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# PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

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**INVENTOR(S)**

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*Additional inventors are being named on the* ______ *separately numbered sheets attached hereto*

**TITLE OF THE INVENTION (500 characters max):**

Two Dimensional Position Sensor

*Direct all correspondence to:* **CORRESPONDENCE ADDRESS**

☑ The address corresponding to Customer Number: 20191

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**ENCLOSED APPLICATION PARTS *(check all that apply)***

☑ Application Data Sheet. See 37 CFR 1.76
☑ Specification *Number of Pages* ~~25~~ 26
☑ Drawing(s) *Number of Sheets* ~~8~~ 8
☐ CD(s), Number of CDs ______
☐ Other (specify) Return post card

**Fees Due:** Filing Fee of $200 ($100 for small entity). If the specification and drawings exceed 100 sheets of paper, an application size fee is also due, which is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

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SIGNATURE [signature]
Date July 08, 2005

TYPED or PRINTED NAME David Kiewit
REGISTRATION NO. 34640 *(if appropriate)*

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Docket Number: P2D

***USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT***

## TITLE OF THE INVENTION

TWO-DIMENSIONAL POSITION SENSOR

## BACKGROUND OF THE INVENTION

The invention relates to a capacitive position sensor for determining the position of an object within a two-dimensional sensing area.

The use of two-dimensional touch-sensitive position sensors is becoming more common. Examples include the use of position sensors in laptop computers in place of mouse pointing devices, as control panels for receiving user inputs to control an appliance, or particularly as a glass touchscreen apparatus having an X-Y coordinate output. Some applications require a clear sensing layer so that a display can be viewed beneath the screen, while others only require an opaque touch surface, for example for a keypanel on a kitchen appliance or a PC peripheral.

Touch-sensitive position sensors are frequently preferred to mechanical devices because they provide for a more robust interface and are often considered to be more aesthetically pleasing. Furthermore, because touch-sensitive position sensors require no moving parts to be accessible to a user, they are less prone to wear than their mechanical counterparts and can be provided within a sealed outer surface. This makes their use where there is a danger of dirt or fluids entering a device being controlled particularly attractive.

There exists a large body of art involving 2D touchpanels and screens. They can be generally divided into two classifications: those that report an X-Y coordinate of a more or less continuous nature ('XY' type), and those that have a discrete sensing surface ('discrete' type) having predefined key areas that are fixed by physical geometry. The XY type find dominant use over LCD or other display types while the latter find use in fixed function key panels. There are exceptions to this, for example touchpad surfaces on laptops report XY position but are opaque. XY types invariably involve a sensing surface on the user-side or 'first surface' of the touch area. For example, both continuous resistive and capacitive touch screens involve a sensing layer that must be either physically depressed by the user or touched almost directly, or at most through a thin layer of insulation (as in mouse touchpads). These types require that the product have a bezel opening to allow direct or near-direct contact by the user with the sensing layer. A significant disadvantage of these types is that there has to be an opening in the panel, which requires sealing against moisture and dirt and hence is expensive to mount. Furthermore the sensing layer is directly exposed to abuse and can be easily damaged by sharp objects or abrasion. While robust capacitive types are known which have buried wires inside a glass layer (e.g. US 5,844,506 [1]), these still require a bezel opening in a panel which must be sealed, and require two sensing layers as a matrix due to the need to cross X and Y conductors. Furthermore these screens are very expensive to produce and in fact cannot be produced on a mass scale; additionally the sensing circuitry is known to be complex and expensive.

In the field of discrete touch buttons, it has been known for some time that capacitive keys can be placed behind a solid surface having no requirement for a bezel opening. However these types only provide for limited resolution, as predefined by the location of discrete electrode shapes. An example of this can be found in US 4,954,823 [2], Figures 4 and 6. While it is well known that these electrodes can be made of a single layer of clear conductor such as Indium Tin Oxide ('ITO') to allow placement over a bezel-less display, for example by the application of the layer as a film on the back of a subsection of a panel, nevertheless the technology is limited to discrete touch areas based on the number, size, and placement of discrete electrodes.

Figure 1 schematically shows in plan view a touch pad 2 of the type described in US 4,954,823 [2], but laid out in an orthogonal array. The touch pad 2 comprises a grid of discrete electrodes 4 mounted on an insulating substrate 6. Each electrode is connected to a channel of capacitance measurement circuitry in a controller 8. US 5,463,388 [3] describes this geometry in passing in conjunction with its Figure 1, to show how such an array can be used to determine a position of an object proximate the sensing layer via a method of determining a centroid of the signals from each pad. However US 5,463,388 fails to show how to implement such a design and describes instead a matrix of conductors along with a centroidal calculation of continuous X-Y position. In fact it is not practical to have so many sensing channels as one per sense pad, and a matrix arrangement is much more efficient as described below.

Figure 2 schematically shows a position sensor 12 based on a matrix of conductors as described in US 5,463,388 [3]. The position sensor 12 comprises a number of vertically aligned strip electrodes (columns) 14 mounted on an upper surface of an insulating substrate 16 and a number of horizontally aligned strip electrodes (rows) 15 mounted on an opposing lower surface of the insulating substrate. Each vertical strip electrode is connected to a channel of capacitance measurement circuitry in a controller 18. Thus, this type of position sensor allows an X-Y coordinate output of a continuous nature by means of calculation of a centroid of capacitance among the rows and columns rather than among discrete pads. However this type requires two sensing layers so that the matrix traces can be routed, and does not allow the use of optically clear materials.

The ideal touch surface would eliminate the need for a bezel opening (or at least, make it optional), have an inexpensive sensing surface that is applied to the rear of the panel surface that can project through a reasonable thickness of panel material (e.g. up to 4mm of glass or plastic), optionally require only one sensing layer with no crossovers in the sensing region, be usable with clear sensing layers such as ITO, have an XY type of output, and have a compact, inexpensive driver circuit. This set of ideal goals has not been achieved with any known prior art.

## SUMMARY OF THE INVENTION

According to a first aspect of the invention there is provided a capacitive position sensor for determining the position of an object in a sensing area, the sensor comprising a substrate having a surface with an arrangement of electrodes mounted thereon, wherein the electrodes define an array of sensing cells arranged in columns and rows to form the sensing area, 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, 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.

Thus a position sensor having electrodes on only a single layer of a substrate can be provided. Furthermore, because the position sensor employs an intersecting array of columns and rows of sensing electrodes (i.e. a matrix), fewer measurement channels are required than with sensors based on an array of discrete electrodes.

Because the position sensor is based on sensing electrodes on only a single surface, it can be cheaper to manufacture than known double-sided position sensors. This also means the sensing electrodes can be deposited directly onto a surface for which the opposing surface is inaccessible (e.g. a display screen). The sensing electrodes can also be deposited on an inside surface of a device housing, thus removing the need for any protective covering that might be required if electrodes were also required to be on the outer surface.

The electrical row wrap-around connections may comprise a conductive trace mounted on the substrate. This allows the connection outside of the sensing area to be made in the same processing step as the sensing electrodes within it. Alternatively, the row wrap-around connections may be made by a free wire appropriately connected to the respective row sensing electrodes.

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