches and the ability of the system to discern multiple objects where the objects were in close proximity to each other. *See* Mehta Thesis at APEL0006858: "Finger - Finger Separation Threshold: The last parameter determined was the minimum distance allowed between two fingers simultaneously placed on an overlay before they were mistaken for a single finger."

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	See Mehta Thesis at APEL0006858: "It will be observed that 1mm separation causes the image of the metal piece to be reduced to single point. The vertical line compression routine will only accept single dark pixels if they are separated from another dark pixel(s) by at most one white pixel."
18. A touch sensor for detecting the operative coupling of multiple fingers comprising:	The Fearing 1990 Reference discloses this limitation. *See* claim 1, above.[2]
means for scanning the touch sensor to (a) identify a first maxima in a signal corresponding to a first finger, (b) identify a minima following the first maxima, (c) identify a second maxima in a signal corresponding to a second finger following said minima, and **<u>Apple's and Elan's constructions:</u>** ***"means for scanning the touch sensor":***	The Fearing 1990 Reference discloses this limitation under Elan's construction but not under either Apple's or the Staff's construction. Namely, the Fearing 1990 Reference <u>does not</u> disclose the temporal order required by Apple's and the Staff's construction nor does it disclose the structure or equivalents thereto required by the Staff. However, one of ordinary skill in the art, for the reasons discussed in my report, would have known to combine the Fearing 1990 Reference with either the Mehta Thesis or the '661 Application to render the claim obvious under Apple's constructions.[3] The combination of the Fearing 1990 Reference with the Mehta Thesis or the '661 Application, <u>does not</u>, however, disclose this limitation under

[2] Claim 18 and its asserted dependent claims mirror independent claim 1 and its dependents. Accordingly, any discussion of claim 1 and its dependents is understood to apply to claims 18 and its dependents, including the discussion of the parties' and the Staff's respective claim constructions for terms that appear in both claim 1 and its dependents and claim 18 and its dependents.

[3] For a discussion of the requirements of this limitation beyond the means plus function language, see claim 1.

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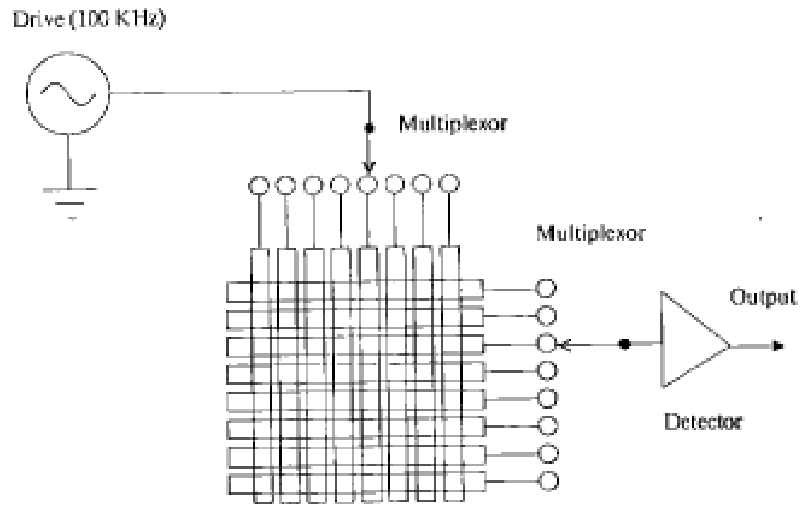
This limitation is governed by 35 U.S.C. § 112(6). The recited function is scanning the touch sensor. The corresponding structure is an analog multiplexer, a circuit to measure changes in capacitance of sensor conductors, an analog to digital converter, a microcontroller, and equivalents thereof. **<u>Staff's constructions:</u>** ***"means for scanning the touch sensor":*** This limitation is governed by 35 U.S.C. § 112(6). The recited function is scanning the touch sensor to (a) identify a first maxima in a signal corresponding to a first finger, (b) identify a minima following the first maxima, and (c) identify a second maxima in a signal corresponding to a second finger following said minima.	the Staff's constructions. The parties agree that "means for scanning the touch sensor" is governed by 35 U.S.C. § 112(6) and the function is scanning the touch sensor.[4] The Fearing 1990 Reference discloses a device which performs this function. *See* Fearing 1990 Reference at APEL0007544: "As shown in Figure 2, capacitors are formed at the intersection of rows and columns of conductive strips. As in the method used by Siegel (1986), the capacitance at a junction is measured by the amplitude of the output voltage for a selected row and column. Unused rows and columns are switched to ground potential to improve shielding and reduce cross-talk. The 8X8 array was originally scanned at 15 Hz, but the rate was reduced to 7 Hz for improved noise performance. This low scanning speed could be increased, but since the analysis has been done for static forces only, it has not been a limitation. The parties agree that the corresponding structure is an analog multiplexer, a circuit to measure changes in capacitance of the sensor conductors, an analog to digital converter, a microcontroller, and equivalents thereof. The Fearing 1990 Reference discloses an analog multiplexer and a circuit to measure changes in the capacitance. *See* Fearing 1990 Reference at Fig. 2 at APEL0007544:

[4] I understand that a prior art reference discloses a means plus function limitation if it performs the same function and discloses the corresponding structure or an equivalent thereof.

Claim Language	Disclosure
The corresponding structure is an analog multiplexer, a circuit to measure changes in capacitance of sensor conductors, an analog to digital converter, a microcontroller, the algorithms at 400-440 in Fig. 5, the algorithms at 200-278 in Fig. 6-1, and equivalents thereof.	 *See* Fearing 1990 Reference at APEL0007544: "As shown in Figure 2, capacitors are formed at the intersection of rows and columns of conductive strips. As in the method used by Siegel (1986), the capacitance at a junction is measured by the amplitude of the output voltage for a selected row and column. Unused rows and columns are switched to ground potential to improve shielding and reduce cross-talk. The 8X8 array was originally scanned at 15 Hz, but the rate was reduced to 7 Hz for improved noise performance. This low scanning speed could be increased, but since the analysis has been done for static forces only, it has not been a limitation. Simplicity of construction was an issue; thus the electronics are mounted remotely from the sensor at the base of the hand, at a distance of about 30 cm. While performance would be significantly improved by having the

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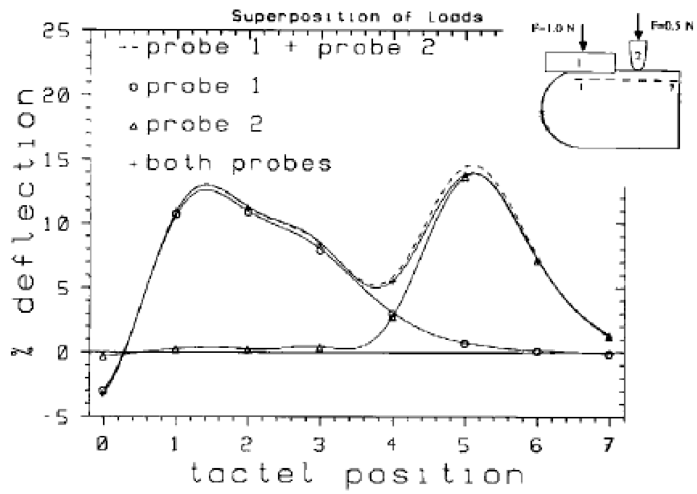
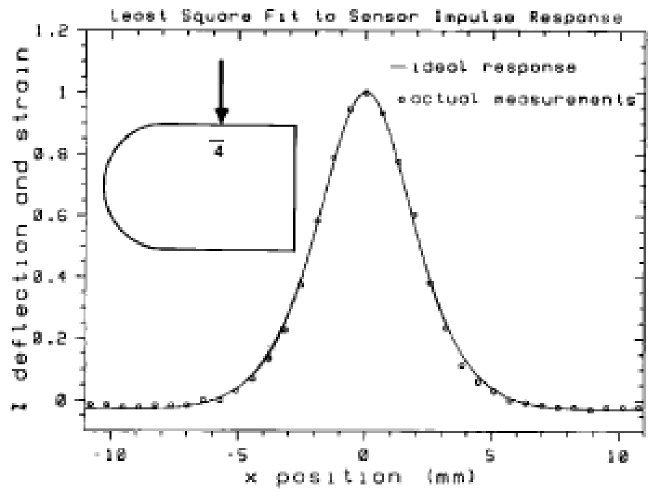
	electronics built into the finger tip, it was not felt that the sensor design was stable enough for the considerable cost of installing electronics internally. A significant fraction of the signal is thus lost in the shielding capacitance. The large capacitance of this sensor allows significant cable capacitance. Two shielded cables are required to reduce coupling, one for driving the array and one for sensing the array output. Improvements in sensitivity and reduced wiring constraints could be accomplished by a custom hybrid circuit embedded in the core of the finger." One of ordinary skill in the art would further recognize that an A/D converter and a microcontroller are being used to derive and calculate the formulas discussed at APEL0007545 and particularly to allow plotting of the following figures. Accordingly, the Fearing 1990 Reference disclose all the structure required by the parties. *See* Fearing 1990 Reference at Fig. 9 at APEL0007549:

Claim Language	Disclosure
	 *See* Fearing 1990 Reference at Fig. 16 at APEL0007552:

Claim Language	Disclosure
	 The Staff disagrees with the parties' understanding of the function and identification of corresponding structure. The Staff understands the function to be scanning the touch sensor to (a) identify a first maxima in a signal corresponding to a first finger, (b) identify a minima following the first maxima, and (c) identify a second maxima in a signal corresponding to a second finger following said minima, in that order. The Fearing 1990 Reference does not perform the claim limitations in order. Furthermore, the additional structure required by the Staff includes the algorithm in Figs. 5 and 6. The Fearing 1990 Reference does not disclose this required structure literally or by equivalence thereto.
means for providing an indication of the simultaneous presence of two fingers in	The Fearing 1990 Reference discloses this limitation under the parties' construction but does not disclose this limitation under the Staff's construction.

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response to identification of said first and second maxima. **<u>Apple's constructions:</u>** ***"means for providing an indication":*** This limitation is governed by 35 U.S.C. § 112(6). The recited function is providing an indication of the simultaneous presence of two fingers in response to identification of said first and second maxima. The corresponding structure is the algorithm found in Fig. 8-1, which sets a finger value equal to two after determining if a scan in either the X direction or the Y direction has detected two fingers. **<u>Staff's constructions:</u>** ***"means for providing an indication":*** This limitation is governed by 35 U.S.C. § 112(6). The recited function is providing an indication of the simultaneous presence of	Namely, the Fearing 1990 Reference does not disclose the structure or equivalents thereto required by the Staff.[5] The parties agree that "means for providing an indication" is governed by 35 U.S.C. § 112(6) and the function is providing an indication of the simultaneous presence of two fingers in response to identification of said first and second maxima. Apple's understanding of the corresponding structure requires the algorithm found in Fig. 8-1 (specifically, block 860), which sets a finger value equal to two after determining if a scan in either the X direction or the Y direction has detected two maxima. The Fearing 1990 Reference discloses this structure for performing the required function (see claim 1 above for discussion of Fearing 1990 Reference's disclosure of the function). Specifically, the Fearing 1990 Reference discloses that the first and second order derivate of the profile is taken to identify the number of objects on the touch sensor. *See* Fearing 1990 Reference at APEL0007557: "Localization of a line force could in principle be done by solving for location, angle of force, and magnitude of force from the strain equations at three sensors as was proposed in Fearing and Hollerbach (1985). A more general approach when there is no tangential force at the surface and the applied pressure is an even, single maximum function, is to find the peak strain by interpolation." Points that satisfy the following conditions are maxima, while points that only satisfy the first derivative condition are minima. *See* Fearing 1990 Reference at APEL0007558:

[5] For a discussion of the requirements of this limitation beyond the means plus function language, see claim 1.

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two fingers in response to the identification of said first and second maxima. The corresponding structure is a microcontroller programmed as shown in Fig. 5 (items 450-540) or as shown in Fig. 8-1 (item 850) to Fig. 8-2 (915). **<u>Elan's constructions:</u>** ***"means for providing an indication":*** This limitation is governed by 35 U.S.C. § 112(6). The function is providing an indication of the simultaneous presence of two fingers in response to identification of said first and second maxima. The corresponding structure is firmware or software that provides data indicating the presence of two fingers in response to the identification of two maxima and equivalents thereof.	The conditions for a maximum of a surface are: $$\frac{\partial f}{\partial x} = 0, \quad \frac{\partial f}{\partial y} = 0, \quad \frac{\partial^2 f}{\partial x^2} < 0, \quad \text{and} \quad \frac{\partial^2 f}{\partial y^2} < 0. \quad (52)$$ *See* Fearing 1990 Reference at APEL0007548: "If the sensor behaves as a linear space invariant system, there are many powerful techniques from linear system theory that can be used to analyze it. If the sensor response is linear and obeys the principle of superposition, the linear space invariant assumption will hold. Figure 9 shows interpolated strain profiles for two probes applied independently and jointly. The sum of the individual strain profiles corresponds well to the joint strain profile. Thus superposition seems to be a valid assumption, at least with forces less than 100 grams or so." Elan agrees with Apple regarding the function required by the limitation, but understands the corresponding structure to be firmware or software that provides data indicating the presence of two fingers in response to the identification of two maxima and equivalents thereof. The Fearing 1990 Reference discloses firmware or software for performing the required function (see claim 1 above for discussion of the Fearing 1990 Reference's disclosure of the function). Specifically, the Fearing 1990 Reference, using a software algorithm, recognizes the number of contacts on the touch sensor. *See* Fearing 1990 Reference at APEL0007557: "Localization of a line force could in principle be done by solving for location, angle of force, and magnitude of force from the strain equations at three sensors as was proposed in Fearing and Hollerbach (1985). A more general approach when there is no tangential force at the surface and the applied pressure is

Claim Language	Disclosure
	an even, single maximum function, is to find the peak strain by interpolation.” Points that satisfy the following conditions are maxima, while points that only satisfy the first derivative condition are minima. *See* Fearing 1990 Reference at APEL0007558: The conditions for a maximum of a surface are: $$\frac{\partial f}{\partial x} = 0, \quad \frac{\partial f}{\partial y} = 0, \quad \frac{\partial^2 f}{\partial x^2} < 0, \quad \text{and} \quad \frac{\partial^2 f}{\partial y^2} < 0. \quad (52)$$ *See* Fearing 1990 Reference at APEL0007548: “If the sensor behaves as a linear space invariant system, there are many powerful techniques from linear system theory that can be used to analyze it. If the sensor response is linear and obeys the principle of superposition, the linear space invariant assumption will hold. Figure 9 shows interpolated strain profiles for two probes applied independently and jointly. The sum of the individual strain profiles corresponds well to the joint strain profile. Thus superposition seems to be a valid assumption, at least with forces less than 100 grams or so.”
21. The touch sensor of claim 18 wherein said maxima are peaks.	*See claim 7, above.*