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[54] **METHOD AND APPARATUS FOR OPERATING A CAPACITIVE TACTILE KEYBOARD**

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.**[6] **H03K 17/94**; H03M 11/00

[52] **U.S. Cl.** **341/33**; 341/22; 341/34

[58] **Field of Search** 341/20, 22, 24, 341/26, 33, 34; 345/173, 174; 200/600

[56] **References Cited**

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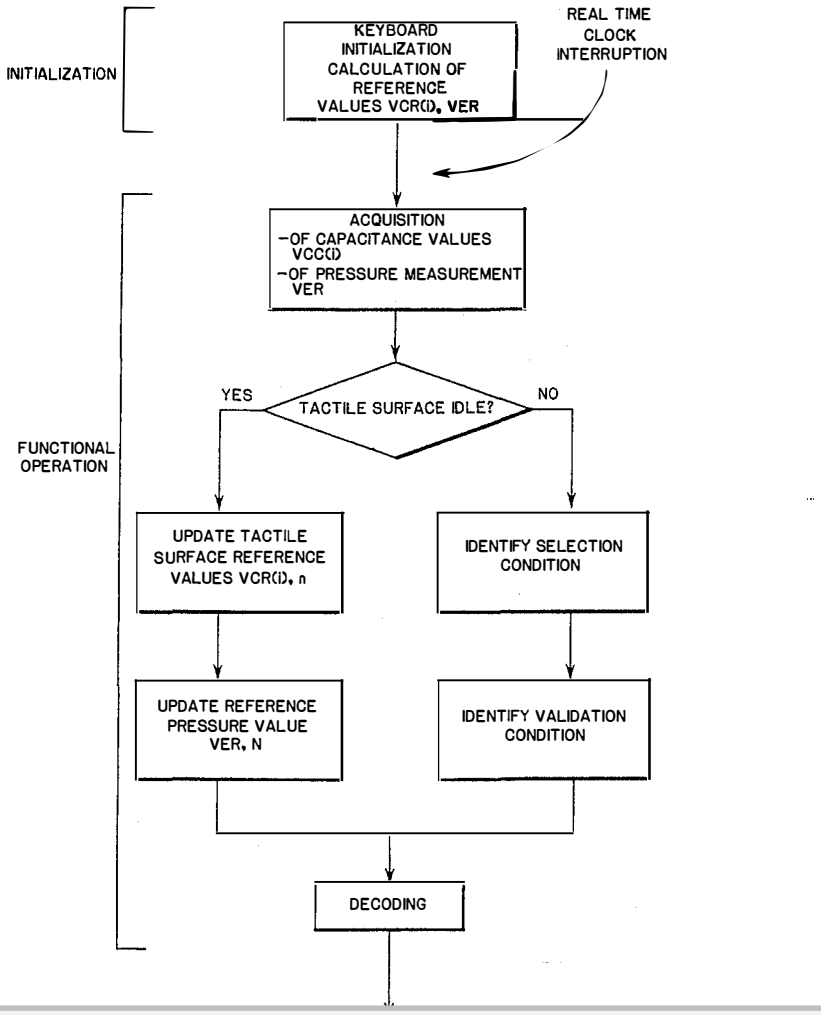
Attorney, Agent, or Firm—Barnes & Thornburg

[57] **ABSTRACT**

A method and apparatus for determining a valid selection of a capacitance tactile keyboard as a function of a selection state and validation state of the keyboard. The selection state is determined from measured capacitive values of each key by during a first phase of a cycle. The validation state is determined from measured pressure on the keyboard, for certain key selection states only, during a second phase of the cycle.

21 Claims, 3 Drawing Sheets



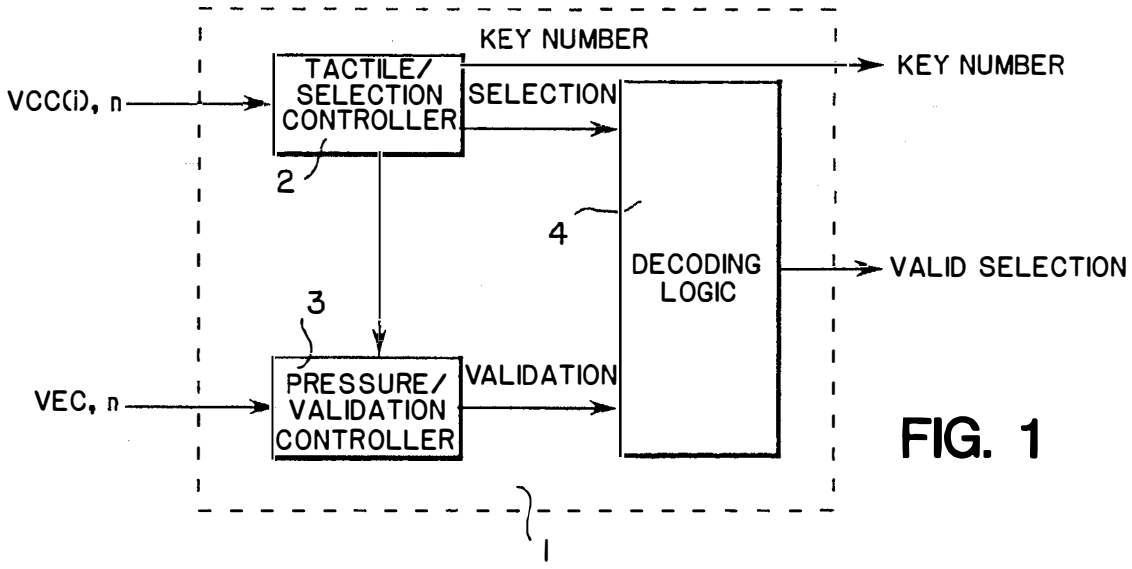


FIG. 1

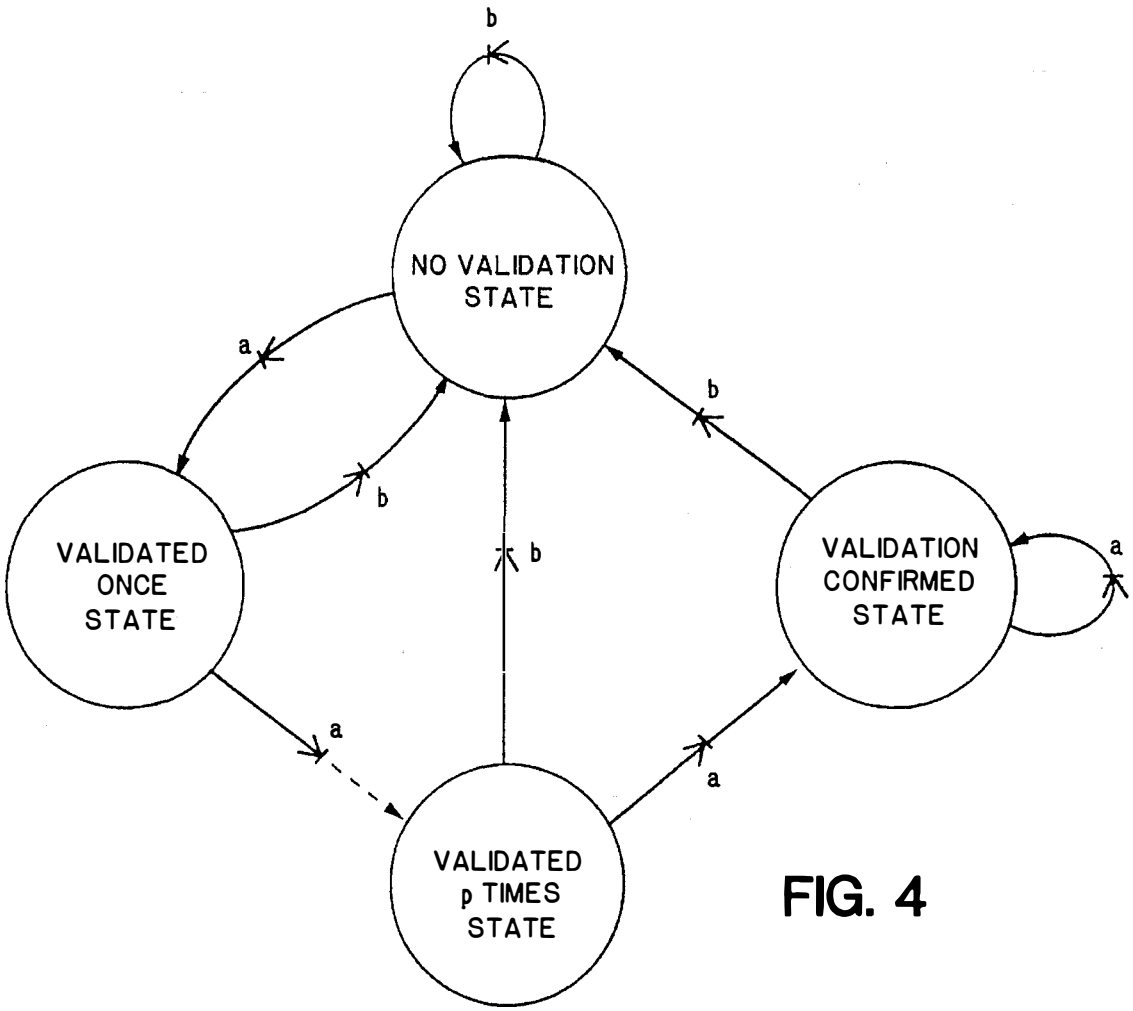


FIG. 4

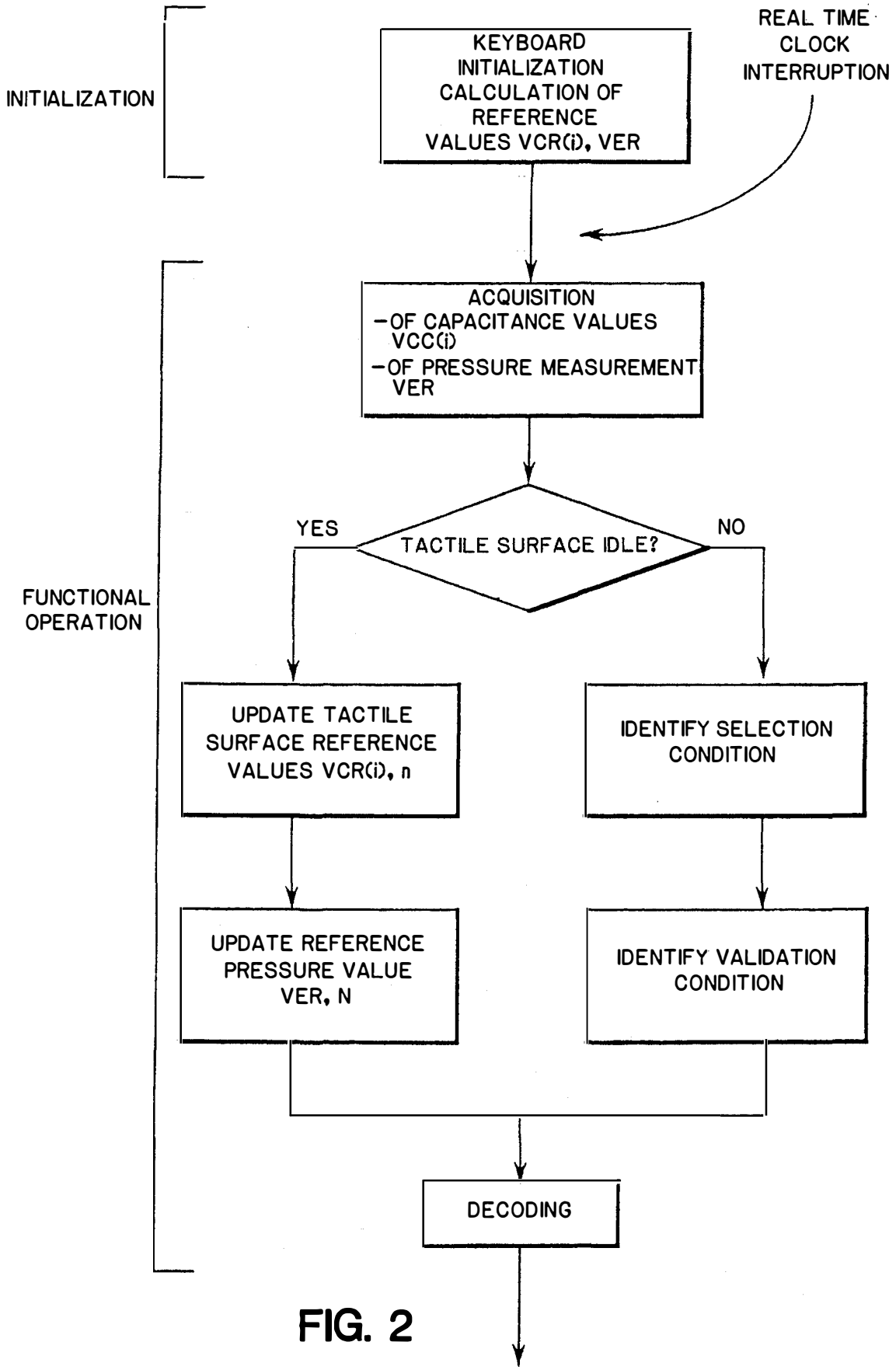
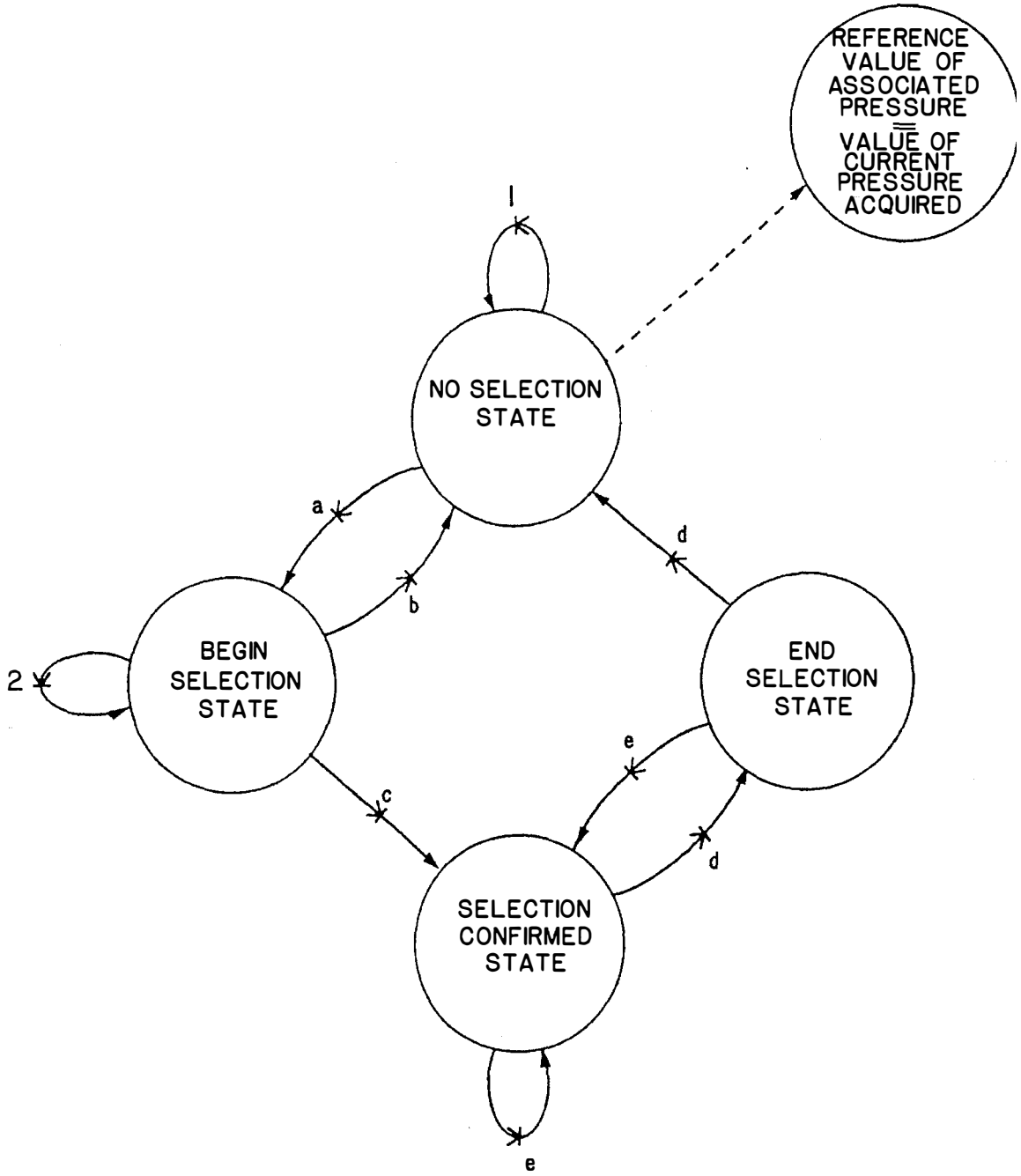


FIG. 2

FIG. 3



METHOD AND APPARATUS FOR OPERATING A CAPACITIVE TACTILE KEYBOARD

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates to a method of apperature for operating a capacitive tactile keyboard and, more particularly, to such a process wherein the position of the operator's finger on the keyboard and the pressure exerted by that finger are determined cyclically by measuring capacitance and pressure.

Such tactile keyboards are composed of a capacitive tactile surface positioned in front of a display, such as a liquid crystal display, for example, and make it possible to designate a specific area of the display by using a finger. To this end, the position of the finger on the surface is determined by capacitance measurements and the finger pressure exerted on the surface is detected by means of a pressure measuring device, consisting of resistance gauges, for example.

One object of the process according to the invention is to make it possible to use the signals generated by the capacitive tactile surface and the pressure measurement device.

Another object is to provide a fully programmable parameter keyboard designed to meet the requirements of operating applications and environmental constraints.

A still further object is to provide for the adjustment of keyboard sensitivity and to compensate for drifts and interference.

To this end, the object of the invention is a device for operating a capacitive tactile keyboard wherein the position of the operator's finger on the keyboard and the pressure exerted by that finger are determined cyclically by capacitance measurements and pressure measurements, characterized in that:

- during a first phase of each cycle, the capacitance value of each key on the keyboard is measured and a keyboard selection state is defined based on these measurements;
- during a second phase of the cycle, for certain keyboard selection states only, the pressure measurements are taken into account to define a keyboard validation state; and
- a decision is made on whether a valid selection has occurred as a function of the selection state and the validation state of the keyboard.

The process according to the invention is implemented by two controllers operating in a master/slave relationship and by a decoding logic.

The first controller is associated with the capacitance measuring device. Its input parameters are analog and are composed of the capacitance measurements at each cycle for each key of the keyboard, and its output parameters consist of a positive integer characterizing the selected key and a logic parameter defining the selection state of this key.

The second controller is associated with the pressure measuring device. Its input parameter is also analog and consists of the value of the pressure measured at each cycle; and its output parameter is the logic parameter defining the validation state.

The two logic parameters of the two controllers, selection and validation, are applied at the input of the decoding logic, which generates a valid selection logic parameter at its

To adjust for drifts and interference due to environmental factors, means may be provided for comparing the measured capacitance and pressure values to reference values and, if all measured differences in capacitance are less than a predefined low threshold, for updating the reference values.

Consequently, as long as the measured differences in capacitance are less than the low threshold, the keyboard is considered to be idle and the differences in both the capacitance values and the pressure values are considered to be attributable to drift or interference. In this case, both reference values are modified or updated. Conversely, as soon as the difference in capacitance is greater than or equal to the aforesaid low threshold, this difference is considered to be due to actuation of the keyboard, and the corresponding reference capacitance value and reference pressure value are no longer updated.

In a particular embodiment of the process of the invention, the updated reference capacitance value is obtained by calculating a weighted average using at least the previously calculated average and the measured capacitance value, and the updated reference pressure value is the last measured pressure value.

The updated reference capacitance value is obtained by calculating a weighted average from at least the previously calculated average and the measured capacitance value and therefore depend not only on currently measured capacitance values, but also on capacitance values measured during at least one preceding cycle. By weighing the current capacitive values when calculating the reference capacitive value, sensitivity can be adjusted to compensate for drift and interference, mainly of electrical origin.

Conversely, the updated reference pressure value is the current pressure value which has just been measured. This is possible because this pressure value is not in any event updated until the measured differences in capacitance are less than the low threshold and, consequently, until the keyboard is idle. This arrangement makes it possible to overcome the load factor problem.

In one particular embodiment of the invention, the differences between the measured capacitance values and the reference capacitance values are calculated. The keyboard has at least one non-selection state, one pre-selection state, and one confirmed selection state. Also, the transitions from one state to another are determined by comparing the differences in capacitance to a low threshold and to a high threshold.

More particularly, a key may be preselected when its difference in capacitance is greater than the low threshold, and a key may be selected if it has already been preselected and its difference in capacitance is greater than the high threshold.

Measurements may also be made for sorting from among several keys that are likely to be preselected, to manage conflicts, and to compensate for inadvertently brushing against the keyboard.

More particularly, when the difference in capacitance between two keys is greater than their low threshold, it is possible to preselect only the key with the highest difference in capacitance.

Moreover, when the keyboard is in the idle state or when a key has already been preselected, the keyboard remains or returns to the non-selection state if the difference in capacitance of at least two keys is or was greater than the high threshold, respectively.

Finally, when one, and only one, non-preselected key has a difference in capacitance greater than the high threshold,

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