

Patent Application

METHOD AND APPARATUS FOR PROVIDING TACTILE SENSATIONS

CROSS-REFERENCES TO RELATED APPLICATION

[0001] This application is a continuation of co-pending U.S. Patent Application No. 10/285,450 entitled "Method and Apparatus for Providing Tactile Sensations" filed November 1, 2002, which claims priority to U.S. Provisional Application No. 60/335,493, filed November 1, 2001, and U.S. Provisional Application No. 60/399,883, filed July 31, 2002, the entirety of all of which is hereby incorporated by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to methods and apparatus for providing tactile sensations.

BACKGROUND

[0003] Conventional electronic devices, such as mobile telephones and Personal Digital Assistants (PDAs), include visual displays. A user of such devices interacts with the visual display using any one of a number of input devices. Examples of such input devices include computer mice, joysticks, trackballs, steering wheels, stylus, tablets, pressure-sensitive spheres, scroll wheels, keyboards, and keypads. The user provides instructions, responses, and other input to the device using such input devices.

[0004] In conventional mobile telephones and PDAs, confirmation of the input provided by the user is primarily limited to visual or audible confirmation. In some such devices, physical feedback is provided by conventional mechanical switches in the form of the conventional mechanical feedback of switches, for example the switch closure force-displacement profile. Typically, in such devices, the mechanical feedback provided

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by each button is identical. In addition, in such conventional devices, for those buttons that serve multiple functions, the mechanical feedback generally remains the same regardless of the current function of the button.

[0005] In addition to providing extremely limited and rudimentary mechanical confirmation of button selection, conventional buttons as used, for example, in keypads for mobile telephones and PDAs, provide simple passive touch cues regarding the alignment of keys. Such cues include raised bumps on the center key of a telephone keypad or on the "F" and "G" keys of a keyboard that assist a user in orienting to the pattern of keys in the keypad and keyboard. Again, these physical queues are very limited, and users typically need to view a keypad or keypad for visual confirmation that the correct instructions or information is being entered.

[0006] When a flat surface interface device is used, such as a touchpad for a computer or PDA, these simple mechanical cues are unavailable to the user. Often, touchpads are combined with flat-panel display screens that display one or more graphically generated buttons or softkeys. Normally, the softkeys are visible through the touchpad. A user's contact with the touchpad in an area defined by a softkey provides the electronic device having the touchpad with the input associated with that softkey.

[0007] The use of electronic devices using such conventional mechanical buttons and touchpad arrangements are particularly difficult to use in distracting environments or when the user is attempting to perform another task simultaneously with using the electronic device. For example, if the other task involves operating a motor vehicle or heavy machinery, it may be difficult or impossible for a user to simultaneously use such an electronic device because such devices typically require the user to look at the device,

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at least briefly, when interacting with the device. In addition, electronic devices relying on softkeys can be difficult to read in bright light environments such as in bright sunlight and can contain very small fonts and graphics that are difficult to read and select.

[0008] Some conventional touchpads include vibratory feedback to the user of the touchpad. U.S. Patent No. 5,977,867 is one example. Such conventional systems and methods are limited, though. They lack a full range of functionality assistance to a user interacting with an electronic device. Moreover, such systems and methods still require considerable visual attention from the user.

SUMMARY

[0009] The present invention comprises products and processes for providing tactile sensations to input devices or electronic devices. Input devices include mechanical input devices (such as, for example, mechanical switches) and non-mechanical input devices (such as, for example, touchpads). Tactile feedback is provided by using an actuator or other means in communication with the input device or electronic device. A controller may be employed to receive signals from the input devices and to control the actuator. Tactile feedback to an input device or electronic device may be provided in response to one or more events or situations. Such an event or situation may be any one designated. Examples of such events and situations include the level of pressure placed on an input device; the availability or lack of availability of a function associated with an input device; and the function, menu, or mode of operation associated with an input device's activation. A variety of feedback types and combinations may be selected. Mobile telephones and PDAs benefit from employing such products and processes, but

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other devices benefit as well. The advantages offered by the various embodiments of the present invention may be understood by examining this specification.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Figure 1 is a perspective view of an embodiment of an apparatus according to the present invention;

[0011] Figure 2 is a plan view of another embodiment of an apparatus according to the present invention;

[0012] Figure 3 is a plan view of an electronic device including an embodiment of the present invention;

[0013] Figure 4 is a schematic representations through line 4-4 of Figure 3;

[0014] Figure 5 is a plan view of another electronic device including another embodiment of the present invention;

[0015] Figure 6 is a schematic representations through line 6-6 of Figure 5;

[0016] Figure 7 is a block diagram illustrating an embodiment of the apparatus in an electronic device;

[0017] Figure 8 is a flow chart illustrating a method according to the present invention;

[0018] Figure 9 is a table illustrating a first set of data to be used in one embodiment of the present invention; and

[0019] Figure 10 is a table illustrating a second set of data to be used in another embodiment of the present invention.

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[0020] The present invention includes methods and systems for providing tactile sensations. One embodiment includes methods and systems for providing tactile sensations to input devices, both mechanical and non-mechanical (for example soft-keys that are computer generated and displayed on a screen). Embodiments of the present invention can be utilized in wide variety of electronic devices including telephones, mobile telephones, remote controls, gamepads, joystick handles, automotive controls (radios, Compact Disc (CD) players, automobile functions, etc.), consumer electronics devices, Personal Digital Assistants (PDAs), personal computers, laptop computers, portable gaming devices, pagers, I-pagers, audio equipment, televisions, security or alarm systems, Automated Teller Machines (ATM), calculators, home appliances, and white goods.

[0021] Figure 1 shows one embodiment of the present invention. The apparatus 1 shown in Figure 1 includes an input device 2 having multiple positions for communicating a plurality of input signals. The input device 2 can be any device capable of transmitting an input signal. In the embodiment shown, the input device 2 is a rocker-type switch. The rocker switch 2 shown can pivot or rock between two positions in which the rocker switch contacts and activates one of two rubber switches 3 containing conductive pads. The use of rubber switches 3 provides the advantage of allowing the user to still feel a substantial vibration or force through the input device 2 when the user had fully depressed the switch. Suitable rubber switches are available and known in the art. In other embodiments, the input device may include an analog switch, a force sending resistor, a strain gauge based sensor, a capacitative touch switch, a scroll wheel, a mini-

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joystick, a touchpad, a touch screen, a 3-way switch, a 4-way switch, a 5-way switch, or other input device. Each position of the input device 2 corresponds to one of the input signals.

[0022] The input device 2 and rubber switches 3 are mounted on a Printed Circuit Board (PCB) 4 in the embodiment shown to facilitate electrical communication between the input device 2 and an electronic device (not shown). The PCB 4 can be custom shaped according to the device into which the apparatus 1 is placed. The PCB 4 also provides for secure mounting within the device by including, for example, a plurality of holes 5 to accept fasteners for securing to the electronic device. In another embodiment, the input device 2 can be directly connected or mounted in the electronic device.

[0023] The apparatus 1 shown in Figure 1 also includes a vibrotactile actuator 6 in communication with the input device 2. Preferably, the actuator 6 is configured to output a plurality of distinct tactile feedback sensations to the input device 2. Suitable tactile sensations include vibrations, for example, jolts and textures, and a plurality of distinct tactile sensations can be created by varying the frequency, amplitude and waveform output by the actuator 6. The actuator 6 is selected to deliver the desired tactile sensations to the input device 2. The actuator 6 shown in Figure 1 is a voice coil actuator. Other suitable actuators include, for example, piezo-electric actuators, eccentric mass actuators, moving magnet actuators, and friction brakes in contact with metal shafts. In addition, the actuator can include a flexure, for example an arrangement of flexible material, coupled to the rotating shaft of a DC motor or step motor to transform the rotation of the motor shaft into vibrations or other haptic sensations. Various arrangements of a flexure coupled to a motor may be used as an actuator. For example,

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U.S. Patent Application No. 09/585,741, filed June 2, 2000, illustrates suitable arrangements of flexures and motors for use as an actuator in embodiments of the present invention. The entire disclosure of the application No. 09/585,741 is incorporated herein by reference. Tactile sensations can also be delivered to the input device 2 from a speaker included with an electronic device into which the apparatus is placed, for example the speaker in a mobile telephone or in a personal computer.

[0024] Although the embodiment shown in Fig. 1 includes one input device 2 and one actuator 6, other embodiments include a plurality of input devices, all in communication with a single actuator. Alternatively, an embodiment can include a plurality of actuators each in communication with at least one input device. Various arrangements of actuators in combination with input devices are suitable for use in the present invention. For example, U.S. Patent Application No. 09/263,263, filed July 26, 2001, published on March 21, 2002, as U.S. Patent Pub. No. US2002/0033795 illustrates actuators in combination with input devices that may be used in embodiments of the present invention. The entire disclosure of application No. 09/263,263, Pub. No. 2002/0033795 is incorporated herein by reference.

[0025] As mentioned, the actuator 6 is in communication with the input device 2. In the embodiment shown in Figure 1, the actuator 6 is in communication with the input device 2 through a cantilevered beam or lever arms 7 attached to the pivoting rocker, amplifying the effective forces of the actuator 6 felt by the user. The tactile sensations generated by the actuator 6 propagate through the lever arm 7 to the input device 2. Suitable materials for the lever arm 7 are capable of transmitting the tactile sensations and can be, for example, metal. The lever arm 7 shown includes one or more bends 8 to

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fit within the electronic device in which the apparatus 1 is disposed. Different shapes of bends may be used to fit within the electronic device. In another embodiment, the actuator 6 is mounted directly to the input device 2 or to any component of the input device. Alternatively, the actuator 6 is mounted to the PCB 4 to which the input device is attached, communicating tactile sensations to the input device through the PCB. In another embodiment, the actuator is an existing eccentric mass motor as is used, for example, as a vibrating ringer in a pager or mobile telephone.

[0026] The vibrotactile actuator 6 can also be mounted to a portion of the case or housing of the electronic device in which the apparatus 1 is disposed, communicating the tactile sensations to the entire electronic device. In one embodiment, two actuators can be incorporated in the case or back of an electronic device, for example the case of a mobile phone in an area that contacts the user's hand. This arrangement effectively doubles the amplitude of the tactile sensation, and the user's fingers do not tend to attenuate the tactile sensation.

[0027] The apparatus 1 also includes a controller 9 in communication with the input device 2 to receive the input signals therefrom. The controller 9 can also receive additional information from the input device 2 including the position of the input device 2 and the amount of pressure applied to the input device 2. In one embodiment, the input signal includes information related to the amount of pressure applied to the input device 2, information related to the position of the input device 2, or a combination of information about pressure and position. In addition to being in communication with the input device 2, the controller 9 is in communication with the actuator 6 to produce a

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tactile sensation in the actuator 6 corresponding to the input or input signal received by the controller 9 from the input device 2.

[0028] The controller 9 is located in a suitable location according to the needs of the device in which the apparatus 1 is placed. In one embodiment, the controller 9 is attached to the PCB 4 as shown in Figure 1. Suitable controllers, include, for example, digital logical processors capable of processing input, execute algorithms, and generate output as necessary to create the desired tactile sensations in the input device in response to the inputs received from that input device. Such controllers may include a microprocessor, an Application Specific Integrated Circuit (ASIC), and state machines. Such controllers include, or may be in communication with, media, for example computer readable media, which stores instructions that, when executed by the controller, cause the controller to perform the steps described herein as carried out, or assisted, by a controller. One embodiment of a suitable computer-readable medium includes an electronic, optical, magnetic, or other storage or transmission device capable of providing a processor, such as the processor in a web server, with computer-readable instructions. Other examples of suitable media include, but are not limited to, a floppy disk, CD-ROM, magnetic disk, memory chip, ROM, RAM, ASIC, configured processor, all optical media, all magnetic tape or other magnetic media, or any other medium from which a computer processor can read. Also, various other forms of computer-readable media may transmit or carry instructions to a computer, including a router, private or public network, or other transmission device or channel.

[0029] In one embodiment, the apparatus 1 includes a dedicated controller 9 for use specifically with the apparatus 1. This embodiment is particularly well suited for

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applications where the apparatus 1 is retro-fitted into an existing electrical or electronic device. In another embodiment, the controller 9 is the microprocessor or Central Processing Unit (CPU) of the electronic device in which the apparatus 1 is disposed. The apparatus 1 can also include additional circuitry such as the drive circuitry (not shown) necessary to create the tactile sensations in the actuator 6 in response to input from the controller 9 and a memory medium for storing data to be accessed by the controller 9 for example a correlation between the tactile sensations to be produced in the actuator 6 and the input information or input signal received from the input device 2.

[0030] Figure 2 shows another embodiment of the present invention. An apparatus 60 shown in Figure 2 includes multiple input devices. These multiple input devices include twelve fixed or pre-assigned alphanumeric input buttons 10a-l, three pre-assigned function buttons 11a-c, and three assignable function buttons 12a-c. The plurality of inputs devices are arranged according to the electronic device in which the apparatus 60 is situated. In the embodiment shown, the plurality of input devices are arranged as the keys in a key pad for a telephone or mobile telephone.

[0023] Embodiments of the present invention include an input device having a means for determining or sensing pressure. The input device is capable of resolving multiple levels of pressure placed on the input device, and of transmitting a signal associated with the level of pressure placed on the input device. These multiple levels of pressure may be defined by, for example, the physical location of, or distance traveled by, a switch-type input device in the x-plane when pressed by a user (higher / lower), the magnitude of pressure placed on a touchpad-type input device, or other means.

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[0031] The buttons of Figure 2 are illustrative of such an embodiment. Each of the alphanumeric input buttons 10 shown in Figure 2 is a keypad button. Each of the buttons 10 is capable of resolving multiple levels of pressure placed on the buttons 10. For example, the button 10i (corresponding to the number 9 on the keypad) is capable of resolving five levels of pressure placed on the button 10i. In the embodiment shown, the first level is a state in which no pressure is placed on the button by a user, the second level being a first magnitude of pressure placed on the button (greater than no pressure placed by the user), the third level being a second magnitude of pressure placed on the button (where the second magnitude of pressure is different from or greater than the first magnitude), the fourth level being a third magnitude of pressure placed on the button (where the third magnitude is different from or greater than the second magnitude), and the fifth level being a fourth magnitude of pressure placed on the button (where the fourth magnitude is different from or greater than the third).

[0032] In button 10i, each of levels two through five is associated with a distinct input signal. When the button 10i is in its first state, then the button 10i does not transmit an input signal. When pressure is applied to the button 10i by a user that exceeds the first magnitude of pressure, the button 10i transmits a first signal to the controller 9. When greater pressure is applied to the button 10i that exceeds the second magnitude of pressure, the button 10i transmits a second signal to the controller. When still greater pressure is applied to the button 10i that exceeds the third magnitude of pressure, the button 10i transmits a third signal to the controller. When even greater pressure is applied to the button 10i that exceeds the fourth magnitude of pressure, the button 10i transmits a fourth signal to the controller. The structural arrangement of the communication by the

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button 10i to the controller 6 of an input signal is further illustrated in Fig. 4, described below.

[0033] Each of the levels two through five of button 10i (and thus each of their associated signals) is associated with a letter, W-Z. The second level is associated with the letter W, the third level is associated with the letter X, and so on. The second level is associated with the letter W, the third level is associated with the letter X, and so on. In the embodiment shown, the key 10i has five positions corresponding to no pressure, and the letters W, X, Y, and Z. In an alternative embodiment, the key 10i has six positions corresponding to no pressure, the number "9," and the letters W, X, Y, and Z.

[0034] In the embodiment shown, the alphanumeric buttons 10 are all capable of resolving five levels of pressure. In alternative embodiments, the various buttons are capable of resolving differing levels of pressure. For example, in an alternative embodiment, while the button 10i is capable of resolving five levels of pressure, the button 10b (corresponding to the number 2 on the keypad) is capable of resolving four levels of pressure placed on the button 10b (the first level being no pressure placed on the button). Like button 10i, the levels resolved by button 10b in the alternative embodiment are each associated with a distinct input signal, and are each associated with a distinct letter of the alphabet, A-C.

[0035] The pre-assigned function buttons 11a-c of the apparatus 1 are keypad push buttons. Each of the buttons 11a-c is capable of resolving three levels of pressure placed on the buttons 11a-c no pressure, a first magnitude of pressure (greater than none), and a second magnitude of pressure (greater than the first magnitude). Examples of

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functions carried out by such pre-assigned function buttons 11 a-c include "Send" 11a, "Power" 11b, and "End Call" 11c.

[0036] In the embodiment shown, each of the pre-assigned function buttons 11 a-c is configured such that the first magnitude of pressure is an amount of pressure that signifies that a user's finger is "hovering" over, or touching with more than passing force, the button. Each is also configured such that the second magnitude of pressure is an amount of pressure that signifies that a user's finger applies when the user wishes to activate the button.

[0037] Thus, in the embodiment shown, when a user's finger "hovers" over the "Send" button 11c, a first signal is transmitted by the button 11c to the controller. And, when a user's finger activates the "Send" button 11c, a second signal is transmitted by the button 11c to the controller.

[0038] The assignable-function buttons 12a, 12b, 12c are buttons whose function depends upon the mode of operation of the device with which the apparatus 1 is associated. For example, when such an apparatus 1 is associated with a mobile telephone, such buttons 12a, 12b, 12c may be used to navigate the menus displayed to carry out various functions, such as scrolling through an address book, selecting a number to dial, editing a number, re-setting the time displayed, and similar functions.

[0039] In addition, the assignable-function buttons 12a-c are configured similarly to the pre-assigned buttons 11a, 11b, 11c, in that the buttons 12a, 12b are configured such that the first magnitude of pressure is an amount of pressure that signifies that a user's finger is "hovering" over, or touching with more than passing force, the button, and such that the second magnitude of pressure is an amount of pressure that signifies that a user's

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finger applies when the user wishes to activate the button. Preferably, the buttons 11a, 11b, 11c, 12a, 12b, 12c are configured such that they receive and analyze other data in determining whether the user is merely hovering or, instead, wishes to activate the button (such as type of, and duration of, contact with the button). Any suitable input-device may be used as an assignable-function input device. Examples of such input-devices include rocker-switches and scroll wheels.

[0040] In an alternative embodiment (not shown), the middle assignable-function button 12c, includes the input device of Fig. 1. It is in communication with the actuator 6 (not shown) shown in Fig. 1 as well, and operates in the manner described with reference to Fig. 1. In such an embodiment, the PCB 62 is separated at line 62a, such that the PCB4 of Fig. 1 is not in contact with PCB62.

[0041] Referring again to Fig. 2, although in the embodiment shown there the alphanumeric keys have four or five available states (embodying an alphanumeric-character selection), and the pre-assigned buttons 11a, 11b, 11c, and the assignable-function buttons 12a, 12b, 12c are configured to indicate hover / activation signals, in other embodiments, other configurations may be used. Moreover, although the alphanumeric keys 10 have four or five available states, thus allowing them to be associated with three or four (or more) input signals, such keys 10 may be configured to provide input signals at, for example, only two of the states. In this way, such keys 10 may be configured to provide hover / activation signals similar to that which is provided in the pre-assigned buttons 11a, 11b, 11c, and assignable-function buttons 12a, 12b, 12c in the embodiment shown in Fig. 2.

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[0042] Moreover, in the embodiment shown, the levels for the alphanumeric input devices 10 correspond to magnitudes of pressure, but in other embodiments the levels resolved can be type of touch, magnitude, physical position of the switch and other attributes of contact with the button, or some combination thereof. The input signals provided by such input devices may be configured accordingly.

[0043] In the embodiment shown in Fig. 1, the input signals that are transmitted by the input devices are transmitted to a controller 9. In the embodiment shown, the controller is in communication with storage memory (not shown). Examples of such memory includes Read Only Memory (ROM). The storage memory includes a table in which input signals are associated with various haptic feedback signals. This is explained more fully in relation to Figures 9-10.

[0044] The apparatus 1 shown in Fig. 2 also includes an actuator 61. The actuator 61 is shown in representative fashion in Fig. 2, and not to scale or in physical placement. An alternate actuator 61 and physical placement of the actuator 61 is shown in Fig. 4. The actuator 61 is in communication with the various input devices, and is configured to provide vibrations of varying frequencies, magnitudes, and wave-forms to the input devices. The actuator 61 is also in communication with the controller 9. Further description of embodiments of such communication and configuration is provided below.

[0045] In the embodiment shown, the controller 9 receives an input signal from one of the input devices. The controller 9 then analyzes the input signal received to determine a signal to transmit to the actuator 61.

[0046] For example, the controller 9 of Fig. 2 is configured such that when the controller 9 receives a signal associated with the second level from button 10i (the "9"

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key), the controller 9 sends a first control output signal to the actuator, and when the controller receives a signal associated with the third level from the button 10i, the controller sends a second control output signal to the actuator 61, and so on. The first control output signal is one that causes the actuator to provide a vibration of a certain, first frequency. The second control output signal is one that causes the actuator to provide a vibration of a certain, higher frequency, and so on. In other embodiments, the vibrations provided may be of the same frequency.

[0047] Fig. 3 shows another embodiment of the present invention, in the form of a mobile telephone 14 having the apparatus of Fig. 2. The controller 9, actuator 61, and the PCB 62 of the apparatus 60 of Fig. 2 are encased in a case 18 of the mobile telephone 14. The mobile telephone 14 also includes a display screen 15 capable of displaying graphic objects 16 and alpha-numeric information 17. The alpha-numeric information 17 that may be displayed includes phone numbers and lists, for example of list of entries in a phone book, that are input by the alpha-numeric input buttons 10 and accessed by the assignable function buttons 12a-12c.

[0048] Fig. 4 is a schematic representation through line 4-4 of Fig. 3 illustrating that the alpha-numeric input buttons or keys 10 in the mobile telephone pass through the case 18 of the mobile telephone and contact a plurality of switches 19 disposed on the PCB 62. The switches 19 are in communication with the controller 9 (not shown). Suitable switches 19 include any analog or digital switch, for example rubber switches, snap dome-type switches, and pressure sensitive switches. Preferably, the switches 19 are capable of producing distinct input signals to the controller. Even more preferably, the switches 19 are capable of producing such signals for two or more positions. In the

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embodiment shown, the keys 10 contact a plurality of digital switches, each capable of producing four distinct input signals to the controller 9 to correspond to the four levels at which pressure is applied to the buttons 10 by the user.

[0049] The PCB 62, on a side opposite the switches, is in communication with the actuator 61. As illustrated, the actuator 61 is a piezo-electric actuator having a metal diaphragm 20 in contact with the PCB 62 through one or more spacers 21 and a piezo ceramic element 22 in contact with the metal diaphragm 20. Alternative actuator embodiments include a flexure coupled to the shaft of a motor, secured to the PCB 62.

[0050] As illustrated, the keys 10 are initially in a rest position 23. A biasing member arrangement (not shown) as is available and understood in the art is used to hold the keys in the rest position 23. An object 24, for example the user's finger or a stylus, is used to select one or more of the keys 10 by applying pressure in the direction of arrow A. This pressure causes the selected key to progress through a plurality of positions. As illustrated, after leaving the rest position 23, the keys pass sequentially through a second position 25, a third position, 26, a fourth position 27, and a fifth position, 28 as greater and greater pressure is applied to the button 10. The distance of travel between each position does not have to be equal, and the amount of pressure required to move between each position can vary. In addition, for a given key, the number of positions can vary from two (no pressure and activated) up to the number of input signals assigned to a given key. Therefore, in the embodiment shown, a key 10i is moveable from a first level (rest) 23 to a second level 25 upon the application of a sufficient amount of pressure to the input device. In the embodiment shown in Fig. 3, the amount of pressure necessary to move the key 10i from rest 23 to the second position 25 is about equal to the amount of

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pressure that user's finger would exert upon contact with the key without actually selecting the key.

[0051] Accordingly, in one method of using the embodiment shown in Fig. 3, when a user of the mobile telephone 14 shown in Fig. 3 presses the "9" key 10i using a relatively light amount of pressure, the button 10i moves from rest state 23 to its second level 25. Such movement causes the button 10i to apply pressure to switch 19a, which is received by switch 19a. The switch 19a is in communication with the controller 9. The switch 19a is configured to transmit a first signal to the controller 9 upon receiving a pressure of magnitude indicating that sufficient pressure has been placed on button 10i to move from its first level 23 to its second level 25. The controller 9 receives this first signal. The controller 9 is configured to transmit a first controller output signal to the actuator 61 upon receipt of this first signal from the switch 19a. The controller transmits the first controller output signal to the actuator 61. The actuator 61 is configured to provide a vibration of a first pre-selected frequency to the metal diaphragm 20 of a pre-selected duration upon receipt of such a first signal. In the embodiment shown, the actuator 61 provides a side-to-side vibration to the diaphragm. The diaphragm 20 thus vibrates at the pre-selected frequency, in turn causing the PCB 62 to vibrate at that same frequency, and thus in turn causing the switches 19 to vibrate at that frequency. The switch 19a is in communication with the button 10i, thus causing the button 10i to vibrate at that frequency.

[0052] When the user applies further pressure to the button 10i sufficient to cause the button to move from the second level 25 to a third level 26, the button's force is applied to switch 19a. Switch 19a receives the force and is configured to transmit a

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second signal to the controller 9 whenever it receives force to indicate that the button 10i has moved from the second level 25 to the third level 26. The switch 19a does so, and the controller 9 receives the second signal. The controller 9 is configured to transmit a second controller output signal to the actuator 61 upon receipt of this second signal from the switch 19a. The controller 61 transmits the second controller output signal to the actuator 61. The actuator 6 is configured to provide a vibration of a second pre-selected frequency, different from the first pre-selected frequency, for a pre-determined duration to the metal diaphragm 20 upon receipt of such a second signal. In other embodiments, the first and second pre-selected frequencies are the same. As above, the actuator 61 provides a side-to-side vibration to the diaphragm, which is communicated through the PCB 62 and switches 19 to the button 10i.

[0053] When a user applies pressure to the button 10i, which is communicated to the switch 19a, at each level 25, 26, 27, 28, a distinct signal is transmitted by the switch 19a to the controller 9. Thus, in the embodiment shown, different signals are transmitted by the switch 19a for each pressure-applied levels 25, 26, 27, 28.

[0054] In the embodiment shown, a "dwell to select" function is employed. For example, when a user provides sufficient input to cause the button to move to its second level 25, the first signal is transmitted to the controller 6 continuously while the button receives pressure to push it at or past the second level 25 but not sufficient pressure to push the button 10i to the third level 26. The controller 9 determines the length of time the button is maintained at the second level 25 by monitoring the length of time the first signal is transmitted to the controller 9. If the first signal is received for greater than a pre-determined length of time, the controller determines that the user wishes to

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"select" the function associated with the second level 25 by the fact that the user "dwelled" at that level for the pre-determined time. Upon so determining, the controller 9 transmits a signal to a processor (not shown) indicating that the user has selected the function associated with the second level of button 10i, in this case the selection of the letter "W." In embodiments, the controller 9, upon so determining, also transmits a signal to the actuator 61 to cause the actuator 61 to vibrate at a frequency, magnitude, and/or wave-form indicative of selection of the function.

[0055] In one embodiment, in addition to providing haptic feedback to the input device, the controller 9 also sends a signal to the display 17 to cause the alphanumeric character associated with the input signal to be displayed. For example, in one embodiment, upon detecting the presence of a first pressure (through receipt of a first input signal) and sufficient dwell time to indicate a selection, the controller sends a signal to the display 17 indicating that the display should display the letter "X." Upon detecting the presence of a second pressure (through receipt of a second input signal) and sufficient dwell time to indicate a selection, the controller sends a signal to the display 17 indicating that the display should display the letter "Y." Upon detecting the presence of a third pressure (through receipt of a third input signal) and sufficient dwell time to indicate a selection, the controller sends a signal to the display 17 indicating that the display should display the letter "Z." The display 17 then displays each of these characters, X, Y, Z.

[0056] Various other embodiments may be employed. For example, instead of having a single actuator to provide feedback to all input devices receiving such feedback, like the embodiments shown in Figs. 2-3, other embodiments have two or more actuators. These two or more actuators may be in communication with all or part of the input

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devices that provide tactile feedback. The two actuators may each provide significantly different types of feedback to the same set of input devices, or each may be in communication with a different group of input devices to provide the same or different types of feedback. As another example, the actuator and input devices may be configured to provide vibration to only the button that is receiving pressure from the user, or they may be configured to provide vibration to all buttons or at least more buttons than the one(s) receiving pressure from the user.

[0057] Moreover, although the actuator 61 is shown as disposed below the PCB 62 in Fig. 4, in other embodiments the actuator 61 may be disposed at other locations within the device having such apparatus, whether the device is a mobile telephone, PDA, or other device. Preferably, the actuator is disposed within the housing of the device. Preferably, it is communication with the PCB 62, but is placed anywhere in communication with the PCB 62 as the size and space restrictions of the application will allow. In other embodiments, the actuator 61 is located outside the housing of the device (such as beside it). In still other embodiments, the actuator 61 is in communication with the input devices other than through the PCB 62.

[0058] In the embodiment shown, a distinct tactile sensation is produced for each of the various levels at each of the various keys. In other embodiments, the controller 6 selects one of a pre-selected group of sensations to provide in response to the various signals received by the controller.

[0059] Fig. 5 shows another embodiment of the present invention. Referring to Fig. 5, a PDA 31 having an input device in the form of a pressure-sensitive touchpad 30 is shown. The PDA 31 also includes a plurality of mechanical type buttons 32. The PDA

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31 also includes a display panel 33 capable of displaying computer generated graphics. Suitable display panels include flat-panel type displays including a Liquid Crystal Display (LCD), plasma displays, Thin Film Transistor (TFT) type displays or other flat displays, such as are found in laptops and color PDA"s, and conventional cathode ray tube displays.

[0060] Fig. 6 shows a cross-sectional view of the PDA 31 of Fig. 5 along line 6-6. As is best displayed in Fig. 6, the display 33 is underneath the touchpad 30 and is in communication with the touchpad 30 to transmit tactile sensations thereto. The display 33 is also in communication with an actuator 64 to receive a tactile sensation therefrom for communication to the touchpad 30. Other arrangements of the touchpad 30, display 33 and actuator 64 are also possible including arrangements in which the actuator 64 is in direct contact with the touchpad 30. The display 33 is in communication with the touchpad 30 through two spacers 34. Suitable spacers are constructed of a material that can transmit the tactile sensations between the display 33 and the touchpad 30. In other embodiments, the touchpad 30 and display 33 are in direct physical contact, and the touchpad 30 and display are not in communication. The tactile sensations produced in the touchpad 30 are transmitted to the object 24 when the object 24 is brought into contact with a surface 35 of the touchpad 30.

[0061] Referring again to Fig. 5, the display 33 displays a plurality of software-generated buttons or keys, called softkeys 36a-i. The softkeys 36a-i provide a graphical user interface for the PDA 31 and are arranged in a desired pattern or grid. Each softkey 36 occupies a distinct location on the display panel. As illustrated, the PDA 31 can function as a mobile telephone, and the softkeys 36 are arranged as a telephone keypad to

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provide the same functionality as the mechanical keys on a conventional telephone keypad. The display 33 of the PDA 31 also includes additional graphical outputs 37 and areas 38 without graphical output. The displayed softkeys 36 are viewable through the touchpad 30 and represent corresponding unique positions on the touchpad 30.

[0062] An object 24, for example a human finger, selects a desired softkey 36a-i by contacting the touchpad 30 at the appropriate location. A controller (not shown) is in communication with the touchpad 30. The controller of this embodiment is similar in structure and functionality to the controller described in relation to the embodiment of Fig. 3. The controller is capable of determining the location on the display screen 33 that is touched by the object 24, and the softkey 36 corresponding to the touched location. Based upon this information, the controller causes the actuator 64 to provide a corresponding tactile sensation. The actuator 64 can cause vibrations in the touchpad 35 in a direction parallel to the surface 35 of the touch pad or perpendicular to the surface 35 of the touchpad 30. The controller also determines when an input is ambiguous, such as when two or more softkeys are simultaneously selected or when an area of the display containing no graphics 38 is touched, and causes the actuator to output an appropriate tactile sensation. Preferably, the same controller that controls the displayed softkeys 36 also controls the tactile feedback sensations produced by the actuator 64.

[0063] Certain softkeys 36b-i represent multiple positions or multiple inputs, each input or position corresponding to a distinct amount of pressure applied to the softkey 36b-i. This distinct amount of pressure is detected by the controller in communication with the touchpad 30. Alternatively, the apparatus can include a separate pressure calculator to measure the amount of pressure applied to the touchpad 30. In the

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embodiment shown, the amount of pressure applied to the touchpad 30 is calculated by the controller based upon the amount of area of the object 24 used to select the softkey that is in contact with the surface 35 of the touchpad 30.

[0064] The amount of pressure applied to the input device or to the softkey 36a-i on the touchpad can be determined by reading or determining the size or area of the contact patch created by the object 24, such as the user's finger, on the input device or softkey 36a-i. In addition to reading the current size of the contact patch, the rate of change of the contact patch can also be determined, using dynamic thresholds and to look at how fast the user's pressure is changing. If the contact patch area changes at a sufficiently large rate, the controller can determine that the corresponding input device or softkey 36a-i is being selected.

[0065] The functionality of the softkeys shown in Fig. 5 is similar to the mechanical key counter parts described in relation to Figs. 2 and 3. Therefore, the pressure level of a selected softkey may be moveable from a first position to a second position upon the application of a sufficient amount of pressure. The amount of pressure necessary to move the softkey 36a to the second position (the first position being at rest or no contact) input device to the first position is about equal to the amount of pressure that user's finger would exert upon contact with the touchpad surface and sliding lightly along the surface. In this embodiment, the controller is configured to cause the actuator to produce a first tactile sensation when the softkey 36a is in the second position or when the applied pressure is less than the amount of pressure necessary to indicate that the softkey has been selected, that is the third position. The controller would then cause the actuator 64 to produce a second tactile sensation upon receipt of the input signal

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associated with the third position or upon detection of a sufficient amount of pressure applied to the softkey 36a. The softkey 36i has five positions associated with four distinct applied pressures and no pressure at the softkey 36i, and corresponding to the input signals for the letters W, X, Y, and Z. A dwell to select feature can be used to determine the desired position and associated input signal.

[0066] This functionality facilitates a user moving an object over the various softkeys displayed on the input device and receiving a specific frequency or tactile sensation to signal that a particular softkey has been touched. As the object 24 contacts other softkeys in the display matrix, additional distinct tactile sensations unique to these other softkeys are produced. With continued use, the user can quickly become accustomed to the various distinct tactile sensations and the associations between sensations and specific softkeys, permitting identification and selection of softkeys or buttons by touch alone. In fact, distinct tactile sensations can be used with the same button regardless of the electronic device, creating a universal tactile sensation library similar to for example, a busy signal providing a universal auditory signal that a telephone number is unavailable regardless of the type of telephone equipment used. For example, a distinct tactile sensation can be played when the object is in contact with the "5"key, providing a "home" key indication. In addition, keys located on the center axis can have a single "pop" while keys in the columns to the left and right of the center axis have two "pops", providing an indication of the general location of the object 24 in a keypad matrix.

[0067] In another example, if the user is moving the object 24 over the "9"key, a relatively high frequency vibration can be output on all the keys. When the pressure

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associated with the object is detected at the "6" key, a lower frequency vibration can be output, allowing the user to determine which key is presently in contact with the object through the sense of touch. Since it is unlikely that a user would press or contact more than one softkey simultaneously, a single vibrotactile actuator outputting the same sensation to all of the buttons simultaneously can be used. When the user applies increased pressure to a softkey with the object 24 and that pressure is greater than a predetermined threshold pressure level, the function associated with that softkey is activated.

[0068] Fig. 7 is a block level diagram illustrating a representative embodiment of the present invention. The various components communicate across a common communication bus 39. The input devices 40 produce input signals in accordance with the present invention, and the input signals are communicated to the controller 41 across the communication bus 39. The controller 41 can also receive pressure or position information regarding the input devices associated with the received input signal. Based upon the received input signal, pressure and position data, the controller accesses a memory 42 to obtain the necessary data regarding the functionality and tactile feedback associated with the received input signal. In addition, the controller 41 can update data stored in the memory as for example when the input signal relates to changing the functionality or input options associated with the input device that produced the input signal. Based upon the received functionality, the controller delivers a function signal to the electronic device 43 to which the apparatus is connected. In addition, the controller 41 modifies the output on the display 44 in particular where the display is part of the input device, such as when a touchpad is used. Alternatively, the electronic device controls and

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updates the display. In addition, the controller can be the CPU associated with the electronic device, and the memory can be the memory associated with the electronic device. The arrangement of the controller, memory and display depends upon whether or not the apparatus is constructed as a standalone device that can be retrofitted into an existing electronic device or is incorporated into the electronic device itself. The controller uses the tactile feedback information received from the memory to provide the necessary input to control circuitry 45 to drive the actuator 46 to produce the desired tactile sensation in the appropriate input device.

[0069] Referring to Fig. 8, a flow chart illustrating a method of producing a tactile feedback sensation in an input device according to the present invention is illustrated. A controller monitors an input device in an apparatus 47. When a plurality of input devices are included in the apparatus, the controller can either monitor each input device sequentially or in parallel. Although illustrated as a single pass function, monitoring of the input devices is preferably handled as a continuous loop function.

[0070] The input device, in response to user input, provides one or more input signals, position data, and pressure data to the controller. As the controller monitors the input device, it first detects whether or not an input signal is being generated by the input device 48. If an input signal is being generated, the controller obtains the input signal 49 associated with the input device. The controller then detects if the same input device is generating any position data 50. If position data is being generated, the controller obtains the position data 51 associated with the input device. The controller also detects if the same input device is generating any pressure data 52. If pressure data is being generated, the controller obtains the pressure data 53 associated with the input device. The controller

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may detect and obtain the three types of data in any order. Preferably, the controller, while obtaining the data, maintains an association among the input device, the input signal, the pressure data, and the positions data. In some embodiments, the input signal includes pressure data, or data from which the pressure applied to the input device may be calculated, position data, or a combination of pressure and position data.

[0071] Having obtained the input data from the input device, or from a plurality of input devices, the controller then accesses a memory device 54 in which is stored at least one database containing information necessary to produce the desired function in the electronic device and the predetermined tactile sensation in an input device, and accesses this information 55. In one embodiment, this information is in the form of associations among the detected input data, the functions of the electronic device or apparatus, and the tactile sensations. An exemplars group of associations is represented in tabular form in Fig. 9.

[0072] As is shown in the table, for any given input device, a plurality of combinations of input signals, position data, and pressure data is possible, and each combination relates to a specified function of either the electronic device or a distinct tactile sensation. These combinations vary depending on the type of input device assigned to each input signal and the current functionality of that input device. The controller, using the data obtained from monitoring the input device, reads the table and obtains the associated function and tactile feedback information.

[0073] Referring to Fig. 9, in one embodiment, a controller monitors input device number 5. On subsequent monitoring passes, the controller does not detect either an input signal or position data, but detects a distinct pressure, Pressure 1. Based upon the

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information in the table associated with Pressure 1, the controller obtains the associated function information for selecting the number "2", and information for distinct tactile Sensation 13. The controller delivers the function information to the electronic device 70 which uses that information to display the number "2" or to indicate that the number "2" has been selected. The controller uses the information for distinct tactile Sensation 13 to produce Sensation 13 in an input device 56, by for example, causing an actuator to cause the input device to vibrate at a frequency associated with Sensation 13.

[0074] On a later monitoring pass, the controller detects a pressure magnitude of pressure 3 on input device number 5. Similarly, based upon the information in the table associated with Pressure 3, the controller obtains the associated function information for selecting the letter "B" and information for distinct tactile Sensation 15. The controller delivers the function information to the electronic device which uses that information to display the letter "B" or to enter the letter "B" in a program such as a telephone keypad. Therefore, in response to the detection of at least two distinct pressures applied to the input devices, the controller has produced at least two distinct tactile sensations in the input device number 5. The controller can also detect a plurality of distinct pressures applied to input device number 5 and can produce a plurality of distinct tactile sensations in input device 5, each tactile sensation related to one of the plurality of distinct pressures. Although illustrated for a single input device, the controller can detect two distinct pressures for a plurality of input devices and can produce at least two distinct tactile sensations in each one of these input devices. In another embodiment, the controller can detect a plurality of distinct pressures in the plurality of input devices and

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produce a plurality of distinct tactile sensations in the plurality of input devices. The distinct pressures can represent either discrete pressures or a range of applied pressure.

[0075] In another embodiment, the controller monitors input device number 3, which is capable of inputting a plurality of input signals, Inputs 2A-E, to the apparatus. Each input signal corresponds to a distinct pressure applied to input device number 3, Pressures 1-5. Each input signal and pressure corresponds to a distinct function and a distinct tactile sensation, Sensations 5-9. In one embodiment, each input signal corresponds to an alphanumeric character. In this embodiment, the controller delivers function information to the electronic device related to displaying the proper alphanumeric character on an output device associated with the electronic device. Alternatively, the controller can display the associated alphanumeric character directly on the output device.

[0076] Referring still to Fig. 9, in another embodiment of a method according to the present invention, the controller monitors input device number 1 and detects a first pressure being applied on a first location on input device number 1. Preferably, input device number 1 is a touchpad input device. In one embodiment, the first pressure is a discrete pressure, pressure 1. In another embodiment, the first pressure represents a range of pressures having a value less than Pressure 1. The function associated with the first applied pressure indicates that this is the pressure range associated with a user simply searching or feeling for the location of the desired button or key. Therefore, the controller does not provide a function input to the electronic device. The controller does, however, provide a first tactile sensation, Sensation 1, to input device number 1.

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[0077] The controller then detects an input signal, Input 1 and a pressure greater than or equal to Pressure 1 at Input 1. In response, the controller delivers a function input corresponding to "Select" to the electronic device and produces a second distinct tactile sensation, Sensation 2, in Input Device 1.

[0078] In another embodiment, the controller monitors Input Device 7 and detects a first pressure, Pressure 1, at a first location, Location 1 on the input device. Preferably, the input device is a touchpad input device. In response, the controller provides a first tactile sensation, Sensation 20, in Input Device 7. In addition, the controller detects a second pressure, Pressure 2, applied at a second location, Location 2, on Input Device 7. In response, the controller provides a second tactile sensation, Sensation 21 in Input Device 7. The first pressure can correspond to a first input signal, Input 7, and a first function, Function 1, and the second pressure can correspond to a second input signal, Input 8, and a second function, Function 2. The controller delivers the associated function input to the electronic device in response to each received pressure. Note that the controller may cause the actuator to include a different wave form, frequency, and/or magnitude as tactile feedback in relation to different pressures, modes, menus, and other functionality.

[0079] The controller can also determine if any an ambiguous input is received 71. The ambiguous input can represent a combination of input device, input signal, position data, and pressure data that is not represented the data contained in memory. Alternatively, an ambiguous input signal can represent input simultaneously from two input devices or an input from a portion of a touchpad that is not associated with an input device. In response to receiving an ambiguous input signal, the controller obtains the

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associated ambiguous tactile feedback information 72 and produces the associated distinct tactile sensation, Sensation 22, in one or more input devices associated with the ambiguous input. In one embodiment, when the controller detects both a first and second input, the controller determines if either one of the inputs is ambiguous. If not, then the controller produces the associated first and second tactile sensations. If either input signal is ambiguous, then the controller produces the ambiguous output tactile sensation 56 in the appropriate input device.

[0080] Since the function corresponding to the input signals, positions, and pressures detected by the controller may involve modification of the functions associated with a given combination, the controller can also update the database stored in memory 57. In one embodiment, the controller is monitoring Input Device 6, and detects a first pressure, Pressure 1, applied to that input device. The first pressure corresponds to one of a plurality of input signals, Input 4, corresponding to a first set of input functions, Functions 1-3. The controller obtains Function 1 and Sensation 17 information and produces the appropriate tactile sensation at Input Device 6. Function 1 can represent one set of menus from a list of menus or one operating mode out of a plurality of operating modes. Suitable operating modes include instant messaging, electronic mail, voice mail, games, and missed phone calls.

[0081] Since Function 1 represents a menu or mode that may have additional sub-menus or mode functions associated with it, the controller, in response to Function 1 updates the database as illustrated in Figure 10. As the controller continues to monitor Input Device 6, it detects a second pressure 3" corresponding to one of the input signals, Input 6, which corresponds to one function in the second set of functions, Function 6. The

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controller also obtains the tactile sensation, Sensation 19", associated with the selected second set function and provides this tactile sensation at Input Device 6. In addition, the controller provides an associated function signal to the electronic device. Suitable second set functions include sub-menus and functions corresponding to the selected first set function. In addition, the second set functions can include a function that returns the set of functions to the first set of functions. Although the pressures and tactile sensations associated with the first and second set of functions can be the same, preferably, the first pressures and tactile sensations, Pressures 1-3 and Sensations 17-19, are distinct from the second pressures and tactile sensations, Pressures 1"-3" and Sensations 17"-19".

[0082] In an embodiment of the apparatus of the present invention, for example, the apparatus is incorporated into a mobile phone and includes an assignable-function input device and assignable function rocker switch input device. In a main or home screen of the mobile telephone that is displayed upon powering up the mobile telephone, the assigned function for the assignable-function input device is "PHONEBOOK" and the rocker switch has no current function assigned to it. Light searching pressure applied to the assignable input device and the rocker switch will produce first and second distinct tactile sensations to indicate which input device is being contacted. Selecting the rocker switch will not produce any function in the mobile phone since no function is currently assigned and a function failure tactile sensation, as described herein, will be output through the rocker switch. Selecting the assignable input device will place the mobile telephone in "Phonebook" mode and a third distinct tactile sensation will be output through the assignable input device.

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[0083] A list of phonebook entries is now displayed on the screen of the mobile telephone. The assignable input device is assigned the function "SELECT" and the rocker switch is assigned a scroll function. Light pressure on the assignable input device or the rocker switch produce a fourth and fifth distinct tactile sensations, indicating that the mobile phone and the input devices are in "Phonebook" mode. Selecting the rocker switch to either scroll up and down produces bumps or clicks associated with scrolling a list of entries in the rocker switch. Special clicks can be output for passing each alphabetical tab in the phonebook or for passing frequently called entries. In one embodiment, an analog switch is included under the rocker switch to provide an analog signal roughly in proportion to the pressure registered on the rocker switch. This allows the list that is being scrolled to be scrolled at a rate that can be controllable with the amount of pressure applied, and which is communicated to the user by corresponding increase in the rate of haptic events played on the rocker switch. Once the rocker switch has been used to highlight the desired entry, the assignable input device is pushed to select that entry and a sixth distinct tactile sensation is output through the assignable input device.

[0084] The assignable input device continues to be assigned the function of select and the rocker switch is still used as a scrolling device. The display of the mobile telephone, however, display another menu list containing the functions "EDIT", "VIEW", "CALL", and "DELETE". Light pressure on assignable input device and rocker switch again produces the fourth and fifth tactile sensations, indicating that the "Phonebook" mode or function is still active. Using the rocker switch to scroll up or down through the list again produces a click in the rocker switch as each entry is passed. The magnitude of each click and the spacing between clicks can be varied to indicate that a relatively short

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list is being scrolled. In addition to a click, seventh, eighth, ninth and tenth distinct tactile sensations as output to the rocker switch as the switch scrolls past "EDIT", "VIEW", "CALL", and "DELETE" respectively. Scrolling is stopped on the "CALL" entry, and the assignable input device is pushed, calling the number associated with the chosen entry from the phonebook. In addition, the ninth tactile sensation is output to the assignable input device. An attempt to active one of the functions, such as "CALL", before the device is ready causes the controller to indicate that the function is available.

[0085] Various other functions may be initiated by using the buttons. For example, in a mobile telephone having the functionality of instant messaging, electronic mail, voice mail, games, and missed call read-out, the user may select one of these functions. In an embodiment, a distinct tactile sensation is initiated by the controller whenever the user initiates one of these functions, and the distinct tactile sensation is different for each function.

[0086] Regardless of the input device being monitored by the controller, upon detection of first and second input signals, first and second pressures or first and second positions and obtaining the associated first and second functions, the controller can determine if these functions are available for execution 58. Alternatively, the controller provides the necessary function signals to the electronic device which determines the availability of those functions. If the first and second functions are available, then the controller produces the associated tactile sensations in the appropriate input devices. If one of the first or second functions are not available then the controller obtains the tactile sensation information for the tactile sensation associated with function failure 59, Sensation 23, and produces that sensation in the appropriate input device. Examples of

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function failure include selecting the re-dial feature on a telephone when no number is stored in the re-dial memory, attempting to access a program or menu for which the user does not have authority to access, and attempting to initiate a mobile telephone call having entered an incomplete phone number.

[0087] Figure 11 aids in illustrating another embodiment of the present invention.

In one embodiment of the present invention, a device provides haptic feedback while navigating a menu structure, allowing a user to navigate the menu structure more efficiently, preferably without having to refer to the visual display. In such an embodiment, an actuator generates distinct sensations that represent various sections of the menu structure, specific menu options, and events that occur while navigating the menu structure.

[0088] For example, in one embodiment, each of the highest level or main menu options corresponds to a distinct vibrotactile sensation that varies in pitch. As the user navigates between the main menu topics, the actuator produces a distinct number of pulses. The varying pitch combined with the alternating pulses provides feedback that identifies to the user the menu currently selected or highlighted.

[0089] In another embodiment, the number of occurrences of a distinct vibrotactile sensation, such as a pop, corresponds to the index number of the menu option within a list of menu options. In such an embodiment, one pop signifies the first option; two pops signifies the second option. In yet another embodiment, a distinct vibrotactile effect signifies that the user is cycling from the end of a particular menu back to the beginning ("rolling over").

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[0090] Fig. 11 is a front view of a personal digital assistant (PDA) 100 in one such embodiment of the present invention. The PDA 100 includes a display 102, a plurality of buttons, including button 104, for executing specific functions and applications, and a 5-way directional pad (D-pad) 105 for navigation within the various interfaces displayed on the PDA 100. With the 5-way D-pad, a user clicks the directional keys to move up and down and left and right through the menu structure and clicks the center of the D-pad to select a particular option. In the embodiment shown, the active application is displaying a menu structure. The menu structure 108 includes main menu topics 110. Selection of the main menu topics results in either the display of a sub-menu or the execution of an associated function or application. In the embodiment shown, selection of the File menu option on the main menu 110 results in the display of a sub-menu 112. As with the main menu options, selection of any of the topics on the sub-menu 112 results in either the display of a secondary sub-menu or the execution of an associated function or application. For example, selection of the Send To option on sub-menu 112 results in display of secondary sub-menu 114.

[0091] In the embodiment shown in Figure 11, a user presses button 104 to activate an application. Within the application, the user utilizes D-pad 106 to navigate to the main menu 108. An actuator (not shown) as described herein, such as an eccentric rotating mass or voicecoil, provides a brief, distinct haptic effect as the user highlights each of the options in the main menu 108. The effect may change in pitch or in some other manner to alert the user to the fact that the highlighted option has changed. The user may either click the center of the D-pad 106 to select an option or click the down arrow. Performing either of these actions over the File option produces sub-menu 112.

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[0092] The user clicks the down arrow to move through the sub-menu 112. In the embodiment shown, when a directional arrow of the D-pad 106 is held down, the menu options in sub-menu 112 scroll at a fixed rate, and a haptic effect plays with each option that appears below the cursor. The longer the directional arrow is held down, the faster the rate of scrolling. The PDA 100 communicates the rate of scrolling by a corresponding change in the haptic effect, such as an increase in frequency. If the user clicks the right arrow when the cursor highlights the Send To option, the secondary sub-menu 114 is displayed. Navigation through the secondary sub-menu 114 occurs in a manner similar to that which occurs in sub-menu 112. To select an option within the secondary sub-menu 114, the user clicks the center of the D-pad 106. Clicking the center of the D-pad 106 triggers the playing of yet another distinct haptic effect. In addition, the D-pad switch 106, either a 5-way or a 4-way, can provide haptic effects indicating the direction that the switch was being pressed.

[0093] The embodiment shown in Figure 11 is applicable to a variety of applications, particularly to applications that display lists. For example, in one embodiment, an address book containing a list of names is displayed on the PDA 100. In such an embodiment, the actuator plays an effect as the user scrolls through the list. Further, the actuator plays a distinct haptic effect as the user navigates from names starting with one letter, for example A, to the next letter, B. Such an embodiment may also include a distinct effect corresponding to names that the user has previously identified as favorites in the address book.

[0094] Another embodiment of the present invention provides the user with distinct haptic effects corresponding to the operational mode of an electronic device. For

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example, in an embodiment utilizing a PDA, such as PDA 31 in Fig. 5, a user may activate one of many modes, including, for example, the phone interface shown in Fig. 5, the application interface shown in Fig. 11, an address book, email, or other modes. Referring to Fig. 5, in one such embodiment, the user clicks a button 32 to activate the phone application. When the user clicks the button, the PDA 31 displays a phone interface 38. While the PDA 31 is in phone mode, the actuator provides a persistent haptic effect indicating to the user that the phone mode is active. In this way, the user is able to determine the mode of the PDA 31 without visually referring to it.

[0095] Another embodiment of the present invention provides the user with distinct haptic effects for modes within a cell phone or other electronic device. Referring to Fig. 3, users of cell phones, such as cell phone 14, often store a list of number that are frequently dialed in a memory associated with one or a combination of number keys 10. In such an embodiment, the user may click a function key before clicking the number key 10, providing a signal to the phone 31 that the user will specify a number to dial by clicking a number key combination. In one embodiment of the present invention, when the user clicks the function button, the actuator provides a persistent haptic effect, indicating to the user that the cell phone is in the rapid-dialing mode. The haptic effect alerts the user to the fact that when the user selects a number-key combination, the cell phone will dial the phone number associated with the number-key combination in memory. By providing a haptic effect identifying the mode that the cell phone 31 is in, the embodiment minimizes or eliminates the user's need to refer to the cell phone 31 visually.

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[0096] In another embodiment of the present invention, an actuator provides feedback when an option or function is unavailable (referred to herein as "negative feedback"). In such an embodiment implemented in a cell phone, such as cell phone 31 shown in Fig. 3, the user is able to place calls. The user dials a combination of number keys 10 and then presses the send key 11 to execute the phone call. In an embodiment utilizing negative feedback, if the user enters an invalid phone number, for example, a phone number including only 6 digits, the cell phone provides negative feedback, indicating that the send function is not available. The negative feedback may, for example, comprise a very low frequency buzz. In another embodiment, the actuator provides negative feedback to the user if the user clicks a redial button (not shown) without having previously dialed a number.

[0097] Other embodiments and uses of the present invention will be apparent to those skilled in the art from consideration of this application and practice of the invention disclosed herein. The present description and examples should be considered exemplary only, with the true scope and spirit of the invention being indicated by the following claims. As will be understood by those of ordinary skill in the art, variations and modifications of each of the disclosed embodiments, including combinations thereof, can be made within the scope of this invention as defined by the following claims.

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CLAIMS

That which is claimed is:

1. A method, comprising:
 - outputting a display signal configured to display a graphical object on a touch-sensitive input device;
 - receiving a sensor signal from the touch-sensitive input device, the sensor signal indicating an object contacting the touch-sensitive input device;
 - determining an interaction between the object contacting the touch-sensitive input device and the graphical object; and
 - generating an actuator signal based at least in part on the interaction; and
2. The method of claim 1 wherein, the actuator signal is configured to cause a haptic effect to be output.
3. The method of claim 1, wherein the actuator signal is generated when the object contacts the touch-sensitive device at a location corresponding to the graphical object.
4. The method of claim 1, wherein the actuator signal is generated when the object contacts the touch-sensitive device at a location not corresponding to the graphical object.
5. The method of claim 1, wherein the display signal is configured to display a keypad comprising a plurality of softkeys.

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6. The method of claim 5, wherein the haptic effect is caused to be output when a user contacts the touch-sensitive device at a location corresponding to a softkey in a home position.
7. The method of claim 5, wherein the plurality of softkeys comprises one softkey for each digit from 0 to 9.
8. The method of claim 5, wherein the plurality of softkeys comprises the key configuration of a standard 101-key keyboard.
9. The method of claim 1, wherein the graphical object comprises a first graphical object and a second graphical object, the haptic effect comprises a first haptic effect and a second haptic effect, and wherein the first haptic effect is configured to be output when the object contacts the first graphical object, and the second haptic effect is configured to be output when the object contacts the second graphical object.
10. A system, comprising:
 - a touch sensitive input device configured to output a sensor signal indicating an object contacting the touch-sensitive input device;
 - an actuator coupled to the touch-sensitive input device, the actuator configured to receive an actuator signal and output a haptic effect to the touch-sensitive surface based at least in part on the actuator signal; and

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a processor in communication with the sensor and the actuator, the processor configured to:

output a display signal configured to display a graphical object on the touch-sensitive input device;

receive the sensor signal from the touch-sensitive input device;

determine an interaction between the object contacting the touch-sensitive surface and the graphical object,

generate the actuator signal based at least in part on the interaction; and

transmit the actuator signal to the actuator.

11. The system of claim 10, wherein the processor is configured to generate the actuator signal when the object contacts the touch-sensitive input device at a location corresponding to the graphical object.

12. The system of claim 10, wherein the processor is configured to output the actuator signal when the object contacts the touch-sensitive device at a location not corresponding to the graphical object.

13. The system of claim 10, wherein the display signal is configured to display a keypad comprising a plurality of softkeys.

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14. The system of claim 13, wherein the haptic effect is caused to be output when a user contacts the touch-sensitive device at a location corresponding to a softkey in a home position.
15. The method of claim 13, wherein the plurality of softkeys comprises one softkey for each digit from 0 to 9.
16. The method of claim 13, wherein the plurality of softkeys comprises the key configuration of a standard 101-key keyboard.
17. The method of claim 10, wherein the graphical object comprises a first graphical object and a second graphical object, the haptic effect comprises a first haptic effect and a second haptic effect, and wherein the first haptic effect is configured to be output when the object contacts the first graphical object, and the second haptic effect is configured to be output when the object contacts the second graphical object.
18. A computer-readable medium comprising program code, comprising:
 - program code for outputting a display signal configured to display a graphical object on a touch-sensitive input device;
 - program code for receiving a sensor signal from the touch-sensitive input device, the sensor signal indicating an object contacting the touch-sensitive input device;
 - program code for determining an interaction between the object contacting the touch-sensitive input device and the graphical object; and

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program code for generating an actuator signal based at least in part on the interaction, the actuator signal configured to cause a haptic effect to be output.

19. The computer-readable medium of claim 18, wherein the actuator signal is generated when the object contacts the touch-sensitive device at a location corresponding to the graphical object.

20. The computer-readable medium of claim 18, wherein the actuator signal is generated when the object contacts the touch-sensitive device at a location not corresponding to the graphical object.

21. The computer-readable medium of claim 18, wherein the display signal is configured to display a keypad comprising a plurality of softkeys.

22. The computer-readable medium of claim 21, wherein the haptic effect is caused to be output when a user contacts the touch-sensitive device at a location corresponding to a softkey in a home position.

23. The computer-readable medium of claim 21, wherein the plurality of softkeys comprises one softkey for each digit from 0 to 9.

24. The computer-readable medium of claim 21, wherein the plurality of softkeys comprises the key configuration of a standard 101-key keyboard.

Patent Application

25. The computer-readable medium of claim 1, wherein the graphical object comprises a first graphical object and a second graphical object, the haptic effect comprises a first haptic effect and a second haptic effect, and wherein the first haptic effect is configured to be output when the object contacts the first graphical object, and the second haptic effect is configured to be output when the object contacts the second graphical object.

Patent Application

ABSTRACT

Products and processes for providing tactile sensations to input devices or electronic devices are provided. Input devices include mechanical input devices (such as, for example, mechanical switches) and non-mechanical input devices (such as, for example, touchpads). Tactile feedback is provided by using an actuator or other means in communication with the input device or electronic device. A controller may be employed to receive signals from the input devices and control the actuator. Tactile feedback to an input device or electronic device may be provided in response to one or more events or situations. Such an event or situation may be any one designated. Examples of such events and situations include the level of pressure placed on an input device; the availability or lack of availability of a function associated with an input device; and the function, menu, or mode of operation associated with an input device's activation. A variety of feedback types and combinations may be selected.

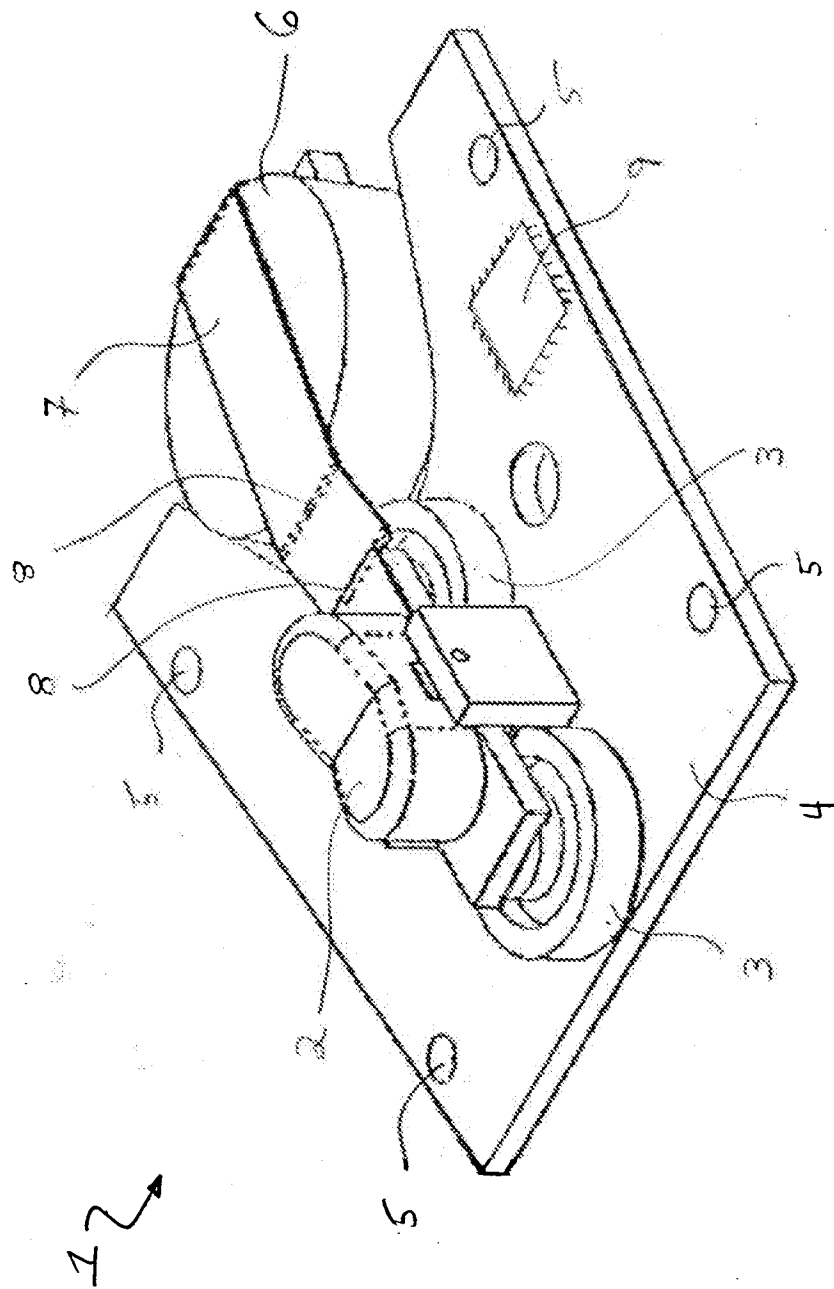


Fig. 1

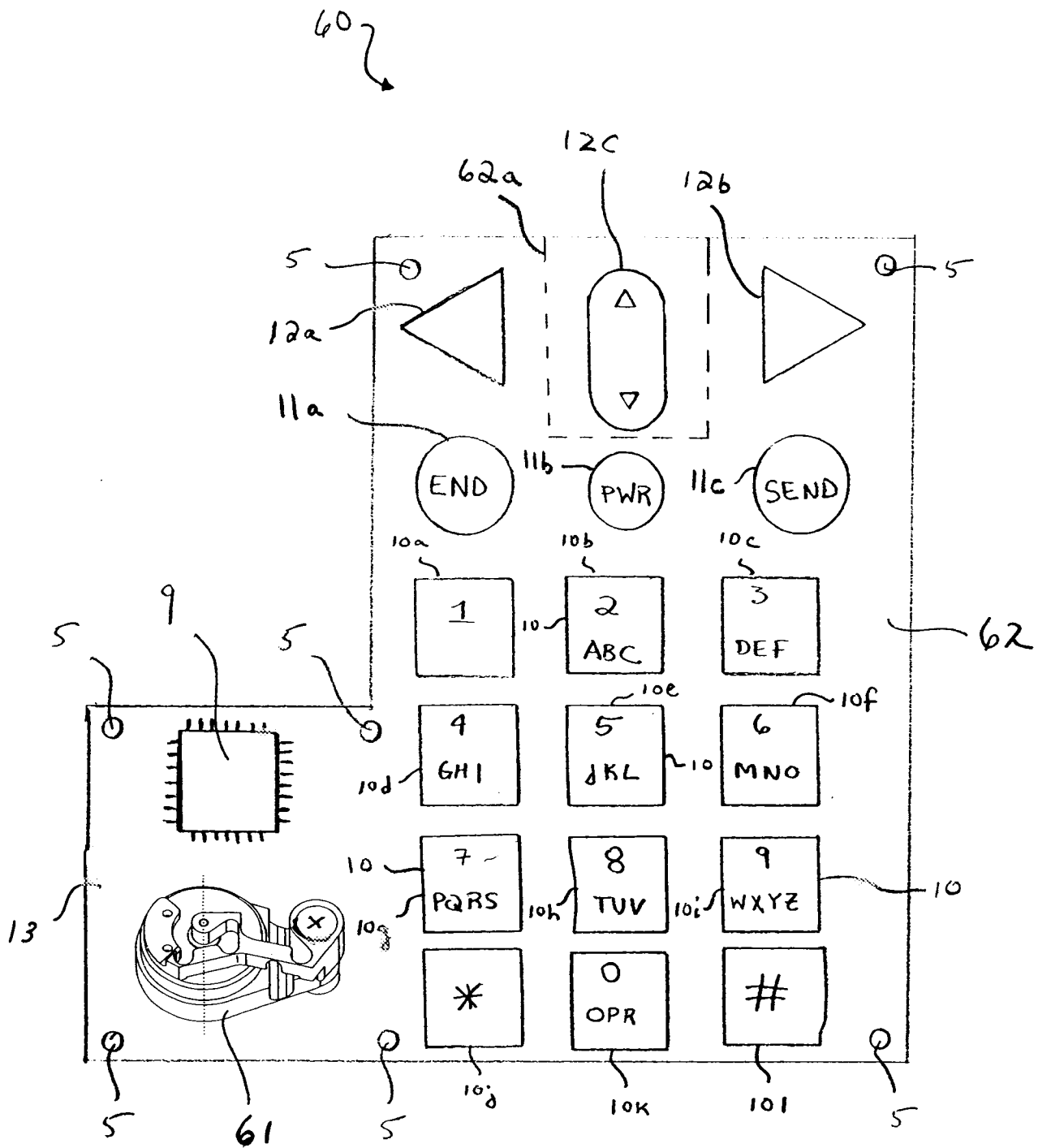


Fig. 2

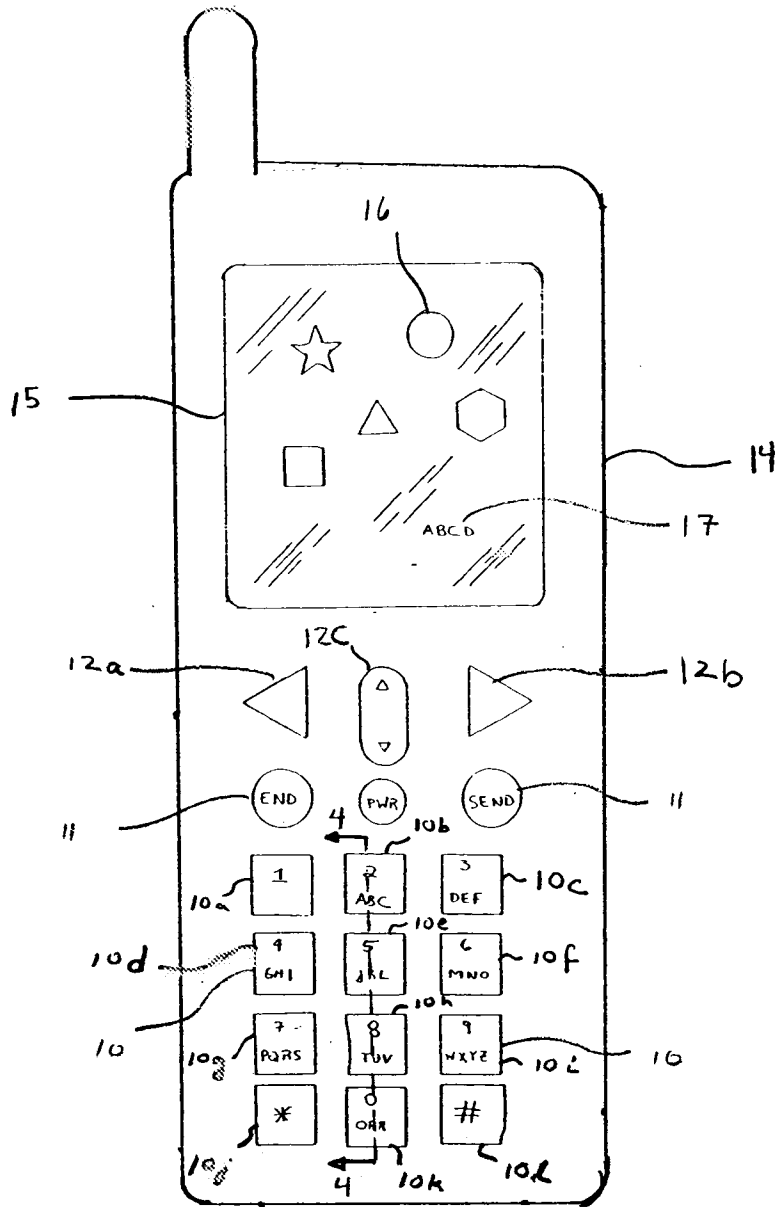


Fig. 3

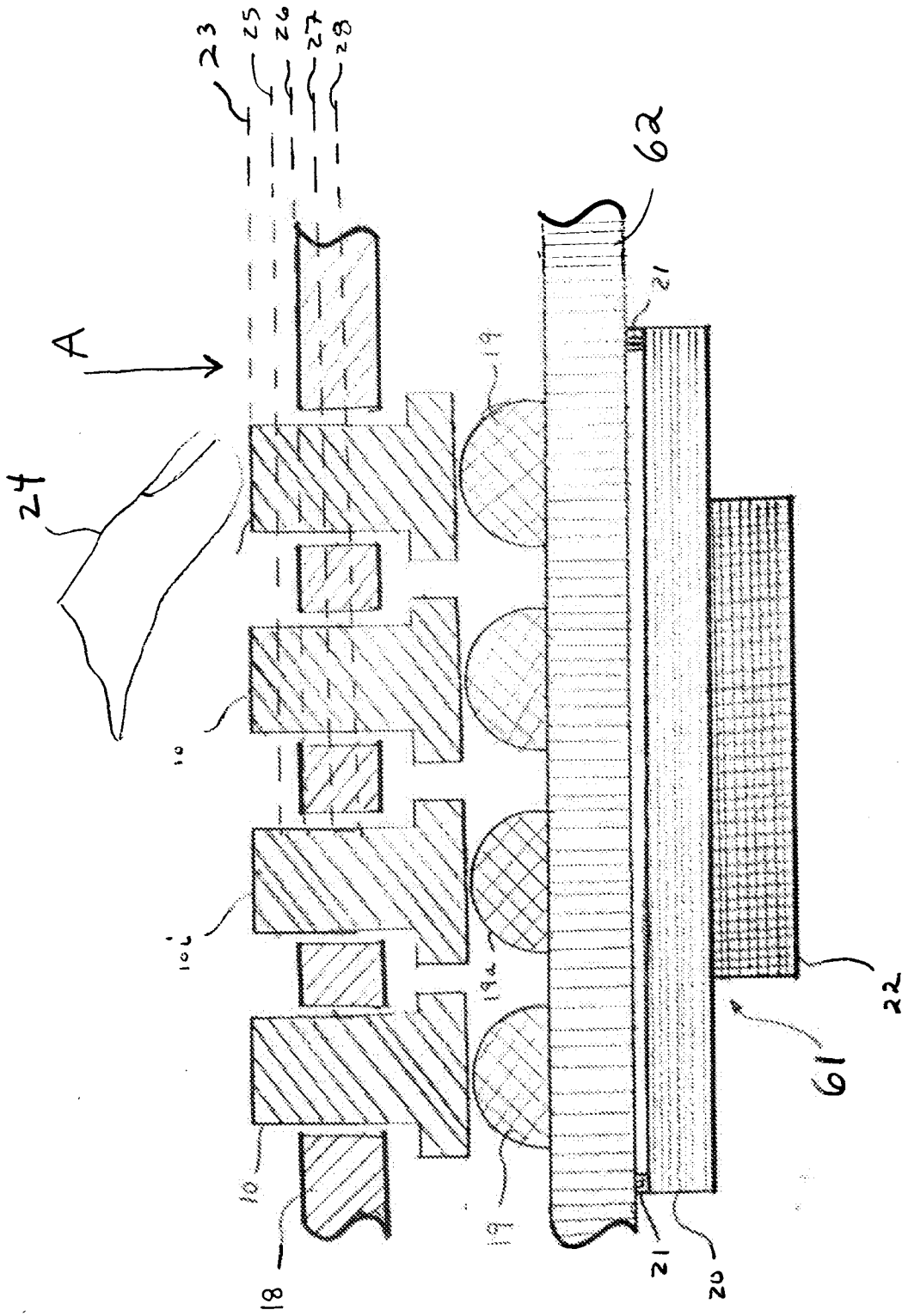


Fig. 4

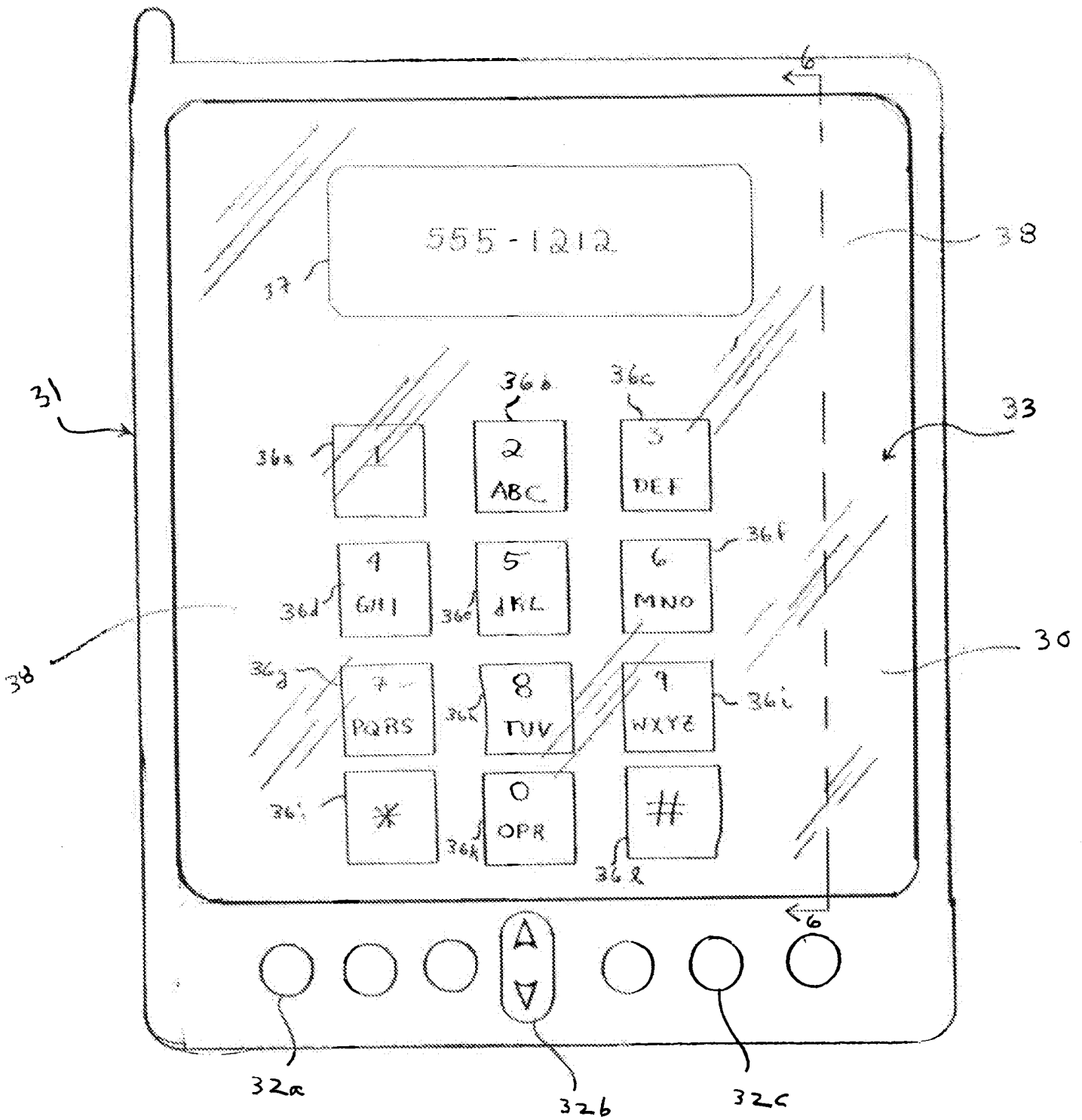


Fig. 5

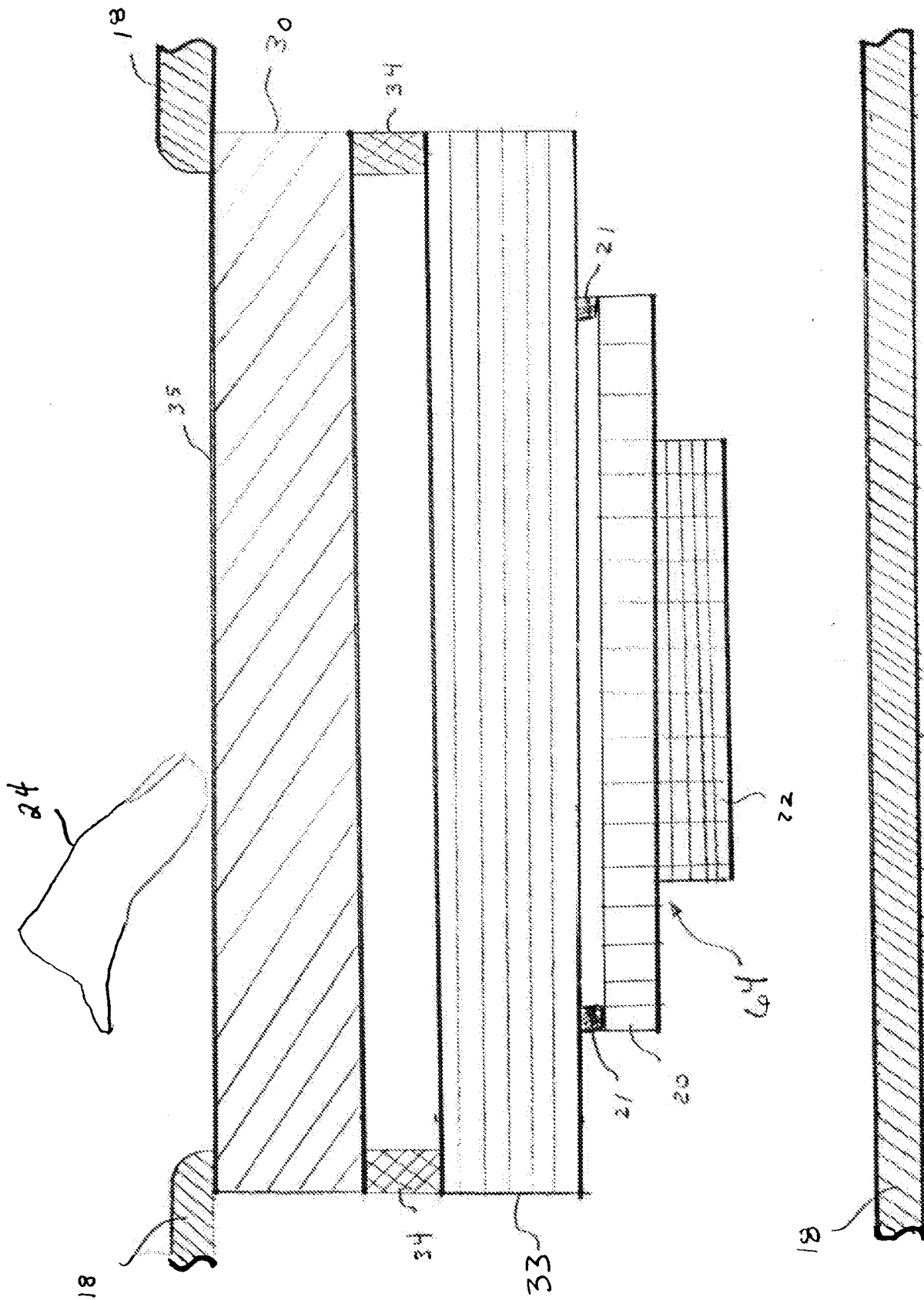


Fig. 6

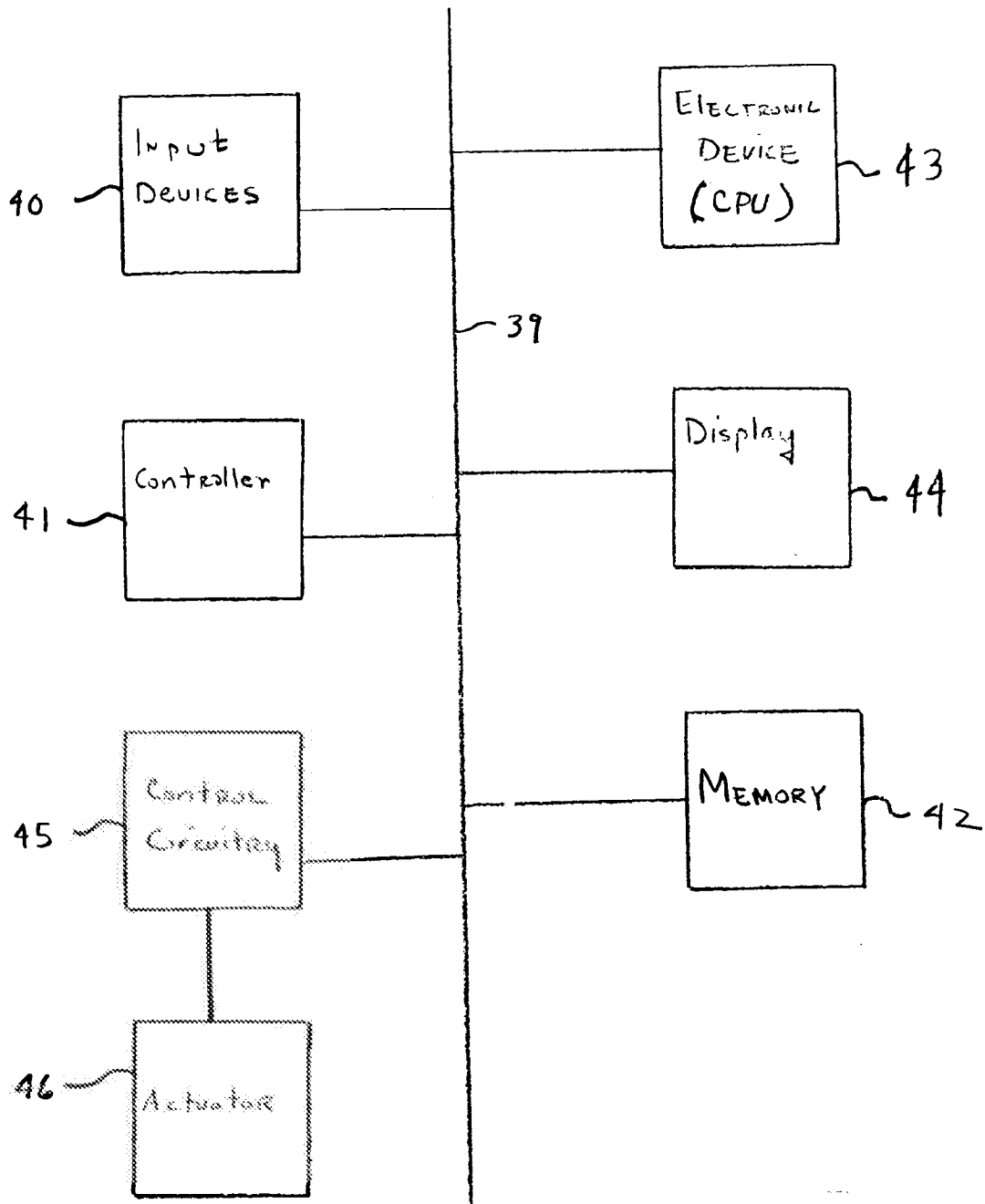


Fig. 7

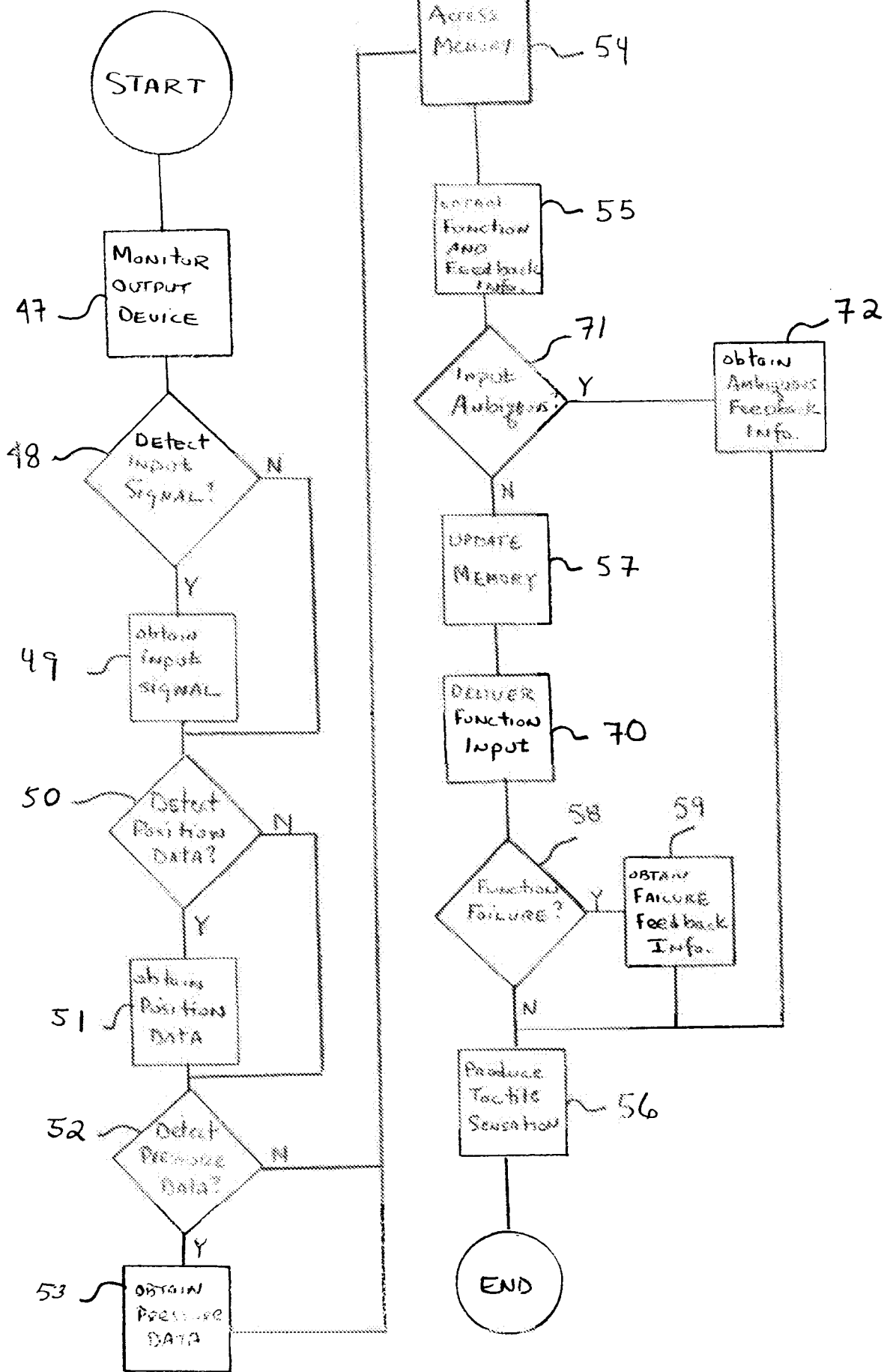


Fig. 8

INPUT DEVICE	INPUT SIGNAL	POSITION DATA	PRESSURE DATA	FUNCTION	TACTILE SENSATION
1	--	Location 1	< Pressure 1	Search	Sensation 1
	Input 1	Location 1	Pressure 1 <=	Select	Sensation 2
2	--	Position 1	--	On	Sensation 3
	--	Position 2	--	Off	Sensation 4
	Input 2A	--	Pressure 1	Q	Sensation 5
	Input 2B	--	Pressure 2	W	Sensation 6
3	Input 2C	--	Pressure 3	X	Sensation 7
	Input 2D	--	Pressure 4	Y	Sensation 8
	Input 2E	--	Pressure 5	Z	Sensation 9
4	Input 3	--	Pressure 1	Menu 1	Sensation 10
		--	Pressure 2	Menu 2	Sensation 11
		--	Pressure 3	Menu 3	Sensation 12
		--	Pressure 1	2	Sensation 13
		--	Pressure 2	A	Sensation 14
5	--	--	Pressure 3	B	Sensation 15
		--	Pressure 4	C	Sensation 16
	Input 4	Position 1	Pressure 1	Function 1	Sensation 17
6	Input 5	Position 2	Pressure 2	Function 2	Sensation 18
	Input 6	Position 3	Pressure 3	Function 3	Sensation 19
7	Input 7	Location 1	Pressure 1	Function 1	Sensation 20
	Input 8	Location 2	Pressure 2	Function 2	Sensation 21
--	AMBIGUOUS	--	--	--	Sensation 22
--	Function Failure	--	--	--	Sensation 23

FIG. 9

INPUT DEVICE	INPUT SIGNAL	POSITION DATA	PRESSURE DATA	FUNCTION	TACTILE SENSATION
1	--	Location 1	< Pressure 1	Search	Sensation 1
	Input 1	Location 1	Pressure 1 <=	Select	Sensation 2
2	--	Position 1	--	On	Sensation 3
	--	Position 2	--	Off	Sensation 4
	Input 2A	--	Pressure 1	9	Sensation 5
	Input 2B	--	Pressure 2	W	Sensation 6
3	Input 2C	--	Pressure 3	X	Sensation 7
	Input 2D	--	Pressure 4	Y	Sensation 8
	Input 2E	--	Pressure 5	Z	Sensation 9
4	Input 3	--	Pressure 1	Menu 1	Sensation 10
		--	Pressure 2	Menu 2	Sensation 11
		--	Pressure 3	Menu 3	Sensation 12
		--	Pressure 1	2	Sensation 13
5	--	--	Pressure 2	A	Sensation 14
		--	Pressure 3	B	Sensation 15
		--	Pressure 4	C	Sensation 16
	Input 4	Position 1	Pressure 1'	Function 4	Sensation 17'
6	Input 5	Position 2	Pressure 2'	Function 5	Sensation 18'
	Input 6	Position 3	Pressure 3'	Function 6	Sensation 19'
7	Input 7	Location 1	Pressure 1	Function 1	Sensation 20
	Input 8	Location 2	Pressure 2	Function 2	Sensation 21
--	AMBIGUOUS	--	--	--	Sensation 22
--	Function Failure	--	--	--	Sensation 23

FIG. 10

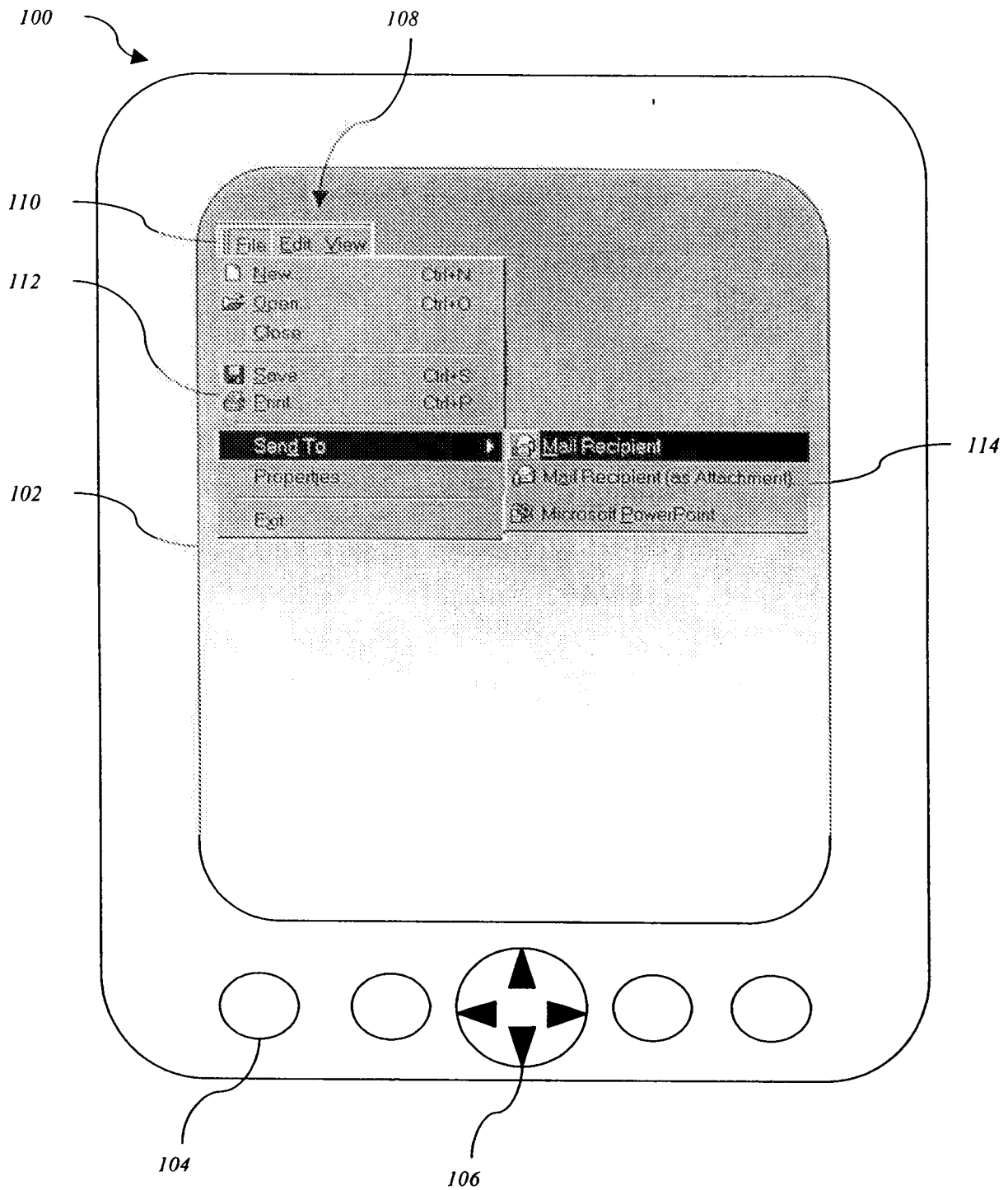


Fig. 11

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)	Attorney Docket Number	IMM147
	First Named Inventor	Kenneth M. MARTIN
	COMPLETE IF KNOWN	
	Application Number	10/285450
	Filing Date	November 1, 2002
	Group Art Unit	Not Yet Assigned
Examiner Name	Not Yet Assigned	

Declaration Submitted With Initial Filing
 Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original and first inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD AND APPARATUS FOR PROVIDING TACTILE SENSATIONS

the specification of which *(Title of the Invention)*

is attached hereto

OR

was filed on (MM/DD/YYYY) 11/01/2002 as United States Application Number or PCT International Application Number 10/285450 and was amended on (MM/DD/YYYY) 12/19/2002 (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY) Country	Priority Not Claimed	Certified Copy Attached?	
				YES	NO
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:


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DECLARATION — Utility or Design Patent Application

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further 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 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.							
NAME OF SOLE OR FIRST INVENTOR:				<input type="checkbox"/> A petition has been filed for this unsigned inventor			
Given Name (first and middle (if any)) Kenneth M.				Family Name or Surname Martin			
Inventor's Signature <i>Kenneth M. Martin</i>					Date 12/19/02		
Residence: City Los Gatos			State CA		Country USA		Citizenship Canada
Mailing Address 21560 Old Mine Road							
City Los Gatos			State CA		Zip 95033		Country USA
NAME OF SECOND INVENTOR:				<input type="checkbox"/> A petition has been filed for this unsigned inventor			
Given Name (first and middle (if any)) Steven P.				Family Name or Surname Vassallo			
Inventor's Signature					Date		
Residence: City Redwood City			State CA		Country USA		Citizenship USA
Mailing Address 3632 Jefferson Avenue							
City Redwood City			State CA		Zip 94062		Country USA
<input checked="" type="checkbox"/> Additional inventors are being named on the one supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto.							

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DECLARATION — Utility or Design Patent Application

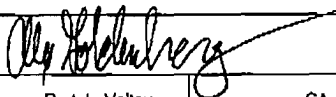
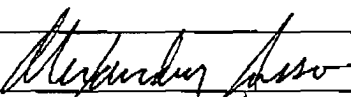
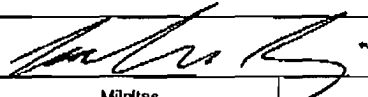
Direct all correspondence to: <input checked="" type="checkbox"/> Customer Number or Bar Code Label				34300		OR		<input type="checkbox"/> Correspondence address below	
Name									
Address									
City				State			ZIP		
Country				Telephone			Fax		
I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further 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 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.									
NAME OF SOLE OR FIRST INVENTOR:				<input type="checkbox"/> A petition has been filed for this unsigned inventor					
Given Name (first and middle [if any]) Kenneth M.				Family Name or Surname Martin					
Inventor's Signature						Date			
Los Gatos			CA		USA		Canada		
Residence: City			State		Country		Citizenship		
21560 Old Mine Road									
Mailing Address									
Los Gatos			CA		95033		Canada		
City			State		Zip		Country		
NAME OF SECOND INVENTOR:				<input type="checkbox"/> A petition has been filed for this unsigned inventor					
Given Name (first and middle [if any]) Steven P.				Family Name or Surname Vassallo					
Inventor's Signature 						Date 12/20/02			
Redwood City			CA		USA		USA		
Residence: City			State		Country		Citizenship		
3632 Jefferson Avenue									
Mailing Address									
Redwood City			CA		94062		USA		
City			State		Zip		Country		
<input checked="" type="checkbox"/> Additional Inventors are being named on the one supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto.									

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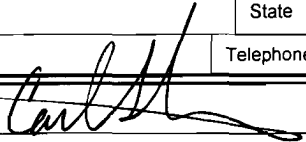
DECLARATION	ADDITIONAL INVENTOR(S) Supplemental Sheet Page <u>22</u> of <u>3</u>
--------------------	---

Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor			
Given Name (first and middle (if any))			Family Name or Surname		
Alex S.			Goldenberg		
Inventor's Signature				Date <u>12/19/02</u>	
Residence: City	Portola Valley	State	CA	Country	USA
Mailing Address 271 Gabarda Way					
Mailing Address					
City	Portola Valley	State	CA	ZIP	94028
			Country	USA	
Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor			
Given Name (first and middle (if any))			Family Name or Surname		
Alexander			Jasso		
Inventor's Signature				Date <u>12/19/02</u>	
Residence: City	Los Altos	State	CA	Country	USA
Mailing Address 405 Fremont Ave					
Mailing Address					
City	Los Altos	State	CA	Zip	94024
			Country	USA	
Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor			
Given Name (first and middle (if any))			Family Name or Surname		
Kollin			Tierling		
Inventor's Signature				Date <u>12/17/02</u>	
Residence: City	Milpitas	State	CA	Country	USA
Mailing Address 622 Costigan Circle					
Mailing Address					
City	Milpitas	State	CA	Zip	93035
			Country	USA	

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UTILITY PATENT APPLICATION TRANSMITTAL <i>(Only for new nonprovisional applications under 37 C.F.R. 1.53(b))</i>	Attorney Docket No.	IMM147.C1
	First Inventor	Kenneth M. Martin
	Title	Method and Apparatus for Providing Tactile Sensations
	Express Mail Label No.	N/A (submitted via EFS)

<p style="text-align: center;">APPLICATION ELEMENTS</p> <p><i>See MPEP chapter 600 concerning utility patent application contents.</i></p> <p>1. <input type="checkbox"/> Fee Transmittal Form (e.g., PTO/SB/17) <i>(Submit an original and a duplicate for fee processing)</i></p> <p>2. <input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27.</p> <p>3. <input checked="" type="checkbox"/> Specification [Total Pages <u>47</u>] Both the claims and abstract must start on a new page <i>(For information on the preferred arrangement, see MPEP 608.01(a))</i></p> <p>4. <input checked="" type="checkbox"/> Drawing(s) (35 U.S.C.113) [Total Sheets <u>11</u>]</p> <p>5. Oath or Declaration [Total Sheets <u>4</u>]</p> <p>a. <input type="checkbox"/> Newly executed (original or copy)</p> <p>b. <input checked="" type="checkbox"/> A copy from a prior application (37 CFR 1.63 (d)) <i>(for a continuation/divisional with Box 18 completed)</i></p> <p>i. <input type="checkbox"/> DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).</p> <p>6. <input checked="" type="checkbox"/> Application Data Sheet. See 37 CFR 1.76</p> <p>7. <input type="checkbox"/> CD-ROM or CD-R in duplicate, large table or Computer Program (Appendix) <input type="checkbox"/> Landscape Table on CD</p> <p>8. Nucleotide and/or Amino Acid Sequence Submission <i>(if applicable, items a.-c. are required)</i></p> <p>a. <input type="checkbox"/> Computer Readable Form (CRF)</p> <p>b. Specification Sequence Listing on:</p> <p>i. <input type="checkbox"/> CD-ROM or CD-R (2 copies); or</p> <p>ii. <input type="checkbox"/> Paper</p> <p>c. <input type="checkbox"/> Statements verifying identity of above copies</p>	<p>ADDRESS TO: Commissioner for Patents P.O. Box 1450 Alexandria VA 22313-1450</p> <p style="text-align: center;">ACCOMPANYING APPLICATIONS PARTS</p> <p>9. <input type="checkbox"/> Assignment Papers (cover sheet & document(s)) Name of Assignee _____</p> <p>10. <input type="checkbox"/> 37 C.F.R. 3.73(b) Statement <input type="checkbox"/> Power of Attorney <i>(when there is an assignee)</i></p> <p>11. <input type="checkbox"/> English Translation Document (if applicable)</p> <p>12. <input type="checkbox"/> Information Disclosure Statement (PTO/SB/08 or PTO-1449) <input type="checkbox"/> Copies of citations attached</p> <p>13. <input type="checkbox"/> Preliminary Amendment</p> <p>14. <input type="checkbox"/> Return Receipt Postcard (MPEP 503) <i>(Should be specifically itemized)</i></p> <p>15. <input type="checkbox"/> Certified Copy of Priority Document(s) <i>(if foreign priority is claimed)</i></p> <p>16. <input type="checkbox"/> Nonpublication Request under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.</p> <p>17. <input type="checkbox"/> Other: _____ _____</p>
<p>18. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in the first sentence of the specification following the title, or in an Application Data Sheet under 37 CFR 1.76:</p> <p><input checked="" type="checkbox"/> Continuation <input type="checkbox"/> Divisional <input type="checkbox"/> Continuation-in-part (CIP) of prior application No: <u>10 / 285,450</u> Prior application information: Examiner <u>Ricardo Osorio</u> Art Unit: <u>2629</u></p>	
19. CORRESPONDENCE ADDRESS	
<p><input checked="" type="checkbox"/> The address associated with Customer Number <u>34300</u> OR <input type="checkbox"/> Correspondence address below</p>	
Name	
Address	
City	State Zip Code
Country	Telephone Email
Signature	 Date March 29, 2007
Name (Print/Type)	Carl E. Sanders Registration No. (Attorney/Agent) 57,203

This collection of information is required by 37 CFR 1.53(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop Patent Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	IMM147.C1
		Application Number	
Title of Invention	Method and Apparatus for Providing Tactile Sensations		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

Secrecy Order 37 CFR 5.2

Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Applicant Information:

Applicant 1						Remove
Applicant Authority <input checked="" type="radio"/> Inventor		<input type="radio"/> Legal Representative under 35 U.S.C. 117		<input type="radio"/> Party of Interest under 35 U.S.C. 118		
Prefix	Given Name	Middle Name	Family Name	Suffix		
Mr.	Kenneth	M.	Martin			
Residence Information (Select One) <input checked="" type="radio"/> US Residency <input type="radio"/> Non US Residency <input type="radio"/> Active US Military Service						
City	Los Gatos	State/Province	CA	Country of Residenceⁱ	US	
Citizenship under 37 CFR 1.41(b)ⁱ		CA				
Mailing Address of Applicant:						
Address 1	21560 Old Mine Road					
Address 2						
City	Los Gatos	State/Province	CA			
Postal Code	95033	Countryⁱ	US			
Applicant 2						Remove
Applicant Authority <input checked="" type="radio"/> Inventor		<input type="radio"/> Legal Representative under 35 U.S.C. 117		<input type="radio"/> Party of Interest under 35 U.S.C. 118		
Prefix	Given Name	Middle Name	Family Name	Suffix		
Mr.	Steven	P.	Vassallo			
Residence Information (Select One) <input checked="" type="radio"/> US Residency <input type="radio"/> Non US Residency <input type="radio"/> Active US Military Service						
City	Redwood City	State/Province	CA	Country of Residenceⁱ	US	
Citizenship under 37 CFR 1.41(b)ⁱ		US				
Mailing Address of Applicant:						
Address 1	3632 Jefferson Avenue					
Address 2						
City	Redwood City	State/Province	CA			
Postal Code	94062	Countryⁱ	US			
Applicant 3						Remove
Applicant Authority <input checked="" type="radio"/> Inventor		<input type="radio"/> Legal Representative under 35 U.S.C. 117		<input type="radio"/> Party of Interest under 35 U.S.C. 118		
Prefix	Given Name	Middle Name	Family Name	Suffix		
Mr.	Alex	S.	Goldenberg			
Residence Information (Select One) <input checked="" type="radio"/> US Residency <input type="radio"/> Non US Residency <input type="radio"/> Active US Military Service						
City	Portola Valley	State/Province	CA	Country of Residenceⁱ	US	APPLE INC.

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	IMM147.C1
		Application Number	
Title of Invention	Method and Apparatus for Providing Tactile Sensations		

Citizenship under 37 CFR 1.41(b) i	US		
Mailing Address of Applicant:			
Address 1	271 Gabarda Way		
Address 2			
City	Portola Valley	State/Province	CA
Postal Code	94028	Country ⁱ	US

Applicant 4				<input type="button" value="Remove"/>
Applicant Authority	<input checked="" type="radio"/> Inventor	<input type="radio"/> Legal Representative under 35 U.S.C. 117	<input type="radio"/> Party of Interest under 35 U.S.C. 118	
Prefix	Given Name	Middle Name	Family Name	Suffix
Mr.	Alexander		Jasso	
Residence Information (Select One) <input checked="" type="radio"/> US Residency <input type="radio"/> Non US Residency <input type="radio"/> Active US Military Service				
City	Los Altos	State/Province	CA	Country of Residence ⁱ
				US
Citizenship under 37 CFR 1.41(b) i	US			

Mailing Address of Applicant:				
Address 1	405 Fremont Ave.			
Address 2				
City	Los Altos	State/Province	CA	
Postal Code	94024	Country ⁱ		

Applicant 5				<input type="button" value="Remove"/>
Applicant Authority	<input checked="" type="radio"/> Inventor	<input type="radio"/> Legal Representative under 35 U.S.C. 117	<input type="radio"/> Party of Interest under 35 U.S.C. 118	
Prefix	Given Name	Middle Name	Family Name	Suffix
Mr.	Kollin		Tierling	
Residence Information (Select One) <input checked="" type="radio"/> US Residency <input type="radio"/> Non US Residency <input type="radio"/> Active US Military Service				
City	Milpitas	State/Province	CA	Country of Residence ⁱ
				US
Citizenship under 37 CFR 1.41(b) i	US			

Mailing Address of Applicant:				
Address 1	622 Costigan Circle			
Address 2				
City	Milpitas	State/Province	CA	
Postal Code	93035	Country ⁱ	US	
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button.				
<input type="button" value="Add"/>				

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).	
<input type="checkbox"/> An Address is being provided for the correspondence Information of this application.	
Customer Number	34300
APPLE INC.	
EXHIBIT 1010 - PAGE 65	

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	IMM147.C1
	Application Number	
Title of Invention	Method and Apparatus for Providing Tactile Sensations	

Email Address		<input type="button" value="Add Email"/>	<input type="button" value="Remove Email"/>
---------------	--	--	---

Application Information:

Title of the Invention	Method and Apparatus for Providing Tactile Sensations		
Attorney Docket Number	IMM147.C1	Small Entity Status Claimed	<input type="checkbox"/>
Application Type	Nonprovisional		
Subject Matter			
Suggested Class (if any)		Sub Class (if any)	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	11	Suggested Figure for Publication (if any)	
Publication Information:			
<input type="checkbox"/>	Request Early Publication (Fee required at time of Request 37 CFR 1.219)		
<input type="checkbox"/>	Request Not to Publish. I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application has not been and will not be the subject of an application filed in another country, or under a multilateral agreement, that requires publication at eighteen months after filing.		

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.

Please Select One:	<input checked="" type="radio"/> Customer Number	<input type="radio"/> US Patent Practitioner	<input type="radio"/> US Representative (37 CFR 11.9)
Customer Number	34300		

Domestic Priority Information:

This section allows for the applicant to claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c). Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status	Pending	<input type="button" value="Remove"/>	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	10/285450	2002-11-01
Prior Application Status	Expired	<input type="button" value="Remove"/>	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
10/285450	non provisional of	60/335493	2001-11-01
Prior Application Status	Expired	<input type="button" value="Remove"/>	

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	IMM147.C1	
		Application Number		
Title of Invention	Method and Apparatus for Providing Tactile Sensations			
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	
10/285450	non provisional of	60/399883	2002-07-31	
Additional Domestic Priority Data may be generated within this form by selecting the Add button.				<input type="button" value="Add"/>

Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

Application Number	Country ⁱ	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
			<input type="radio"/> Yes <input type="radio"/> No

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Assignee Information:

Providing this information in the application data sheet does not substitute for compliance with any requirement of part 3 of Title 37 of the CFR to have an assignment recorded in the Office.

Assignee 1

If the Assignee is an Organization check here.

Organization Name | Immersion Corporation

Mailing Address Information:

Address 1 | 801 Fox Lane

Address 2 |

City | San Jose | State/Province | CA

Country ⁱ | US | Postal Code | 95131

Phone Number | 408-467-1900 | Fax Number | 408-350-8761

Email Address |

Additional Assignee Data may be generated within this form by selecting the **Add** button.

Signature:

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 10.18. Please see 37 CFR 1.4(d) for the form of the signature.

Signature	/Carl E. Sanders/		Date (YYYY-MM-DD)	2007-03-29
First Name	Carl	Last Name	Sanders	Registration Number
				57203

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	IMM147.C1
	Application Number	
Title of Invention	Method and Apparatus for Providing Tactile Sensations	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:				
Filing Date:				
Title of Invention:	Method and Apparatus for Providing Tactile Sensations			
First Named Inventor/Applicant Name:	Kenneth M. Martin			
Filer:	Carl Sanders			
Attorney Docket Number:	IMM147.C1			
Filed as Large Entity				
Utility Filing Fees				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Utility application filing	1011	1	300	300
Utility Search Fee	1111	1	500	500
Utility Examination Fee	1311	1	200	200
Pages:				
Claims:				
Claims in excess of 20	1202	5	50	250
Miscellaneous-Filing:				
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1250

Electronic Acknowledgement Receipt

EFS ID:	1633159
Application Number:	11693117
International Application Number:	
Confirmation Number:	8743
Title of Invention:	Method and Apparatus for Providing Tactile Sensations
First Named Inventor/Applicant Name:	Kenneth M. Martin
Customer Number:	34300
Filer:	Carl Sanders/Tammy Shearer
Filer Authorized By:	Carl Sanders
Attorney Docket Number:	IMM147.C1
Receipt Date:	29-MAR-2007
Filing Date:	
Time Stamp:	13:59:25
Application Type:	Utility

Payment information:

Submitted with Payment	yes
Payment was successfully received in RAM	\$ 1250
RAM confirmation Number	2143
Deposit Account	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)	Multi Part /.zip	Pages (if appl.)
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1	Specification	IMM147C1Specification.pdf	175522	no	47
Warnings:					
Information:					
2	Drawings	IMM147C1Drawings.pdf	842410	no	11
Warnings:					
Information:					
3	Oath or Declaration filed	IMM147C1Declaration.pdf	96957	no	4
Warnings:					
Information:					
4	Miscellaneous Incoming Letter	IMM147C1UtilityApplicationTransmittal.pdf	25616	no	1
Warnings:					
Information:					
5	Application Data Sheet	IMM147C1ApplicationDataSheet.pdf	1293761	no	6
Warnings:					
Information:					
6	Fee Worksheet (PTO-06)	fee-info.pdf	8457	no	2
Warnings:					
Information:					
Total Files Size (in bytes):			2442723		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	11/693,117
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APPLICATION AS FILED – PART I			SMALL ENTITY		OTHER THAN SMALL ENTITY	
	(Column 1)	(Column 2)	RATE (\$)	FEE (\$)	RATE (\$)	FEE (\$)
FOR	NUMBER FILED	NUMBER EXTRA				
BASIC FEE (37 CFR 1.16(a), (b), or (c))						300
SEARCH FEE (37 CFR 1.16(k), (l), or (m))						500
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))						200
TOTAL CLAIMS (37 CFR 1.16(i))	25	minus 20 =	X\$25=		X\$50	250
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3	minus 3 =	X\$100=		X\$200=	
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due 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					
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))			N/A		N/A	
			TOTAL		TOTAL	1250

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED – PART II					SMALL ENTITY		OTHER THAN SMALL ENTITY	
	(Column 1)	(Column 2)	(Column 3)		RATE (\$)	ADDITIONAL FEE (\$)	RATE (\$)	ADDITIONAL FEE (\$)
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT	MINUS	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA				
	Total (37 CFR 1.16(i))	*	**	=	X =		X =	
	Independent (37 CFR 1.16(h))	*	***	=	X =		X =	
	Application Size Fee (37 CFR 1.16(s))							
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))				N/A		N/A	
					TOTAL ADD'T FEE		TOTAL ADD'T FEE	

	(Column 1)	(Column 2)	(Column 3)		RATE (\$)	ADDITIONAL FEE (\$)	RATE (\$)	ADDITIONAL FEE (\$)
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT	MINUS	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA				
	Total (37 CFR 1.16(i))	*	**	=	X =		X =	
	Independent (37 CFR 1.16(h))	*	***	=	X =		X =	
	Application Size Fee (37 CFR 1.16(s))							
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))				N/A		N/A	
					TOTAL ADD'T FEE		TOTAL ADD'T FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
 ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
 *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
 The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comment on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Filing Date: 03/29/07



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
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Table with 7 columns: APPLICATION NUMBER, FILING or 371(c) DATE, GRP ART UNIT, FIL FEE REC'D, ATTY.DOCKET.NO, TOT CLAIMS, IND CLAIMS. Row 1: 11/693,117, 03/29/2007, 2817, 1250, IMM147.C1, 25, 3

CONFIRMATION NO. 8743

FILING RECEIPT

34300
PATENT DEPARTMENT (51851)
KILPATRICK STOCKTON LLP
1001 WEST FOURTH STREET
WINSTON-SALEM, NC27101

Date Mailed: 04/16/2007

Receipt is acknowledged of this regular Patent Application. It will be considered in its order and you will be notified as to the results of the examination. Be sure to provide the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION when inquiring about this application. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please mail to the Commissioner for Patents P.O. Box 1450 Alexandria Va 22313-1450. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections (if appropriate).

Applicant(s)

Kenneth M. Martin, Los Gatos, CA;
Steven P. Vassallo, Redwood City, CA;
Alex S. Goldenberg, Portola Valley, CA;
Alexander Jasso, Los Altos, CA;
Kollin Tierling, Milpitas, CA;

Assignment For Published Patent Application

IMMERSION CORPORATION, San Jose, CA

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 10/285,450 11/01/2002
which claims benefit of 60/335,493 11/01/2001
and claims benefit of 60/399,883 07/31/2002

Foreign Applications

If Required, Foreign Filing License Granted: 04/16/2007

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is US11/693,117

Projected Publication Date: To Be Determined - pending completion of Corrected Papers

Non-Publication Request: No

Early Publication Request: No

Title

Method and Apparatus for Providing Tactile Sensations

Preliminary Class

330

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

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This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).


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 Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING OR 371 (c) DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
11/693,117	03/29/2007	Kenneth M. Martin	IMM147.C1

CONFIRMATION NO. 8743
FORMALITIES
LETTER

 34300
 PATENT DEPARTMENT (51851)
 KILPATRICK STOCKTON LLP
 1001 WEST FOURTH STREET
 WINSTON-SALEM, NC 27101

Date Mailed: 04/16/2007

NOTICE TO FILE CORRECTED APPLICATION PAPERS
Filing Date Granted

An application number and filing date have been accorded to this application. The application is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given TWO MONTHS from the date of this Notice within which to correct the informalities indicated below. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

The required item(s) identified below must be timely submitted to avoid abandonment:

- Replacement drawings in compliance with 37 CFR 1.84 and 37 CFR 1.121(d) are required. The drawings submitted are not acceptable because:
 - The drawings have a line quality that is too light to be reproduced (weight of all lines and letters must be heavy enough to permit adequate reproduction) or text that is illegible (reference characters, sheet numbers, and view numbers must be plain and legible) see 37 CFR 1.84(l) and (p)(1)); See Figure(s) 2, 4-6, 8.

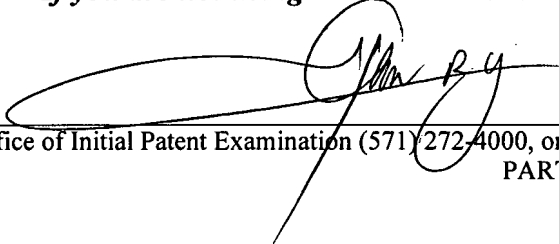
Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

Replies should be mailed to: Mail Stop Missing Parts
 Commissioner for Patents
 P.O. Box 1450
 Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web.
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For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at <http://www.uspto.gov/ebc>.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

A handwritten signature in black ink, appearing to be 'M. R. G.', is written over a horizontal line. The signature is stylized and somewhat illegible.

Office of Initial Patent Examination (571) 272-4000, or 1-800-PTO-9199
PART 3 - OFFICE COPY

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of : Martin et al.
Application No. : 11/693,117
For : METHOD AND APPARATUS FOR
PROVIDING TACTILE SENSATIONS
Filed : March 29, 2007
Group Art Unit : 2817
Examiner : To be assigned

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

TRANSMITTAL OF CORRECTED DRAWINGS

Sir:

In response to the Notice to File Corrected Application Papers mailed April 16, 2007, eleven (11) sheets of replacement drawings is attached hereto.

Kindly direct any other comments or requests with respect to this application to the undersigned at (336) 607-7474.

Respectfully submitted,

Date: 6/18/2007



Carl Sanders (Reg. No. 57,203)

Kilpatrick Stockton LLP
1001 West Fourth Street
Winston-Salem, NC 27101

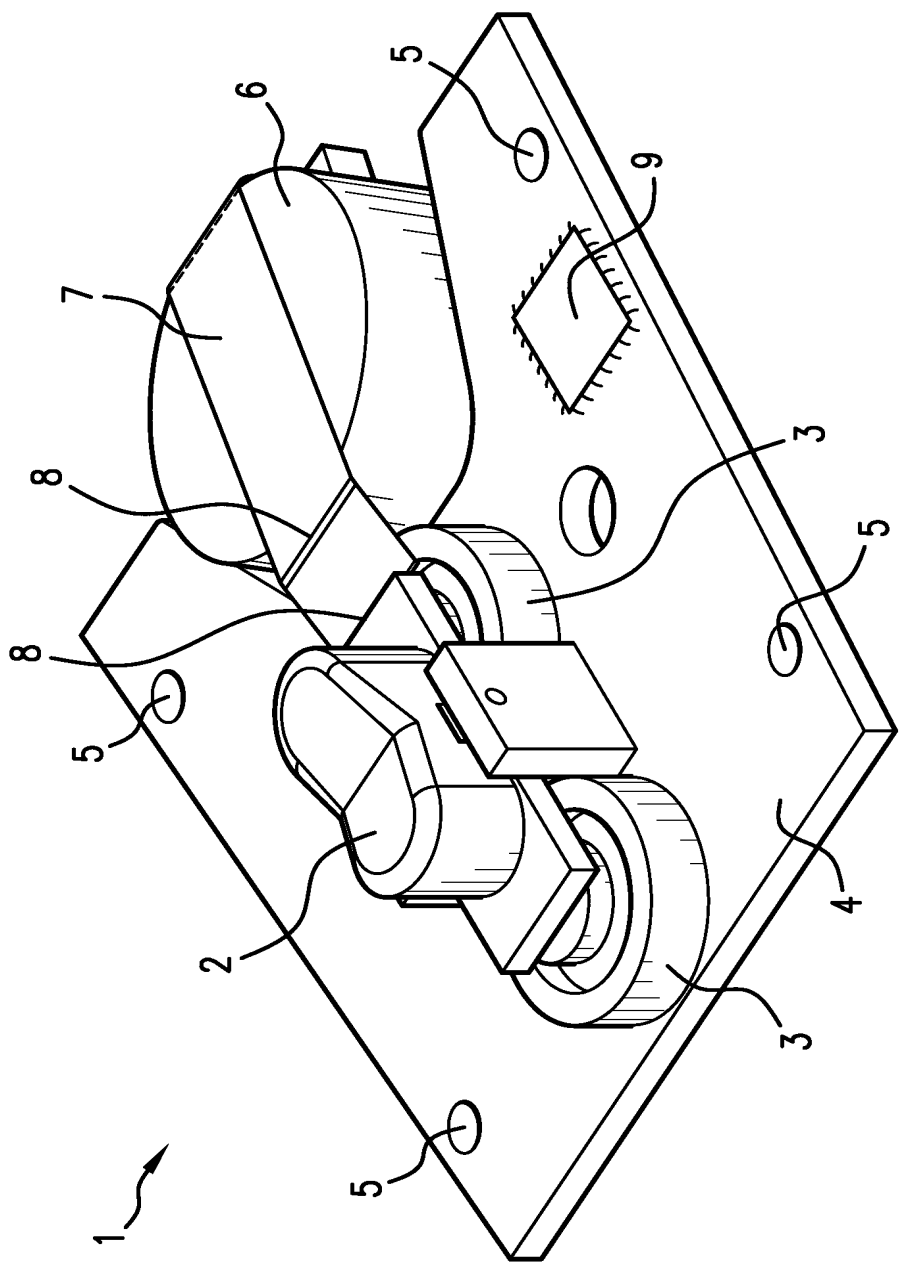


FIG.1

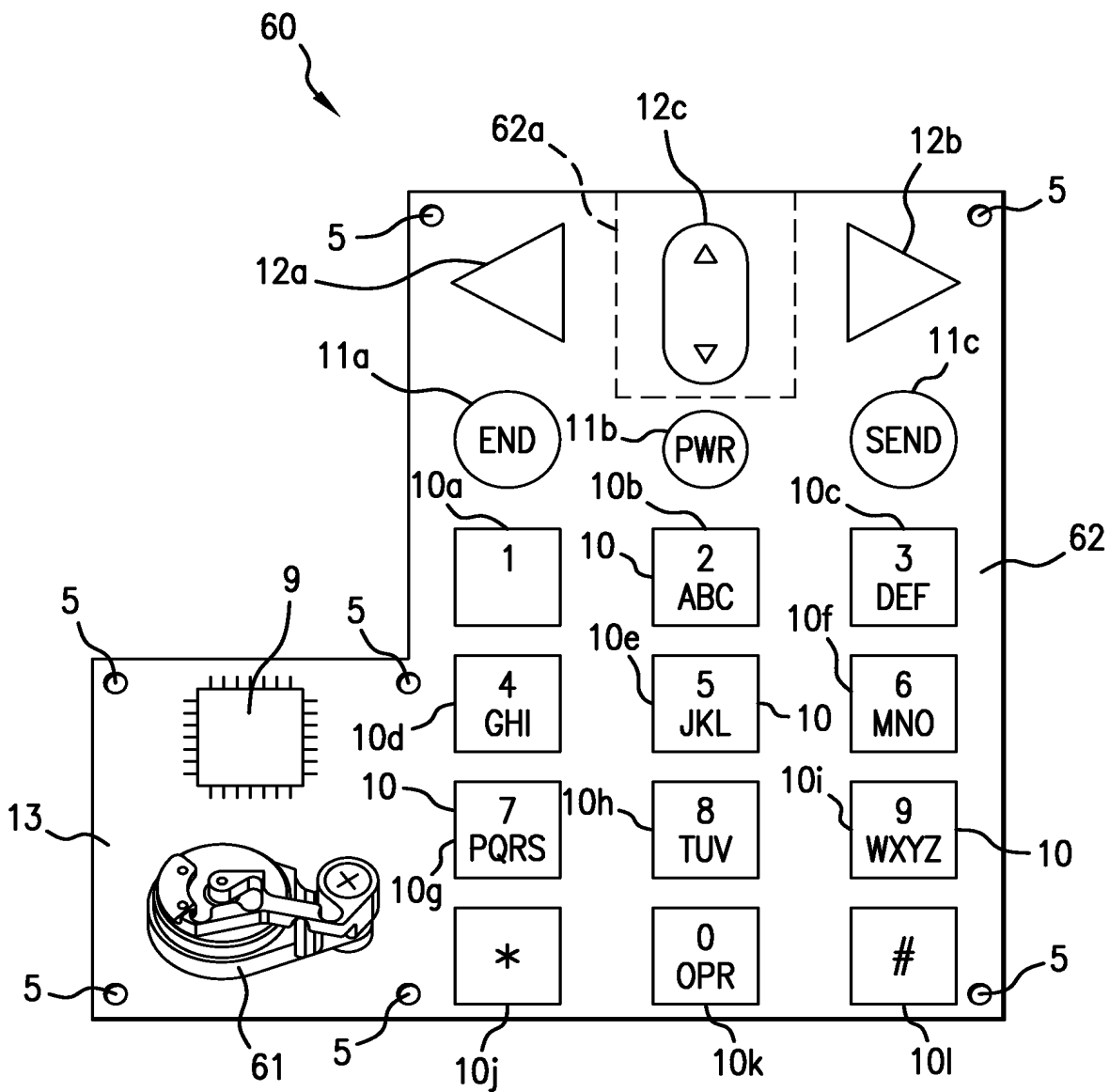


FIG. 2

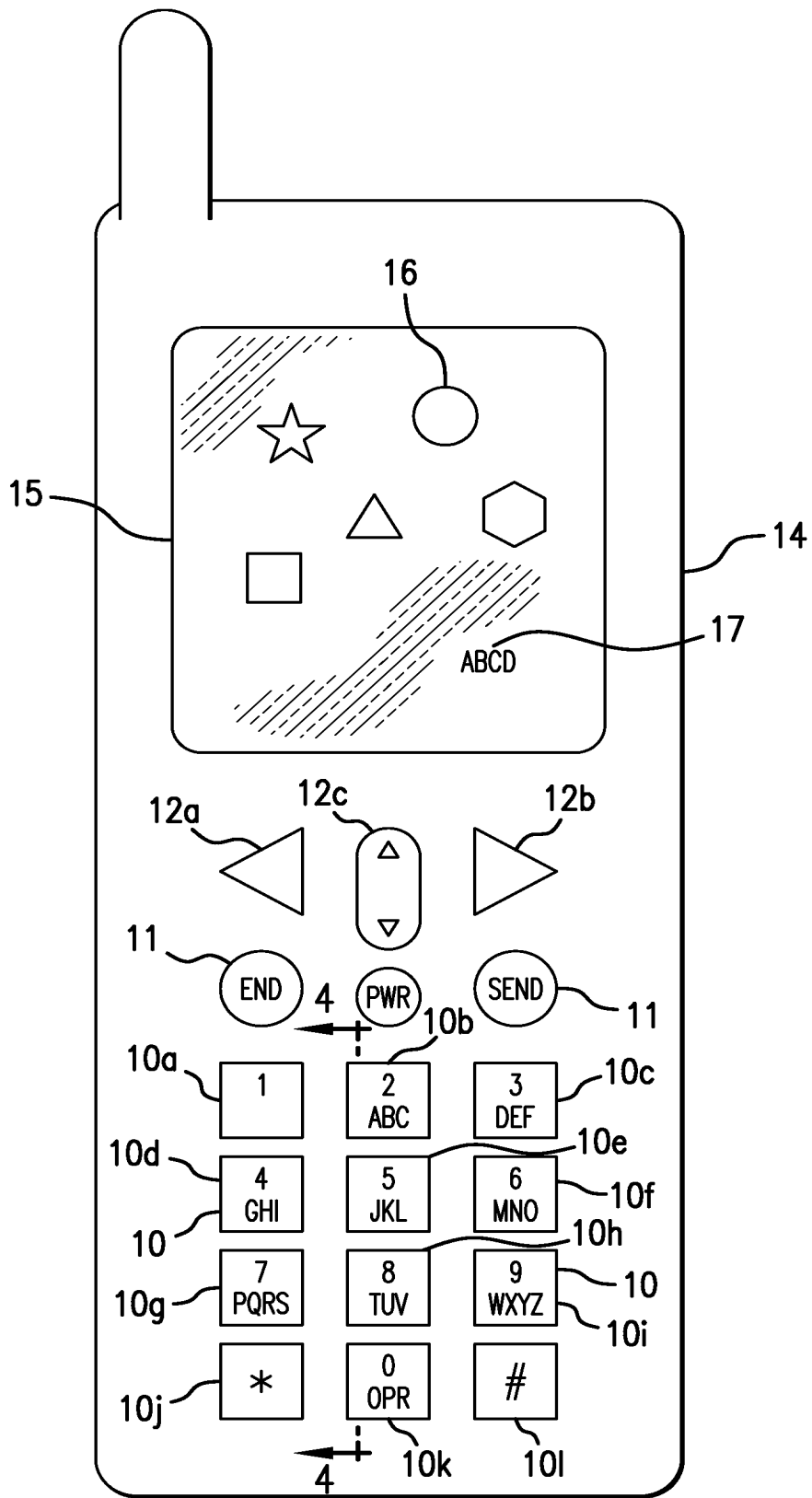


FIG. 3

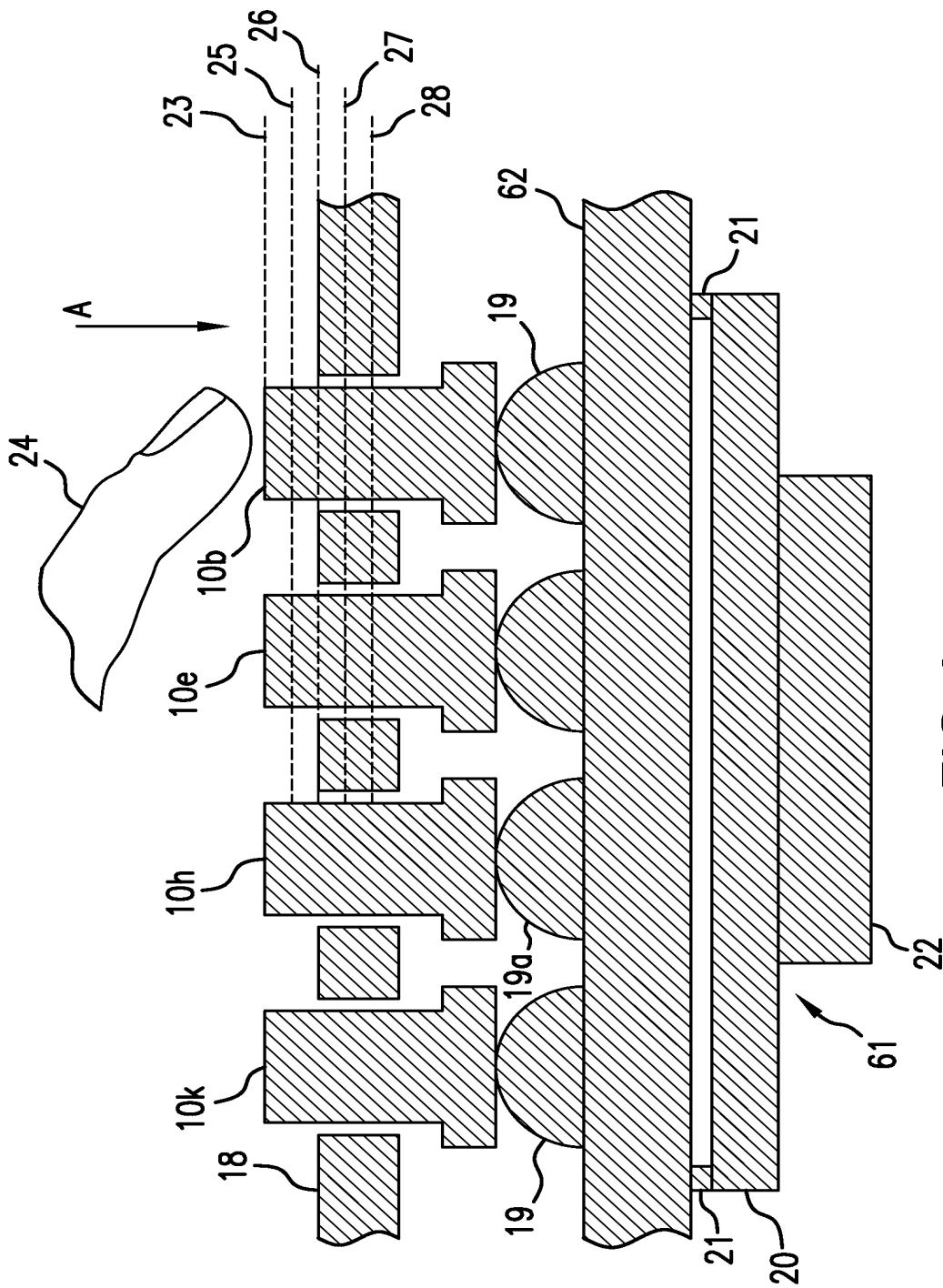


FIG. 4

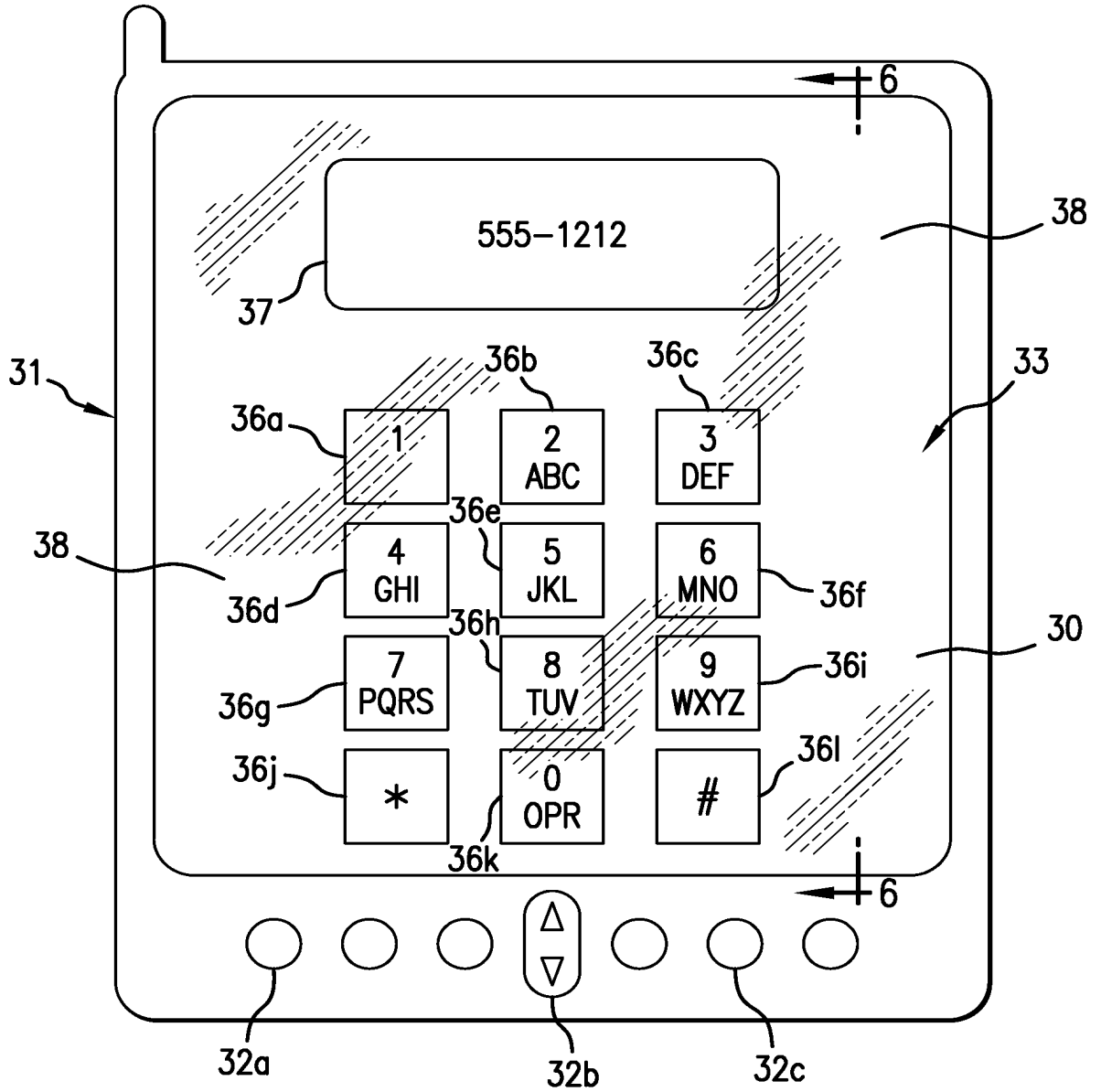


FIG. 5

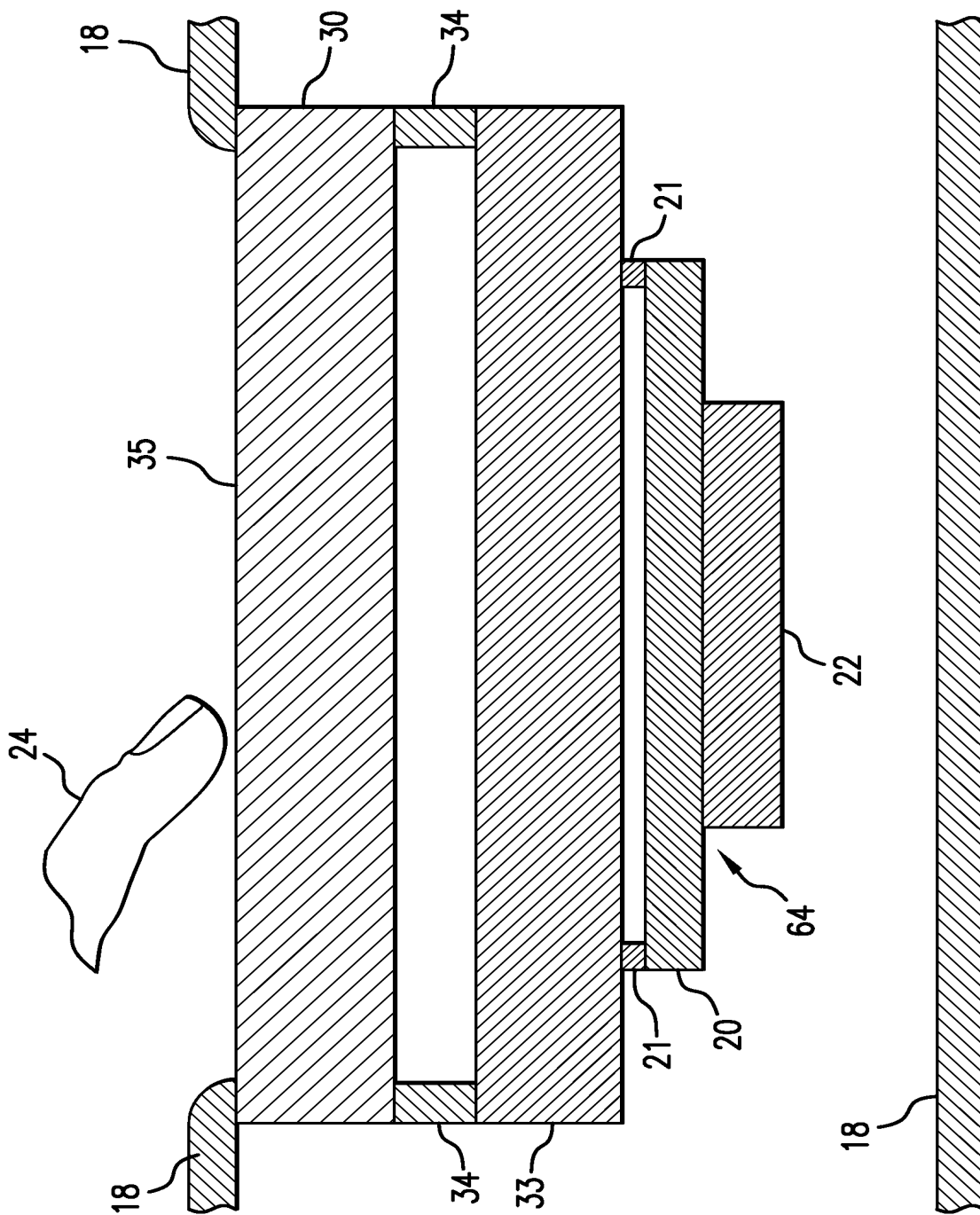


FIG. 6

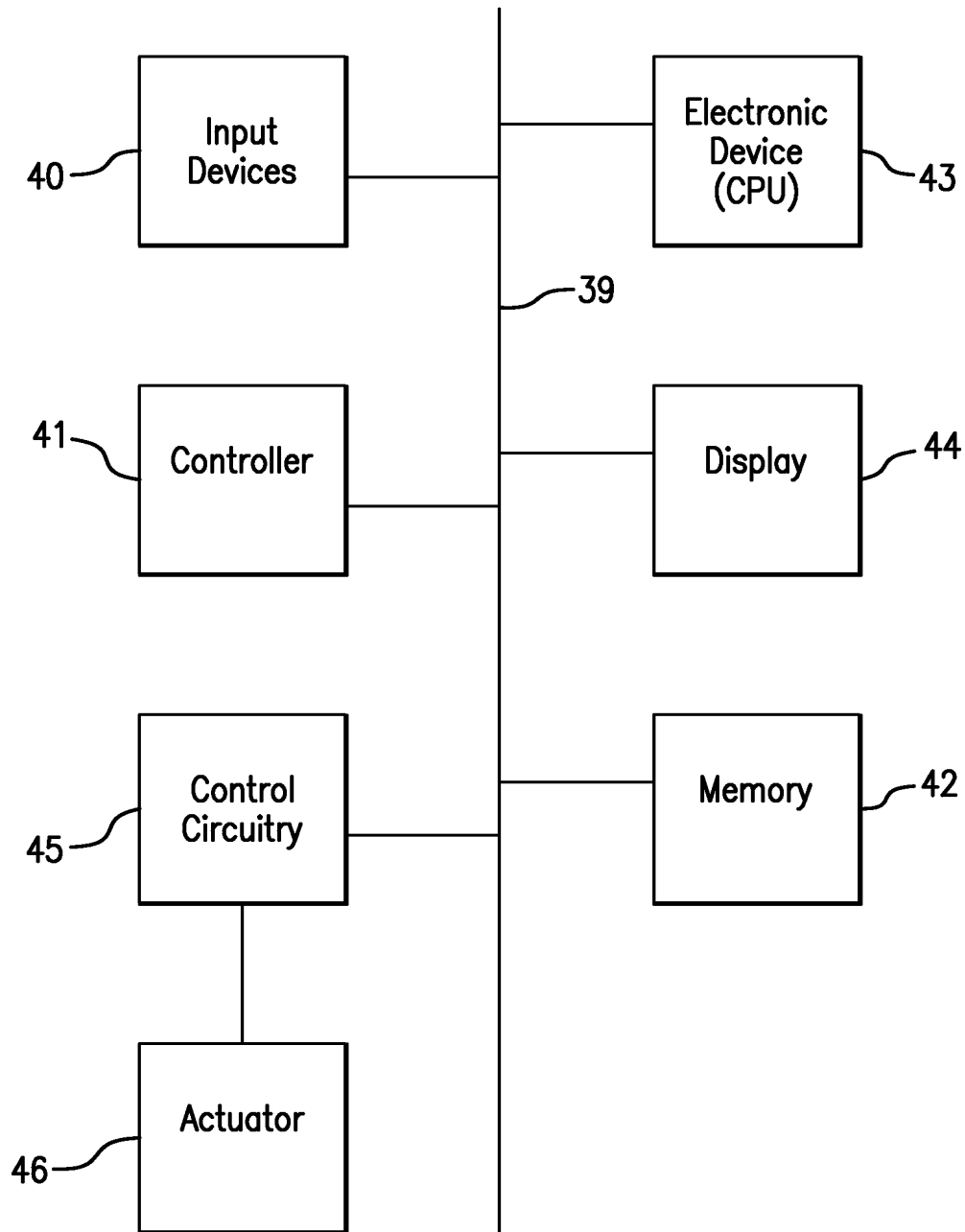


FIG. 7

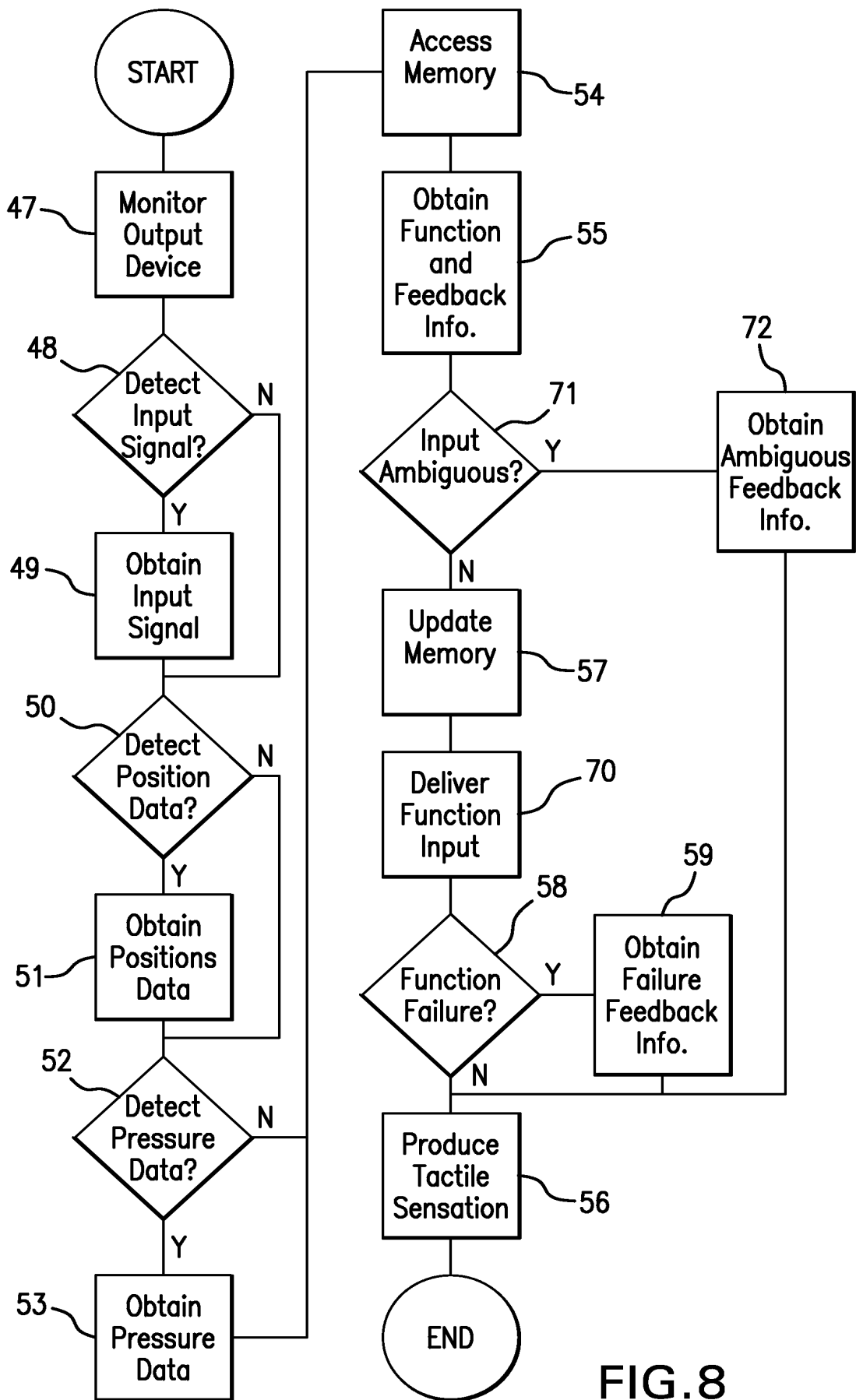


FIG. 8

INPUT DEVICE	INPUT SIGNAL	POSITION DATA	PRESSURE DATA	FUNCTION	TACTILE SENSATION
1	--	Location 1	< Pressure 1	Search	Sensation 1
	Input 1	Location 1	Pressure 1 <=	Select	Sensation 2
2	--	Position 1	--	On	Sensation 3
	--	Position 2	--	Off	Sensation 4
3	Input 2A	--	Pressure 1	9	Sensation 5
	Input 2B	--	Pressure 2	W	Sensation 6
	Input 2C	--	Pressure 3	X	Sensation 7
	Input 2D	--	Pressure 4	Y	Sensation 8
	Input 2E	--	Pressure 5	Z	Sensation 9
4	Input 3	--	Pressure 1	Menu 1	Sensation 10
		--	Pressure 2	Menu 2	Sensation 11
		--	Pressure 3	Menu 3	Sensation 12
5	--	--	Pressure 1	2	Sensation 13
		--	Pressure 2	A	Sensation 14
		--	Pressure 3	B	Sensation 15
		--	Pressure 4	C	Sensation 16
6	Input 4	Position 1	Pressure 1	Function 1	Sensation 17
	Input 5	Position 2	Pressure 2	Function 2	Sensation 18
	Input 6	Position 3	Pressure 3	Function 3	Sensation 19
7	Input 7	Location 1	Pressure 1	Function 1	Sensation 20
	Input 8	Location 2	Pressure 2	Function 2	Sensation 21
--	AMBIGUOUS	--	--	--	Sensation 22
--	Function Failure	--	--	--	Sensation 23

FIG.9

INPUT DEVICE	INPUT SIGNAL	POSITION DATA	PRESSURE DATA	FUNCTION	TACTILE SENSATION
1	--	Location 1	< Pressure 1	Search	Sensation 1
	Input 1	Location 1	Pressure 1 <=	Select	Sensation 2
2	--	Position 1	--	On	Sensation 3
	--	Position 2	--	Off	Sensation 4
3	Input 2A	--	Pressure 1	9	Sensation 5
	Input 2B	--	Pressure 2	W	Sensation 6
	Input 2C	--	Pressure 3	X	Sensation 7
	Input 2D	--	Pressure 4	Y	Sensation 8
	Input 2E	--	Pressure 5	Z	Sensation 9
4	Input 3	--	Pressure 1	Menu 1	Sensation 10
		--	Pressure 2	Menu 2	Sensation 11
		--	Pressure 3	Menu 3	Sensation 12
5	--	--	Pressure 1	2	Sensation 13
		--	Pressure 2	A	Sensation 14
		--	Pressure 3	B	Sensation 15
		--	Pressure 4	C	Sensation 16
6	Input 4	Position 1	Pressure 1'	Function 4	Sensation 17'
	Input 5	Position 2	Pressure 2'	Function 5	Sensation 18'
	Input 6	Position 3	Pressure 3'	Function 6	Sensation 19'
7	Input 7	Location 1	Pressure 1	Function 1	Sensation 20
	Input 8	Location 2	Pressure 2	Function 2	Sensation 21
--	AMBIGUOUS	--	--	--	Sensation 22
--	Function Failure	--	--	--	Sensation 23

FIG.10

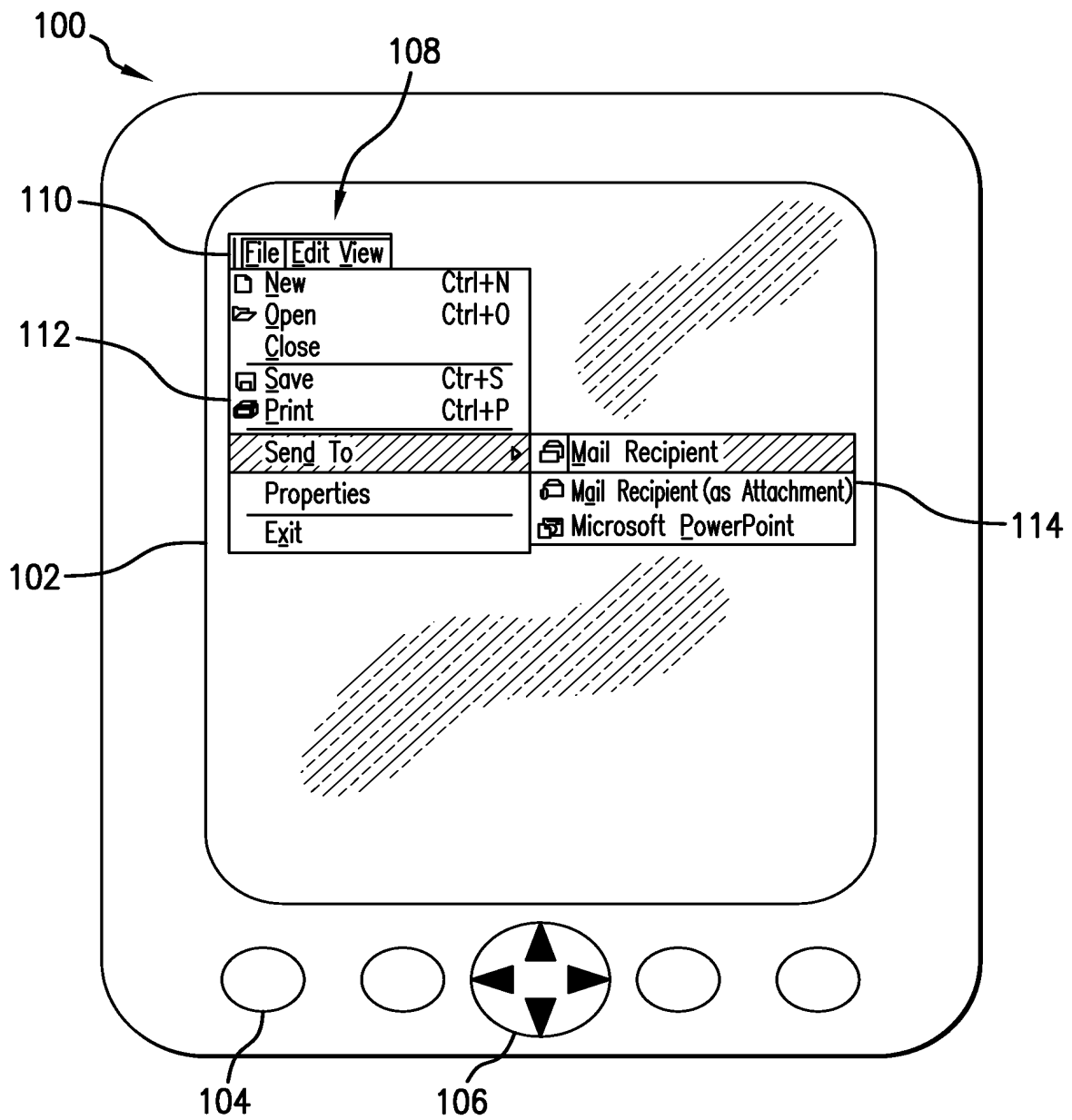


FIG. 11

Electronic Acknowledgement Receipt

EFS ID:	1883163
Application Number:	11693117
International Application Number:	
Confirmation Number:	8743
Title of Invention:	Method and Apparatus for Providing Tactile Sensations
First Named Inventor/Applicant Name:	Kenneth M. Martin
Customer Number:	34300
Filer:	Carl Sanders/Kathryn Huneryager
Filer Authorized By:	Carl Sanders
Attorney Docket Number:	IMM147.C1
Receipt Date:	18-JUN-2007
Filing Date:	29-MAR-2007
Time Stamp:	16:44:23
Application Type:	Utility

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CONFIRMATION NO. 8743

UPDATED FILING RECEIPT

34300
PATENT DEPARTMENT (51851)
KILPATRICK STOCKTON LLP
1001 WEST FOURTH STREET
WINSTON-SALEM, NC27101

Date Mailed: 06/25/2007

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Applicant(s)

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Kollin Tierling, Milpitas, CA;

Assignment For Published Patent Application

IMMERSION CORPORATION, San Jose, CA

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 10/285,450 11/01/2002
which claims benefit of 60/335,493 11/01/2001
and claims benefit of 60/399,883 07/31/2002

Foreign Applications

If Required, Foreign Filing License Granted: 04/16/2007

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is
US11/693,117

Projected Publication Date: 10/04/2007

Non-Publication Request: No

Early Publication Request: No

Title

Method and Apparatus for Providing Tactile Sensations

Preliminary Class

330

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11/693,117	03/29/2007	Kenneth M. Martin	IMM147.C1

CONFIRMATION NO. 8743

34300
PATENT DEPARTMENT (51851)
KILPATRICK STOCKTON LLP
1001 WEST FOURTH STREET
WINSTON-SALEM, NC27101

Title: Method and Apparatus for Providing Tactile Sensations

Publication No. US-2007-0229455-A1

Publication Date: 10/04/2007

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In re Application of	:	Martin et al.
Serial No.	:	11/693,117
For	:	Method and Apparatus for Providing Tactile Sensations
Filed	:	March 29, 2007
Examiner	:	Unknown
Art Group	:	2817

Certification Statement

This Information Disclosure Statement is being submitted prior to the mailing date of a first Office Action in this application. Accordingly, no fee is believed to be required. However, should any fees be due, the Commissioner is authorized to charge such fees to Deposit Account No. 16-1435.

Respectfully submitted,

Date: 10/17/07

Christopher W. Bosken
Christopher W. Bosken (Reg. No. 58,887)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of : Martin et al.
Application No. : 11/693,117
Filed : March 29, 2007
For : **Method and Apparatus for Providing Tactile Sensations**
Examiner : Unknown
Art Unit : 2817

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				<i>Filing Date</i>	March 29, 2007
				<i>First Named Inventor</i>	Martin et al.
				<i>Art Unit</i>	2817
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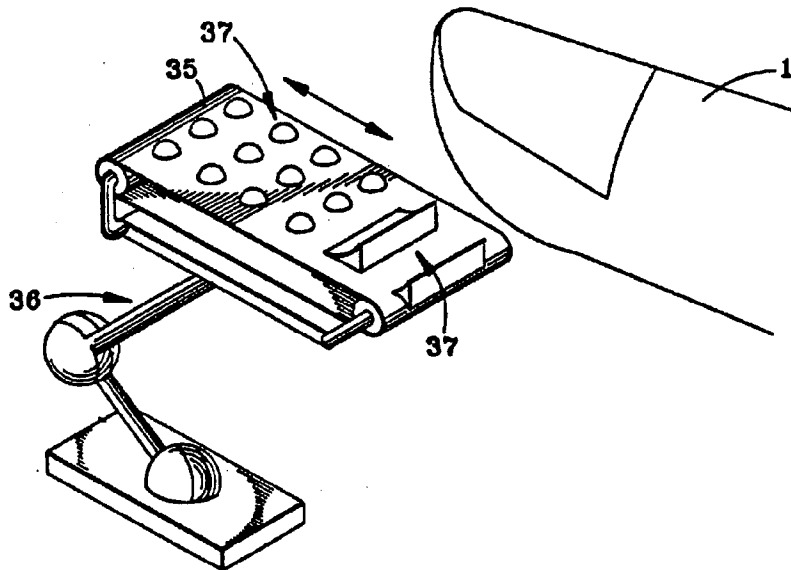
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<p>(51) International Patent Classification ⁶ : G06F 3/00</p>	<p>A1</p>	<p>(11) International Publication Number: WO 95/20787 (43) International Publication Date: 3 August 1995 (03.08.95)</p>
<p>(21) International Application Number: PCT/US95/01226 (22) International Filing Date: 27 January 1995 (27.01.95) (30) Priority Data: 08/187,646 27 January 1994 (27.01.94) US (71) Applicant: EXOS, INC. [US/US]; 2A Gill Street, Woburn, MA 01801 (US). (72) Inventors: CHEN, Elaine; 70 Park Street, Somerville, MA 02143 (US). EBERMAN, Brian; 264 Willow Avenue, Somerville, MA 02144 (US). MARCUS, Beth, A.; 78 Woburn Street, Lexington, MA 02173 (US). (74) Agent: PASTERNAK, Sam; Choate, Hall & Stewart, Exchange Place, 53 State Street, Boston, MA 02109 (US).</p>		<p>(81) Designated States: CA, JP, MX, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>

(54) Title: MULTIMODE FEEDBACK DISPLAY TECHNOLOGY



(57) Abstract

A system for providing haptic information to a human operator. The system utilizes display devices that dynamically convey touch sensations to the human operator, thereby creating various tactile sensations such as texture and slippage. The system can combine multiple display devices as needed in order to create a specified sense.

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MULTIMODE FEEDBACK DISPLAY TECHNOLOGY

The present invention relates generally to a system for providing haptic information to the human body. Haptic or tactual perception, commonly referred to as the "sense of touch", is actually composed of two parts: the cutaneous sense and kinesthesia [Loomis & Lederman, 1986]. The cutaneous sense mediates awareness of stimulation at the skin, while kinesthesia provides information on body parts. Conscious experience of mechanical cutaneous stimulation is known as "tactile perception".

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Background

The sense of touch, of haptic sense, is complex. Unlike vision, touch involves a direct physical interaction, so that human actions cause and change what is perceived. It is the fundamental role of touch to sense the results of these contact interactions in order to guide manipulation and body motion. The current art only contains devices for presenting a crude tactile image to a location on the body. This type of information represents only a fraction of the total information sensed by the human sense of touch. Many different types of basic information about the contacts are extracted by people through a combination of four different tactile sensory systems, measurement of joint motion, and measurement of joint torques. This basic information can be organized broadly into passively acquired information and actively acquired information. Passively acquired information can be gathered without relative motion between the body and an object and without varying the forces between the body and the object. Actively acquired information requires either relative motion or varying contact forces. A summary of some of the basic types of cues or sensed information is given below.

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Passively acquired identification cues

Passively acquired identification cues can be obtained by the act of holding an object in the hand. The inventors herein have identified three major cues in this category.

- 5 1. Determining the local contact normal and curvature of the surface at each contact.

Determining the local contact curvature and labeling it as a point, edge, or planar contact is important for grasp acquisition and object identification. Different contact types have different grasp properties which affect stability [Salisbury, 1985]. In addition, the local contact normal and curvature provide a strong pruning heuristic rule for identifying objects and object pose; Grimson, W.E.L., *Object Recognition by Computer: The Role of Geometric Constraint*, MIT Press, Cambridge, MA (1990). Local object curvature can be measured passively by examining the normal contact force distribution.

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2. Determining the surface texture at each contact.

Surface texture affects grasp stability. Rough textures are generally easier to grasp than smooth textures. In addition, surface texture can also be used as a pruning heuristic rule in identifying objects and object pose. Texture cues are produced both from the spatial distribution of the contact force and the dynamic vibration effects produced at the skin during motion.

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3. Gross object shape.

By using the finger geometry and the location of the contact points in the hand, the shape of the object can be estimated. For example, an initial grasp might be a power grasp in order to get a lot of contact information about an object. Once the object and its shape is identified, a dexterous grasp might be used for manipulation.

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Actively acquired identification cues

With some local active exploration, properties relating the reaction forces to the applied force can also be determined:

- 5 1. Determining the local stiffness at each contact.

The local surface stiffness can be estimated by applying varying normal forces and measuring the change in contact area. Softer surfaces will produce a larger contact area for a given applied force. This is not a significant cue for manipulation of control surfaces and tools since almost all of the objects involved are rigid.

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2. Determining local frictional properties.

The local friction along with the local contact type control the local grasp stability. Friction can be measured by applying varying tangential forces and then detecting the onset of slip (slip detection is a separate basic manipulation cue; see next Section). This task also requires the ability to measure tangential forces.

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3. Overall object stiffness.

By integrating the contact force over an area with the joint torques, and correlating this with joint deflection, the overall object stiffness can be computed.

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4. Detecting slip.

Detecting the onset of slip between an object and the hand is essential for grasp maintenance. Slip detection is used to determine the necessary grasp forces at each contact during all stages of manipulation.

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5. Determining object mass (weight), center of mass, and moments of inertia.

By manipulating a grasped object and measuring the resulting joint torques and net contact forces at the hands for different configurations, the weight, center of mass and moments of inertia of

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the object can be computed. This information can be used for object identification and pose determination, Siegal, D.M., *Pose Determination of a Grasped Object Using Limited Sensing*, Ph.D. Thesis, Department of Electrical Engineering, MIT, Cambridge, Massachusetts (1991), as well as for computing the necessary torques for throwing or manipulating the object.

6. Estimating directions of contact constraint.

Assembly is the process of bringing a moving part into a constrained relationship with a fixed part. In order to control the assembly process, the directions in which movement is constrained need to be estimated. Contact constraints are estimated using measurements of the reaction forces as a function of position and by measuring the direction of impact forces.

7. Detecting changes in contact constraints.

This is one of the most common tasks during manipulation. The detents in switches, the termination in screws, the impacts from mating two parts are all examples. The onset of the change can be detected by looking for unexplained impact forces and the direction of the impact force.

Review of Haptic Devices

Position and Orientation Devices

Devices and systems are well known for measuring or monitoring one or more characteristics of an anatomical part (see for example U.S. Patent Nos. 4,986,280, 3,258,007 and 3,364,929). A human controlled position sensing device for use in the field of robotics is also well known (see for example, U.S. Patent Nos. 4,328,621, 4,534,694, 4,608,525, and 4,674,048).

Force Devices

Systems are also well known for providing force feedback to human operators. Force-reflective devices exist in a variety of forms, from joysticks to arm and hand controllers. These devices serve as input devices and haptic interfaces for virtual environment manipulation, or teleoperation.

While joysticks are probably the oldest of the haptic interface technologies and were originally conceived to control aircraft, many joysticks currently developed are being used for the control of remote manipulators. AT&T Bell Laboratories has developed a high performance, compact force-feedback joystick. It was intended to support engineering, business, and scientific desktop computing applications. It is 7x4.5x3 inches in size, weighs approx. 2lbs, can apply 75 grams force to the end of the joystick (2 inches long), and can run at over 200 Hz. Its use has been demonstrated for navigating through an electronics CAD database by setting the force to have a step jump at the edge of each trace. It is fast enough to allow the users to feel textures, and provides enough force to give a good range of levels for different conditions.

A significant amount of research has been conducted on robot hands, Salisbury, J.K. and Mason, M.T., *Robot Hands and the Mechanics of Manipulation*, MIT Press, Cambridge, Massachusetts (1985), and force-reflecting controllers, (e.g. Bejezy and Salisbury, 1983, Agronin, 1987) for robot arm manipulation. These controllers can be anthropomorphic but are often tailored to the slave robots and imitate their kinematics. The advantage of controllers that imitate the kinematics of the human hands and arms is that they have the largest user range of motion. However, it is difficult to achieve high quality force feedback with these controllers and minimizing actuator size becomes a major design requirement. The Stanford/JPL 6 DOF hand controller is an example of a compact non-anthropomorphic force reflecting arm master. Sargent Industries/CRL manufactures a variety of master-slave manipulators for use in hazardous

environments. Though their systems do provide force feedback, they are large, non-anthropomorphic, and are not meant to be portable. Similarly, Schilling Development, Inc. produces the TITAN 7F, and the GAMMA 7F, both of which are 6-4 Titanium constructed servo, hydraulic master/slave systems. The GAMMA 7F allows operation in radioactive environments. However, the force-feedback versions are still under development, and the master controllers are only semi-anthropomorphic.

One complete anthropomorphic system (Jacobsen 1989) uses high performance hydraulic actuators to provide force-reflection for 7 DOF up to and including the wrist, with more DOF's in the gripper (Sarcos, 1991). The device has a large range of force exertion at a relatively high bandwidth. However, it is bulky and also very expensive. Two other anthropomorphic teleoperation systems include the Force-Reflecting Hand Controller (FRHC) (McAffee et al.), and the Odetics exoskeleton (Burke, 1991). Both use steel cables to reflect forces and moments and remotely locate the motors. The FRHC provides motion in 6 DOF while the Odetics exoskeleton uses 7 DOF to represent the human arm. However, these systems are still not portable force-feedback devices. Iwata (Iwata 1990) describes a system for the thumb, two fingers and the palm. The palm is actuated by a six degree-of-freedom parallel stage driven by electric motors. Each of the two fingers and thumb has single DOF motion and is also driven by electric motors. This system can transmit large forces to the hand and fingers, but is limited to pinch type grasps because of the single DOF plates for the fingers.

Burdea, Zhuang, and Roskos (1991) describe a system based on pneumatic cylinders and the VPL dataglove. This system generates forces using pneumatic cylinders placed between the inside of the palm and the fingertips. The system is compact and lightweight, but at present can only simulate grasp forces between the palm and the fingertips. Contact of the fingers with objects supported externally cannot be simulated. While many

forms of force-feedback devices have been developed, not many complete anthropomorphic systems exist. Of the anthropomorphic arm systems, the main disadvantage is their bulkiness and non-portability.

5 Tactile Devices

Tactile devices are also well known and fall into five basic categories. Tactile displays have been the subject of much research activity in the past thirty years. While neuroscientists studied the physiological roots of human tactile perception, engineers were interested in tactile display devices that substituted or augmented other senses such as sight and hearing. Tactile displays also demonstrated their usefulness in VR simulations and telerobotic operations by EXOS TouchMaster which utilized buzzers to display contact information of objects. To design a high performance force reflective exoskeleton master, tactile displays might provide the teleoperator with additional information such as contact locations that could not be adequately displayed by force alone. Or tactile displays might simplify the requirement on force reflection. It was conceivable that a combination of tactile display and force reflection would be haptically more effective, technically less challenging and economically more feasible than force reflection alone.

20 The following paragraphs present an overview of tactile display technologies and their applications developed in the past thirty years.

Air or water jet displays

Not all tactile displays make mechanical contact with the skin. Air or water jet displays are attractive because they eliminate the need for moving mechanical parts and because they exhibit a consistent frequency response. Air jet arrays were extensively tested by Bliss, J.C., Crane, H.D. and Link, S.W., *Effect of Display Movement on Tactile Pattern Perception*, Perception and Psychophysics, 1:195-202, (1966), and Bliss, J.C., Crane, H.D., Mansfield, P.K. and Townsend, J.T., *Information Available in Brief Tactile*

Presentations, Perception and Psychophysics, 1:273-283 (1966) in different configurations with applications in vision substitution Bliss, J.C., Crane, H.D. and Link, S.W., *Effect of Display Movement on Tactile Pattern Perception*, Perception and Psychophysics, 1:195-202, (1966), Rogers, 5 C.H., *Choice of Stimulator Frequency for Tactile Arrays*, IEEE Transactions on Man-Machine Systems (special issue), MMS-11(1) (March, 1970) and as a user interface in tracking experiments, Hill, J.W., *A Describing Function Analysis of Tracking Performance Using Two Tactile Displays*, IEEE Transactions on Man-Machine Systems (special issue), MMS-11(1) (March, 10 1970). Steerable air and water jets were also investigated as a "substitute cathode ray tube", tracing cursive letters or figures or re-creating a visual image in a raster scanned format on the skin, Bliss, J.C., *Tactual Perception: Experiments and Models*, Stanford Research Institute, Menlo Park, California, Final Report, Technical Report AFAL-TR-66-242, 15 Contracts AF33(615)-1099 and NAS2-2752, SRI Projects 4719 and 5438 (July, 1966), and Collins, C.C. and Madey, J.M.J., *Tactile Sensory Replacement*, Proceedings of the San Diego Biomedical Symposium, pp. 15-26 (1974).

20 Air or water bladder displays

Air or water bladder displays are used to apply a continuous pressure on an area of skin. An example is the TELETACT device (Air Muscle Ltd), which consists of an elastic lycra glove lined with approximately twenty air pockets fed by microcapillary tubes, Stone, R.J., *Advanced 25 Human-System Interfaces for Telerobotics Using Virtual Reality and Telepresence Technologies*, Proceedings of the International Conference on Advanced Robotics, Pisa, Italy, 168-173 (June, 1991). This glove may be worn inside measurement devices such as the Mattel Power Glove or the EXOS Dextrous HandMaster (DHM) when interacting with a virtual

environment. Air pockets generally suffer from extremely low bandwidth (order of 1Hz) because of the elasticity of the bladder material.

Mechanical tactor elements or arrays that impact or indent the skin

5 This group of displays include most of the vibrotactile devices described in the literature in addition to a few displays operated at a very low frequency that would not normally be considered vibrotactile (such as the tactile interface for IBM graphics described by Frisken-Gibson, S.F., Bach-y-Rita, P., Tompkins, W.J. & Webster, J.G., *A 64 Solenoid, Four*
10 *Level Fingertip Search Display for the Blind*, IEEE Transactions on Biomedical Engineering, BME-34:963-965 (1987).

 While there are a few single-element display devices (see Goldstein, M.H. and Proctor, A., *Tactile Aids for Profoundly Deaf Children*, Journal of the Acoustical Society of America, 77:258-265 (1985), Terry, J.A. and
15 Hsiao, H., *Tactile Feedback in a Computer Mouse*, Proceedings of the Fourteenth Annual Northeast Bioengineering Conference, p. 146-149 (March, 1988)), the vast majority of mechanical tactile displays involve tactor arrays. The number of elements in these arrays run from two (such as the stump-mounted upper-limb prosthesis elbow angle display developed
20 by Mann, R.W. and Reimers, S.D., *Kinesthetic Sensing for the EMG Controlled "Boston Arm"*, IEEE Transactions on Man-Machine Systems (special issue), MMS-11:110-115 (1970) to 400 (such as the 20x20 back mounted array of solenoid activated tactors used by White, B.W., *Perceptual Findings with the Vision-Substitution System*, IEEE Transactions
25 on Man-Machine Systems (special issue), MMS-11:54-58 (1970), and Collins, C.C., *Tactile Television - Mechanical and Electrical Image Projection*, IEEE Transactions of Man-Machine Systems, MMS-11, 58-65 (1970).

 Almost all of the devices in this group involve indenting or impacting
30 the skin perpendicular to the skin surface. Two methods of actuation

dominate these displays: solenoid activated pins and cantilevered piezoelectric bimorph reeds with a pin mounted to the tip. The OPTACON is an extremely well known piezoelectric bimorph activated vibrator array developed by Bliss et al (1970). It is a small 1.1x2.7cm display with a

5 matrix of 6x24 tactors, and can be operated from 12.5 Hz to 250Hz. It was originally designed to serve as a reading aid for the blind in conjunction with an optic probe which digitizes the information in printed text, but due to its versatile design it was used extensively as a research tool by a variety of researchers (such as Wiker, S.F., Vanderheiden, G., Lee, S. and Arndt, S.,

10 *Development of Tactile Mice for Blind Access to Computers, Importance of Stimulation Locus, Object Size, and Vibrotactile Display Resolution*, Proceedings of the Human Factors Society , 1: 708-712 (1991). The OPTACON is now commercially available from TeleSensory Systems. Another method of actuation that has great potential is the use of shape

15 memory alloys (SMA). As a current is passed through the alloy, it changes shape and deflects a spring that holds a tactor pin in place; Johnson, A.D., *Shape Memory Alloy Tactical Feedback Actuator*, No. AAMRL-TR-90-039 (available through NTIS), TiNi Alloy Co., Inc., Oakland, California, under sponsorship of Harry G. Armstrong Aerospace Medical Research

20 Laboratory, Wright-Patterson AFB, Ohio (August, 1990), and McCarty, L.H., *Special Alloy is Key to Braille Computer Display*, Design News (Boston), 46(3):158-159, (February 12, 1990). TACTOOLS is a commercial tactile feedback product available from Ztensory Inc. for use in teleoperation and virtual reality (VR) applications. The same product is also

25 available from Mondo Tronics.

Voice coil displays

These displays generate vibratory sensations by mounting a voice coil against the skin. Examples are found in Patrick, N.J.M., Sheridan, T.B.,

30 Massimino, M.J., Marcus, B.M., *Design and Testing of a Non-Reactive,*

Fingertip Tactile Display for Interaction with Remote Environments, SPIE Vol. 1387 Cooperative Intelligent Robotics in Space, 215-222 (1990), and Patterson, P.E. and Katz, J.A., *Design and Evaluation of a Sensory Feedback System that Provides Grasping Pressure in a Myoelectric Hand*, 5 Journal of Rehabilitation Research and Development, **29**(1):1-8, (Winter, 1992). The *TouchMaster* is a voice-coil based tactile feedback device manufactured by EXOS.

Electrotactile displays

10 Electrotactile displays elicit touch sensations by indiscriminately stimulating all the touch and pain sensors in the skin with a current passing through the skin. These devices usually involve a remote stimulator (which supplies the power and generates the stimulation waveform) and a number of electrodes mounted on the skin using a sticky dielectric. Each electrode pair 15 constitutes a stimulation site. While some systems involve single or a small number of isolated electrode pairs (such as the functional electrical stimulation feedback system developed by Rutherford, K.M., Riso, R., and Neuman, M.R., *A Finger Mounted Force Sensor for Use with an FNS Hand Grasp System*, Proceedings of the IEEE 9th Annual Conference of the 20 Engineering in Medicine and Biology Society, pp. 1757-1758, arrays of electrodes were also popular, with number of elements running up to 1024 in one instance, Collins, C.C. and Madey, J.M.J., *Tactile Sensory Replacement*, Proceedings of the San Diego Biomedical Symposium, pp. 15-26 (1974).

25 Large arrays with electrotactile displays are achieved by using small, closely spaced concentric electrode pairs in a grid, Collins, C.C. and Madey, J.M.J., *Tactile Sensory Replacement*, Proceedings of the San Diego Biomedical Symposium, pp. 15-26 (1974). When the stimulation sites are few and sparsely distributed, a large common anode could be placed at a 30 distance from the stimulation sites. The *TICKLETALKER*, Alcantara, J.I,

Blarney, P.J., and Clark, G.M., *Tactile-Auditory Speech Perception by Unimodally and Bimodally Trained Normal Hearing Subjects*, Journal of the American Academy of Audiology, 4(2):98-108, (March, 1993) is one such device, in which 8 cathodes are mounted on four metal rings worn on each
5 of the four fingers, and a large anode is mounted on the wrist.

Current tactile feedback devices present a flat contact image using either arrays of tactors or raster scan techniques. This type of display can only be used for very local shape display or textures, and is limited to a flat type of display. Current force display devices can improve this situation
10 when used in combination with tactile feedback, however the force displays have often geometrically limited the applicability of tactile displays. The concept of multimode feedback, that is the combination of one or more haptic modes in a single system, was developed specifically to overcome the limitations of the prior art.

15

Summary of the Invention

It is therefore a general object of the current invention to provide a set of technologies and a method of providing touch or haptic information.

It is a more specific object of the current invention to provide a set of
20 technologies and a method which can be used to present critical information either separately or in combination.

Another specific object of the current invention to provide a set of technologies and a method which can be used to present haptic cues either separately or in combination.

25 And another specific object of the current invention is to provide a strategy for coordinating multiple feedback modes such as force and tactile.

Yet another specific object of the present invention is to provide a haptic display which provides a continuous range of forces to the skin.

Yet another specific object of the present invention is to provide a haptic display which provides a time varying texture through relative tangential motion between the device and finger.

These and other objects of the present invention are achieved by a
5 system for displaying multimode feedback to an operator. The system comprises:

- A device for displaying tactile information to a body part;
- Means for tracking the position and orientation of the body part;
- Means for applying forces to the body part;
- 10 Means for implementing a multidimensional control strategy; and
- Sensors for sensing body forces.

Other objectives of the invention will in part be obvious and will in part appear hereinafter. The invention accordingly comprises an apparatus
15 possessing the construction, combination of elements, and arrangements of parts which are exemplified in the following disclosure, and the scope of the application of which will be indicated in the claims.

Brief Description of the Drawing

20 Figure 1a and Figure 1b are block diagrams of the preferred computerized system for obtaining and storing sensory information, controlling the displays, and communicating with other computers involved in the application;

- Figure 2 is an overview of the preferred haptic display unit;
- 25 Figure 3 is a detail of the slip display element;
- Figure 4 is a concept sketch of an activated trackball based display;
- Figure 5 is a concept sketch of a two-degree-of-freedom roller display;

30 Figure 6 is a concept sketch of an endless belt with various surface features mounted on a six degree-of-freedom mini-manipulator display;

Figure 7 is a concept sketch of a display consisting of several actuated thimble rings with internal features;

Figure 8 is a concept sketch of a rotating solid cylinder with different surface features at different angular positions;

5 Figure 9 is a concept sketch of a display consisting of a rotating, flat slotted disk with an articulated linkage;

Figure 10 is a concept sketch of a display with a piezoelectric bimorph actuator element mounted on top of a linear piezoelectric actuator element;

10 Figure 11 is a concept sketch of a display in which steel pins are deflected by a varying magnetic field set up by an electromagnet array;

Figure 12 is a block diagram and flow chart of the local processor as it interacts with the world modeling computer.

The same numeral are used throughout the drawings to designate the
15 same or similar parts.

Description of the Preferred Embodiment

The present invention generally relates to a system and method for providing touch feedback to the human operator and is adapted to have at
20 least two applications. The system is useful in the control of computer generated or virtual environments and of real or robotic environments. (See Figures 1a and 1b.)

In the preferred embodiment as shown in Figures 2 and 3, four sense and display elements were used; slip on the finger tips, force feedback to the
25 index finger and thumb, variable frequency and amplitude vibrotactile displays to the fingertips (the EXOS TouchMaster) and vertical resistance. In addition the device provides position and orientation of each of the system elements. The reference numerals are defined as follows:

1. Index finger
- 30 2. Thumb

3. Tactile display (including slip and vibrotactile elements)
4. Slip display motor
5. Vibrotactile display
6. Modified two-degree-of-freedom SAFiRE providing force feedback to
5 the index finger
7. Proximal linkage of the modified two-degree-of-freedom SAFiRE.
8. Distal linkage of the modified two-degree-of-freedom SAFiRE.
9. Cable conduits on the modified two-degree-of-freedom SAFiRE.
10. Motor package for the index finger and thumb force reflection
10 mechanisms
11. Thumb force reflection device
12. Strap mounted bracket for haptic feedback device
13. Mounting bracket for haptic feedback device
14. Proximal passive pivot
15. 15. Horizontally mounted linkage
16. Distal passive pivot
17. High resolution encoder
18. Front linear way
19. Front sliders
20. 20. Front slider mounting plate
21. Second vertical cable
22. Set of idler pulleys
23. Motor actuating vertical degree-of-freedom through a cable system
mounted on the rear slider
25. 24. Vertical support structure
25. Heavy base
26. Textured delrin surface
27. Miniature bearing
28. Set screw
30. 29. Mounting bracket for the slip and vibrotactile display elements

- 30. Finger strap
- 31. Activated trackball
- 32. Pinch rollers for driving the trackball
- 33. Flat surface on trackball
- 5 34. Two-degree-of-freedom roller
- 35. Endless belt
- 36. Six-degree-of-freedom roller
- 37. Surface features on the belt
- 38. Actuated thimble
- 10 39. Independently actuated thimble rings
- 40. Internal features inside thimble rings
- 41. Indexing cylinder
- 42. Surface features at different angular positions on the indexing cylinder
- 43. Slotted flat disk
- 15 44. Actuated, articulated linkage
- 45. Piezoelectric bimorph actuator element
- 46. Linear piezoelectric actuator element
- 47. Steel pins
- 48. Array of electromagnets

20 In this embodiment a simple slip display 3 was developed. This slip display 3 consists of a delrin cylinder 26 with a textured surface, directly mounted on the shaft of a miniature gear motor 4. The cylinder 26 is supported on the other side with a miniature bearing 27. The motor is held by a set screw 28 in the mounting bracket.

25 The motor 4 was powered by a linear motor amplifier (not shown) and controlled by an MC-series Motion Controller board (Motion Engineering Inc., CA.)(not shown). The major specifications for the slip display and the associated experimental setup are: the slip display must be able to provide endless slip; it must be able to overcome the friction
30 imposed by the normal contact force (up to 2 lb) between the fingertip and

the force display; the maximum attainable speed of slip should be around 1 in/sec; the weight of the slip display should be less than 0.5 lb.

A voice coil vibrotactile display 5 which is comprised of a small magnet mounted in a shaped plastic housing. When excited by the control electronics it produces a variable frequency variable amplitude vibration to the housing. In the preferred embodiment this display 5 was attached to the mounting block of the slip display 3, and thus provides a vibratory stimulus to the fingertip.

The slip display 3 was attached to the tip of each of the index finger force feedback apparatus 6 and the thumb force feedback apparatus 11. Force reflection to the index finger 1 is provided by a modified two-degree-of-freedom SAFiRE (U.S.S.N. 07/961,259, filed October 15, 1992, entitled "Sensing and Force reflecting Exoskeleton") prototype, which consists of two cable-driven linkages, with the two motors 10 mounted on the forearm. The axes of rotation of the linkages are co-located with the PIP and MCP joints of the index finger. Force reflection to the thumb is provided by a one-degree-of-freedom device, also driven by cables from a remotized motor mounted on the forearm.

The vertical resistance and position and orientation in space is provided by a boom. The vertical force reflection axis provided up to 2 lbs of virtual weight at the hand. It also supported the weight of the SAFiRE through counterbalancing. The stiffness of the vertical boom up to the SAFiRE attachment bracket exceeded 140 lb/in, the minimum stiffness required for a cantilevered beam to feel rigid to a human operator, Tan, B.T., *Sensor Application to Space-Suit Glove*, Tactile Sensors for Robotics and Medicine, J.G. Webster (Ed.), John Wiley and Sons, New York, 331-340 (1988). The resolution of the vertical and horizontal position sensors for the hand and index finger was 0.005 inch. Two linear ways were mounted on opposite sides of the vertical support structure, which was rigidly attached to a heavy base.

The drive mechanism for the vertical degree-of-freedom was located on the back of the support structure. The motor providing vertical force reflection was horizontally mounted on the slider riding in the rear linear way. A threaded capstan was directly mounted on the shaft of the motor 23.
5 A 7x7, 0.032 inch diameter steel cable was wound 3-4 turns around the capstan. One end of the cable was terminated at the bottom of the vertical support structure. The other end was terminated on a cable tensioner at the top of the structure. As the motor rotated, the cable hoisted the slider up and down the rear linear way.

10 The rear slider was connected through a second cable and a set of pulleys to a plate mounted on two sliders riding in a second linear way 18, mounted on the front side of the vertical support structure. Using two sliders instead of one greatly improved the twisting and bending load capacity of the front linear way. The two sliders were mounted on the plate
15 through two pivots to minimize bending moments applied to the front linear way.

Vertical forces were transmitted to the SAFiRE by a horizontally mounted linkage. The linkage consisted of a distal block attached to the front slider plate 20, proximal block, and a 12 inch long rod. The distal
20 block housed the bearings and the encoder for the first passive pivot, also called the distal pivot. One end of the rod was pivoted about this block so that the linkage rotated freely in the horizontal plane. The other end of the rod was pivoted about a second bearing/encoder housing, also called the proximal pivot 14. The proximal mounting block was attached to the
25 SAFiRE base with a rigid bracket. The length of this bracket was designed to position the hand so that the proximal pivot was between the tip of the index finger and the thumb.

The motor for vertical force reflection was selected based on the power requirements. We would like the motor to produce a force of 2 lbs at
30 the hand. We also estimated that the hand could move at a maximum

vertical speed of 8 in per sec. We selected 90W motor without a gearhead to provide a smooth operation with minimal friction. The HEHD is designed to produce a force of 2 lb. at the fingertip. The tactile display must produce a force that exceeds the corresponding frictional force, if the frictional coefficient between the finger and the display is estimated at 0.5, the tactile display must be able to produce 1 lb. of force. If the display moved past the finger at 1 in/s, the required power would be around 0.112W. A motor producing 0.25-0.5 W would therefore be a suitable actuator for this display. The MicroMo Series 1016 motor fits these requirements; it is 0.384 inch in diameter, 0.63 inch long and weighs 0.23 oz. This is mounted in the space beyond the fingertip.

This touch display hardware is interfaced to the world model, in this case implemented on a graphics rendering PC, through a local processor, in this case a VME card cage which houses a TIC30 DSP board, I/O boards, and a Bit3 VME-ISA bus adapter.

The preferred embodiment is not the only viable implementation of the multimode feedback. Any one element, such as the slip display, when combined with position or orientation sensing becomes a multimode display and thus must use the strategy for coordination, in a simplified form. Each sense and display unit has the ability to provide haptic cues to the operator as do the following alternate embodiments. The alternate embodiments can be roughly classified into trackball ideas, roller and belt ideas, indexing ring/cylinder ideas, piezoelectrically actuated devices, magnetically actuated devices and other miscellaneous concepts.

Trackballs

The trackball (Figure 4) concepts involve frictionally driven balls. The trackball can have two degrees-of-freedom and can produce lateral skin stretch as well as a sense of slip. However, it can not represent the nature of contact geometry.

A variation on this theme involves cutting a flat surface on the ball. This would produce a plane as well as an edge on the ball depending on how it is oriented with respect to the fingertip.

5 Roller and belts

A single roller can represent endless slip in two directions. If the roller is rotated about the center of the fingertip, slip in any direction may be simulated. If it is pressed hard against the fingertip, lateral skin stretch may be induced (see Figure 5). A row of such rollers can represent slip as well as a rough simulation of a flat surface (as long as the rollers are small and closely spaced).

An endless belt 35 (Figure 6) may provide a better representation of a flat surface. If the endless belt can be rotated on its side, the edge of the belt can represent an edge. If the endless belt is mounted on a 6 degree-of-freedom miniature manipulator 36, it can represent slip and lateral skin stretch in any direction. Surface features may be built into the belt so that different textures are represented by different sections of the belt.

Indexing ring/cylinder

20 A thimble 38 (Figure 7) made of several rings 39 with internal ridges may be built. By lining up the ridges on different rings, edges with different orientations may be created under the fingertip. Rotating each ring will also present a sense of slip in a direction normal to the longitudinal axis of the finger.

25 Alternatively, a solid cylinder 41 (Figure 8) with different surface features at different angular positions may be built. By rotating the cylinder, different textures may be presented to the fingertip.

A third variant involves a flat disk 43 (Figure 9) with a slot down the middle of the disk. A miniature articulated linkage 44 may be raised from the slot to create a corner. When the linkage is retracted, a flat circular

30

surface will be presented. Spinning the disk will create a sense of slip. Adding a rotational degree of freedom will allow the disk to be tilted with respect to the fingertip.

5 Piezoelectrically activated devices

A piezoelectrically micromotor may be used to generate rotation in a small package. Alternatively, a deflecting piezoelectric actuator 45 may be mounted on top of a linear piezoelectric actuator 46 to produce a tiny manipulator that can push on the fingertip as well as drag it sideways for normal and lateral force representation (see Figure 10).
10

Magnetically activated devices

Using a complex magnetic field, ferrite dust may be made to form different shapes. Alternatively, by modulating the polarity and strength of an array of electromagnets 48, tiny steel pins 47 may be deflected to generate different shapes at the fingertip (see Figure 11).
15

Others

Other ideas include using a thermoelectric cooling chip mounted against the finger to act as a heat sink. Since most metals are cold to the touch, this artificially induced heat loss may generate an illusion of being in contact with metal.
20

Certain changes may be made in the above apparatus without departing from the scope of the invention involved herein. It is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted in an illustrative and not in a limiting sense.
25

CLAIMS

1. Apparatus for displaying tactile information to a body part comprising:
- 5 means for tracking the position and orientation of the body part;
 means for applying forces to the body part;
 means for implementing a multidimensional control strategy; and
 sensors for sensing body forces.
- 10 2. The apparatus of claim 1 wherein the means for implementing
the control strategy comprises;
 a mounting bracket;
 a rotatable textured cylinder mounted in the bracket; and
 a motor adapted to rotate the cylinder according to the control
15 strategy.
3. The apparatus of claim 2 further including a second haptic
display.

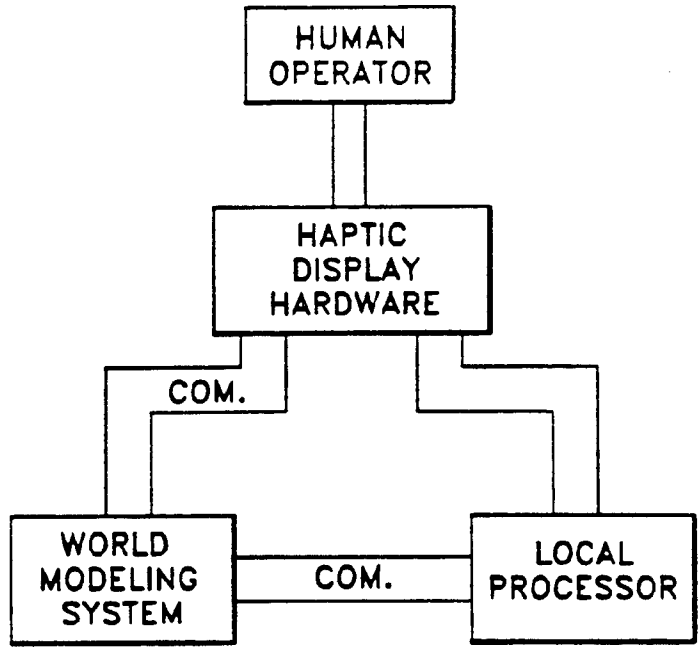


FIG. 1A

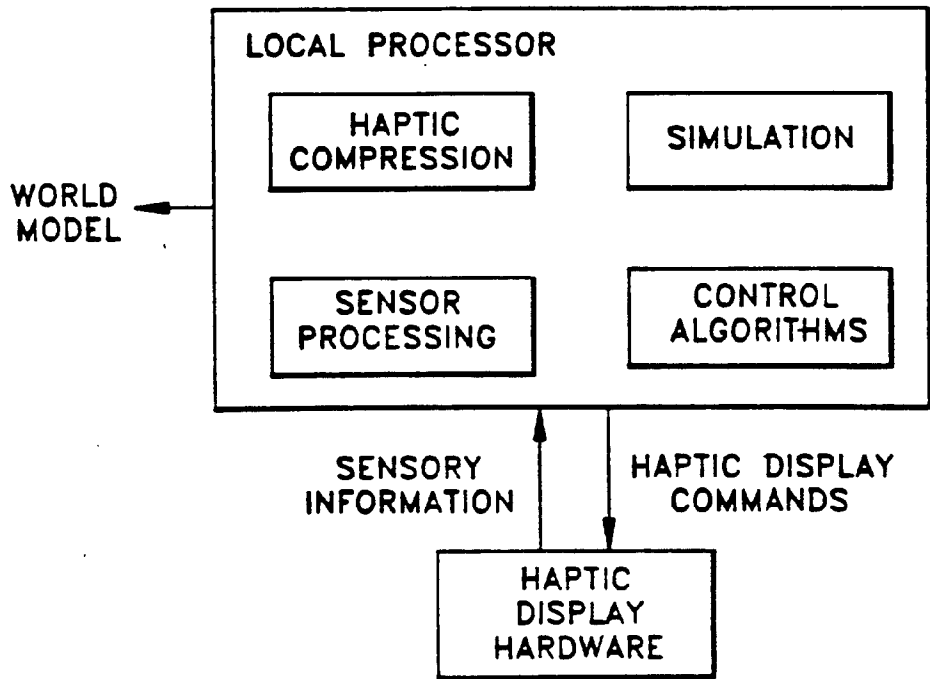


FIG. 1B

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SUBSTITUTE SHEET (RULE 26)

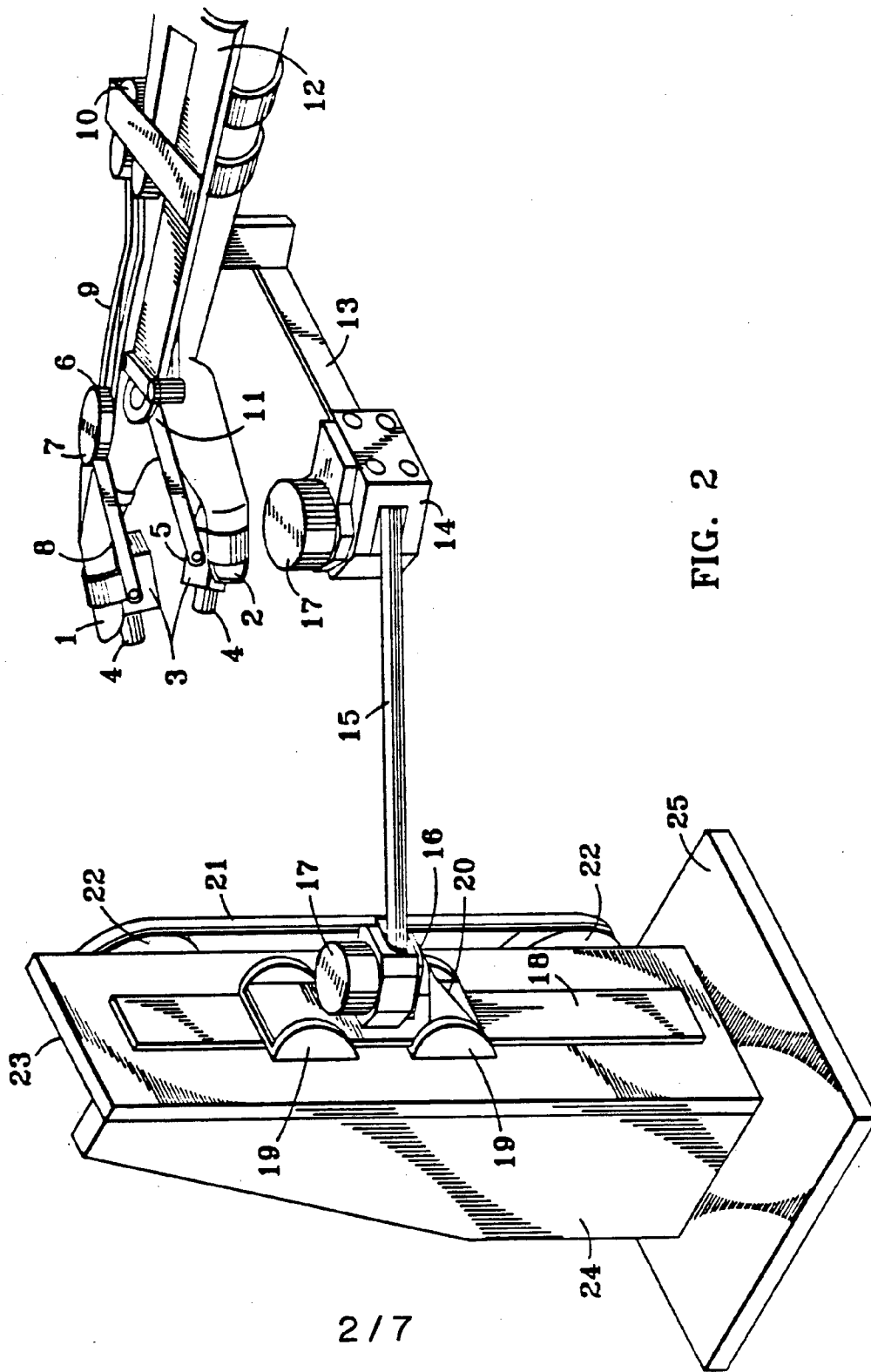


FIG. 2

FIG. 3

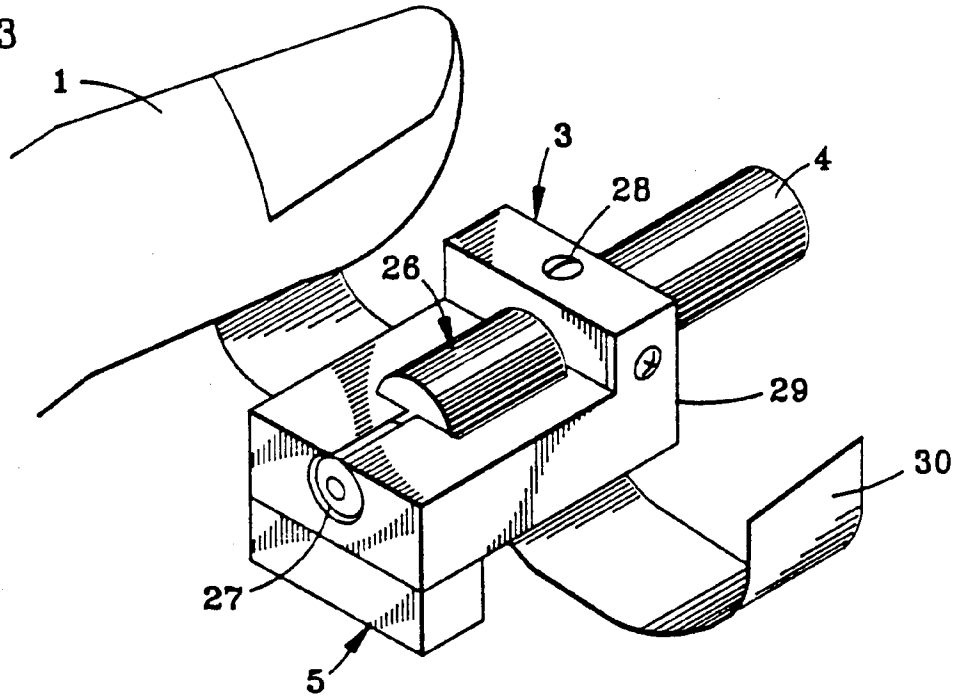


FIG. 4

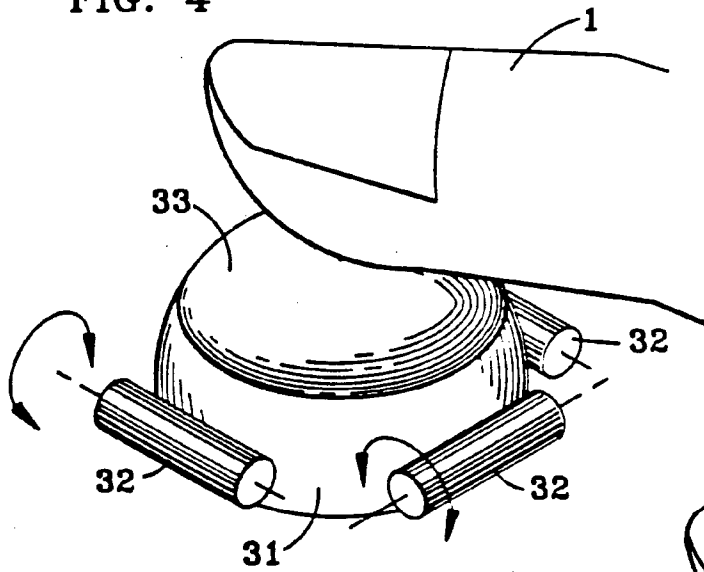
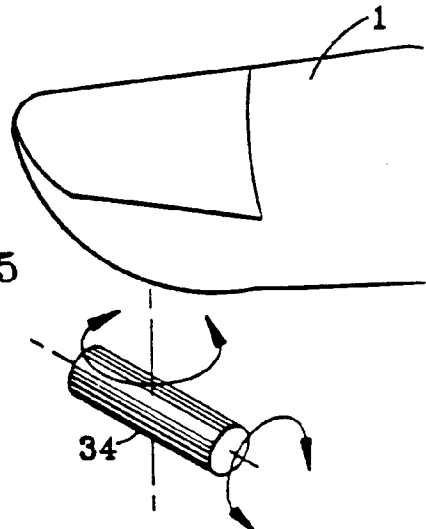


FIG. 5



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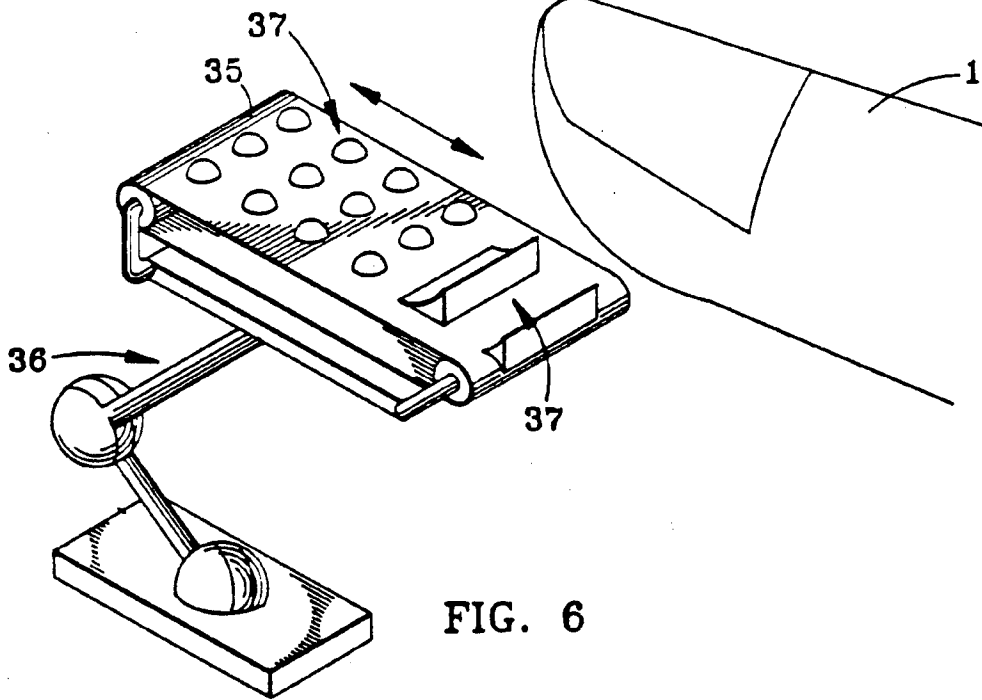


FIG. 6

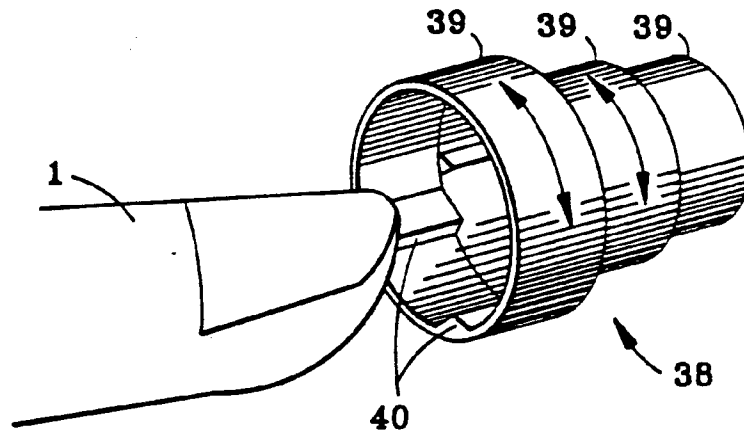


FIG. 7

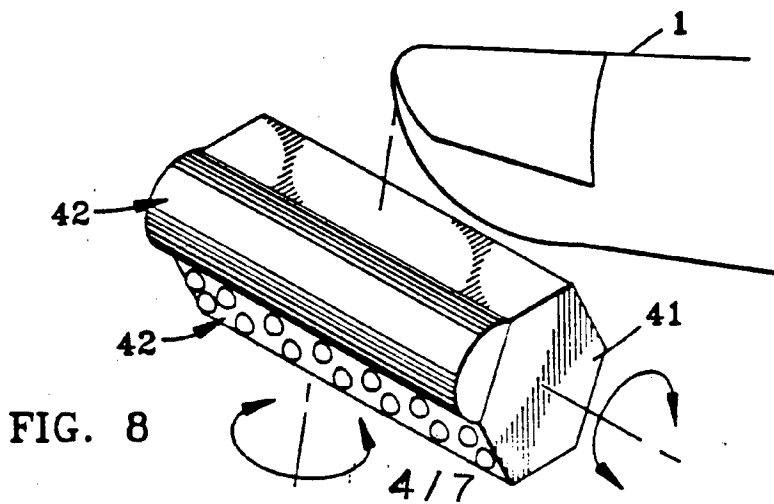


FIG. 8

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FIG. 9

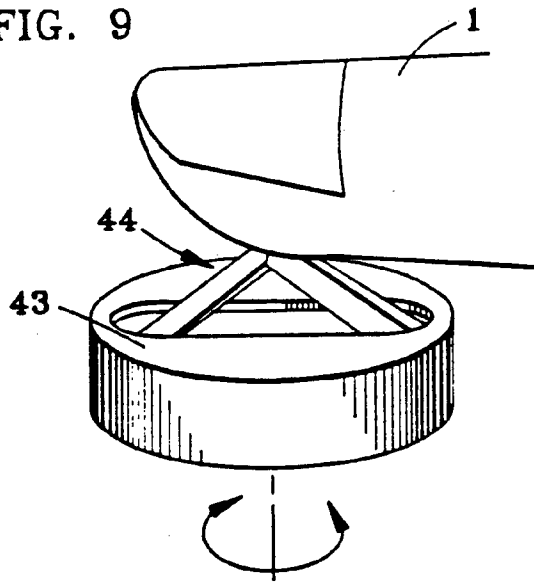


FIG. 10

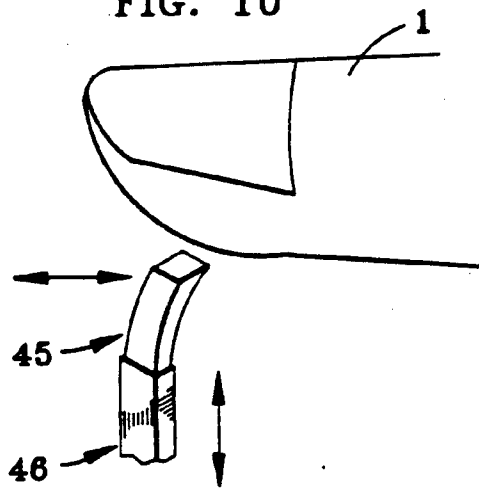
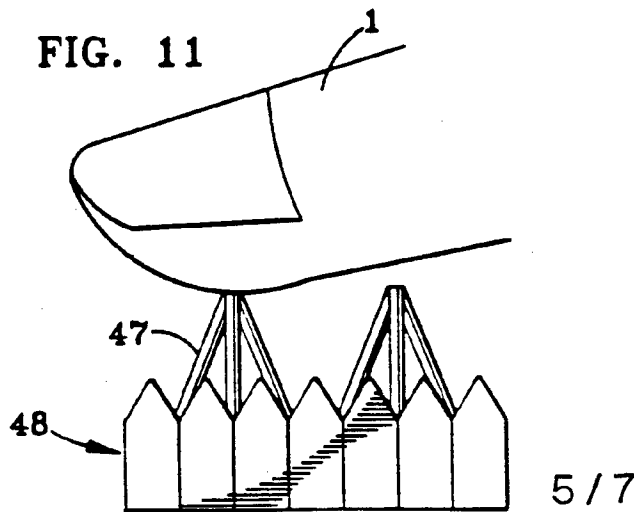


FIG. 11



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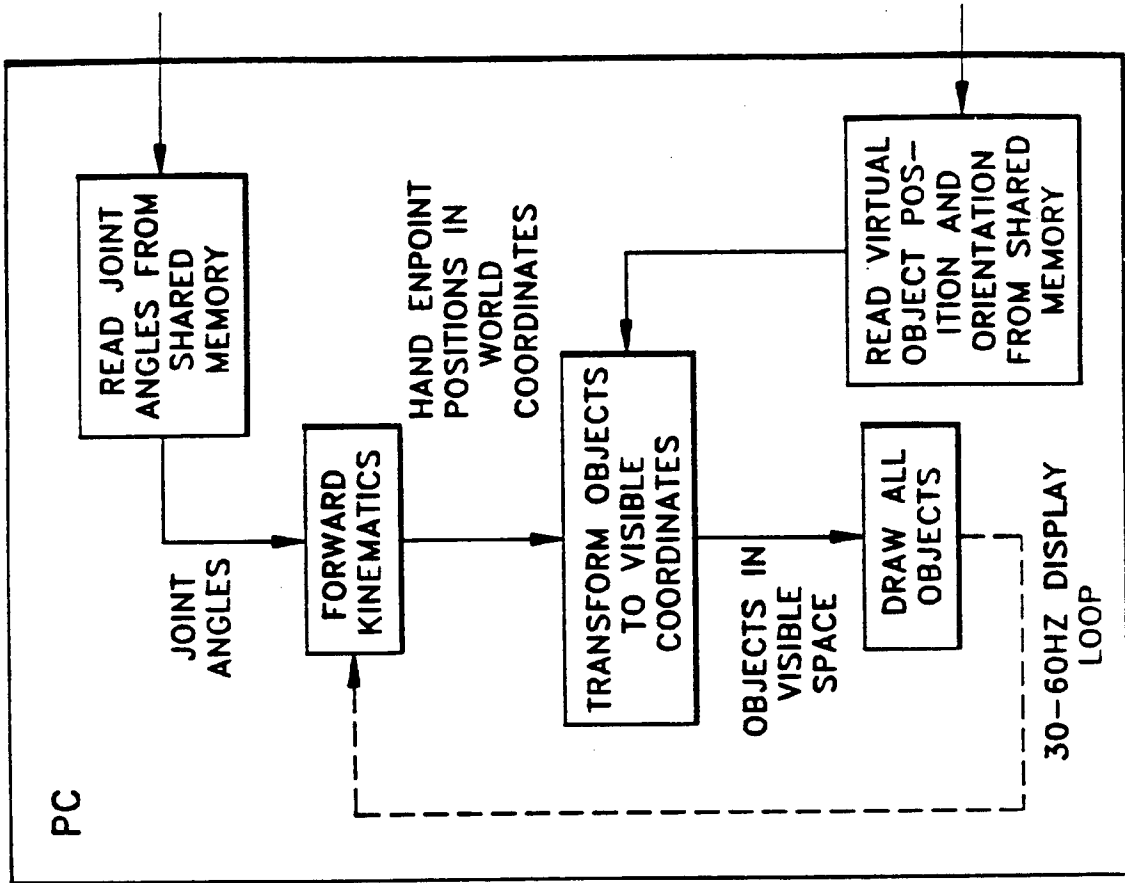
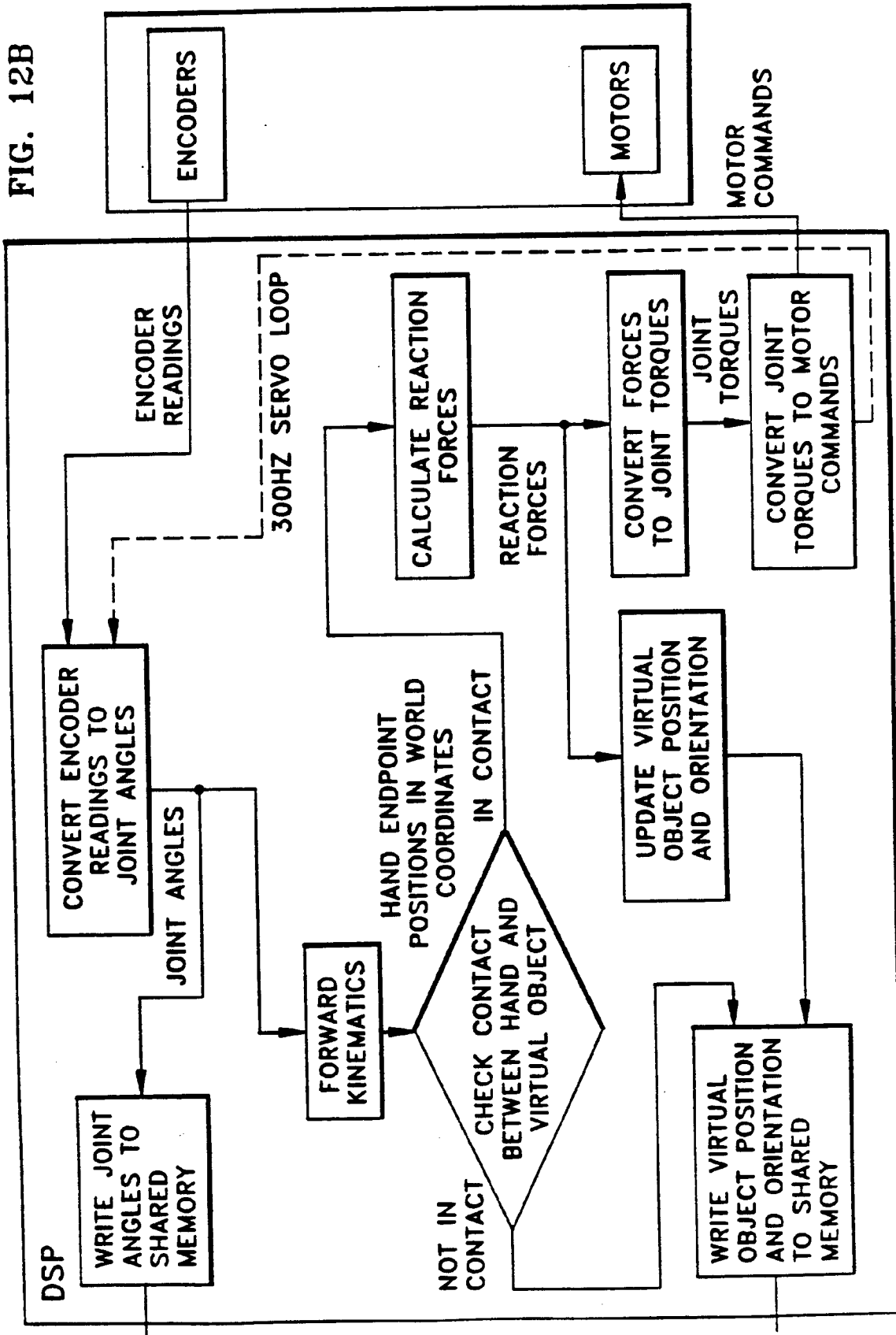


FIG. 12A

FIG. 12
FIG. 12A
FIG. 12B

FIG. 12B



INTERNATIONAL SEARCH REPORT

Inter. Application No
PCT/US 95/01226

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G06F3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G06F B25J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO,A,91 11775 (KRAMER JAMES F) 8 August 1991 see page 4, line 24 - page 5, line 34 see page 6, line 12 - page 7, line 13 see abstract	1
A	---	3
X	IEEE INTERNATIONAL CONFERENCE ON ROBOTICS AND AUTOMATION, vol. 1, May 1993 GA,USA, pages 955-960, CALDWELL D. G. ET AL 'Enhanced Tactile Feedback (Tele-Taction) using a Multi-Functional Sensory System' see page 955, left column, line 17 - page 958, right column, line 33	1
A	---	3
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Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search

19 May 1995

Date of mailing of the international search report

29.05.95

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INTERNATIONAL SEARCH REPORT

Inter. onal Application No
PCT/US 95/01226

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>IEEE VIRTUAL REALITY ANNUAL INTERNATIONAL SYMPOSIUM, 18 September 1993 SEATTLE, WA, pages 256-262, XP 000457695 HIROTA K. ET AL 'Development of Surface Display' see page 256, line 14 - page 257, line 16 see page 258, line 1 - page 259, line 11 see page 261, line 4 - line 21 -----</p>	1

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.
PCT/US 95/01226

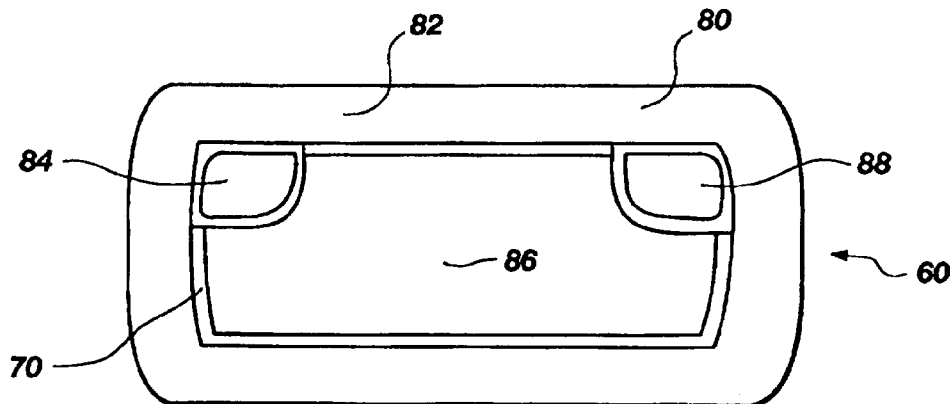
Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A-9111775	08-08-91	US-A- 5184319	02-02-93
		AU-B- 5752394	28-04-94
		AU-B- 649655	02-06-94
		AU-A- 7319991	21-08-91
		EP-A- 0513199	19-11-92



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification ⁶ : G09G 3/02</p>	<p>A1</p>	<p>(11) International Publication Number: WO 97/18546 (43) International Publication Date: 22 May 1997 (22.05.97)</p>
<p>(21) International Application Number: PCT/US96/18046 (22) International Filing Date: 12 November 1996 (12.11.96) (30) Priority Data: 08/556,614 13 November 1995 (13.11.95) US (71) Applicant: CIRQUE CORPORATION [US/US]; 433 West Lawndale Drive, Salt Lake City, UT 84115 (US). (72) Inventor: GERPHEIDE, George, E.; 433 West Lawndale Drive, Salt Lake City, UT 84115 (US). (74) Agents: THORPE, Calvin, E. et al.; Thorpe, North & Western, Suite 200, 9035 South 700 East, Sandy, UT 84070 (US).</p>		<p>(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).</p> <p>Published <i>With international search report.</i></p>

(54) Title: APPARATUS AND METHOD FOR TACTILE FEEDBACK FROM INPUT DEVICE



(57) Abstract

A method and apparatus for providing tactile feedback to a user moving their fingers across the touch-sensitive surface (80) of a touchpad or tablet (60). Different regions (82, 86) of the touch-sensitive surface (80) are differentiated from each other by providing different human perceptible textural surfaces within the regions (82, 86). A different texture provides immediate tactile feedback to a user through a finger making contact with the touchpad (60). Increased functionality is important because it solves problems which are inherent to small touchpad surfaces used as computer input devices to drag an object from one side of a display (20) to another without repeatedly raising a finger to repeat the dragging motion because of the limited surface area of the touchpad surface (60). Providing increased functionality such as a drag extend function solves the movement problem. The present invention then solves the problem of conveying to the user through touch, information about the location of the finger without having to look away from the display (20), thereby facilitating input and cursor manipulation for a computer (16).

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5

**APPARATUS AND METHOD FOR TACTILE
FEEDBACK FROM INPUT DEVICE**

10

BACKGROUND OF THE INVENTION

1. **FIELD OF THE INVENTION**

This invention pertains to computer input and pointing devices used to control cursor movement on a display. More particularly, this invention pertains to touch-sensitive data input and pointing devices for data input to computers and other devices which benefit from interaction with a user.

2. **PRIOR ART**

Input devices for computers are well known in the art. There are several types of input devices including the familiar "mouse." The mouse has become so popular because, when combined with a graphical user interface (GUI), it is so much easier to use than typed keyboard commands. Instead, a cursor is caused to move on a display screen, the cursor being controlled by movements of the mouse being translated into corresponding cursor movements. The mouse has been accepted as a "user friendly" input device for both experienced and novice computer users. The popularity which the mouse has achieved in the art can be given large credit for fostering the explosive growth of the personal computer industry since a mouse provides a simple means for users to input data to a computer.

While mice are currently the most popular non-keyboard input device, a mouse generally requires a free-rolling surface, i.e. a table top, on which it can operate. Disadvantageously, a mouse is not well suited
5 for use in cramped spaces or with a portable computer, particularly laptop, notebook, sub-notebook, and palmtop computers. In answer to the long existing need for a more convenient input device suitable for both portable and desktop computers, various alternative input devices
10 have been proposed. Such alternative input devices include devices commonly referred to as track balls, track pens, track point devices, as well as various devices which sense the position of a pointing object on a position sensing surface. The devices which sense the
15 position of a pointing object on a sensing surface generally have the advantages of being simple to use, being easily integrated with current computers and other computing devices, reliability, ruggedness, compactness, and the ability to be transported and used in a variety
20 of locations.

Numerous types of input devices utilize a position sensing surface. Examples are provided in the following patent references: U.S. Pat. No. 3,886,311, Rodgers et al. (Writing pen for detecting time varying
25 electrostatic field produced by a writing tablet); U.S. Patent No. 4,672,154, to Rodgers et al. (Cordless stylus which emits a directional electric field from the tip of a conductive pen cartridge sensed by a digitizer tablet having an X-Y coordinate system); U.S. Pat. No.
30 4,680,430 to Yoshikawa et al. (A tablet-like coordinate detecting apparatus including a resistive film for determining the coordinate position data of a point on a plane indicated by the touch of a finger tip or other load); U.S. Patent No. 4,103,252 to Bobick (A position
35 sensing tablet with electrodes located on the boundaries of a sensing region which detects a human touch by the change in capacitive charge caused by the touch which

varies the time constant of an RC network which is part of an oscillator); U.S. Patent No. 4,736,191 to Matzke (A touch activated control device comprising individual conductive plates wherein a user's touch on the dielectric layer overlaying the plates is detected by individually charging and discharging each of the sectors in the plates in a sequential manner to determine the increased capacitance of the sector); U.S. Patent No. 4,550,221 to Mabusth (A touch sensitive control device which translates touch location to output signals and which includes a substrate that supports first and second interleaved, closely spaced, non-overlapping conducting plates); U.S. Patent No. 4,639,720 to Rympalski et al. (An electronic sketch pad which contains a graphics input pad having an array of transparent capacitive pixels, the capacitance characteristics of which are changed in response to the passing of a conductive tipped stylus over the surface of the pad); and, European Patent Publication No. 574,213 (A proximity sensor includes a sensor matrix array which senses changes in capacitance between horizontal and vertical conductors connected to the position sensing pad to determine x, y, & z position information).

A particularly useful and advantageous input device is disclosed in U.S. Patent No. 5,305,017 to Gerpheide. The Gerpheide patent discloses devices and methods which overcome the drawbacks inherent in other devices which utilize a sensing tablet or sensing surface. The devices and methods of the Gerpheide patent include a touch sensitive input pad upon which a user conveniently inputs position information with a finger. In operation, the user's finger tip is brought in close proximity to the top surface of the position sensing surface of the touch sensitive pad. The device of the Gerpheide patent detects the position of the finger tip in the x and y directions of the touchpad as well as the

finger's proximity in the z direction in relation to the sensing surface. In addition to a finger, the pointing object can be any other conductive object.

The above mentioned input devices are easily distinguished from each other by focusing on a particular characteristic which each device does or does not possess. Specifically, each input device may either be used by moving a stylus across the touch-sensitive surface, or a human finger, or both. The input devices of interest are only those which are useable by touching the touch-sensitive surface with a finger.

The different input devices allow for various sensing apparatus of the touch-sensitive devices to detect the finger and translate movement of the finger into corresponding movement of a cursor on a display screen. This patent has within its scope of interest those touchpad-type devices which readily provide tactile feedback to the user, and which control a cursor on a display device. Practically speaking, the greatest feedback occurs when using touchpads and tablets operated by a user's finger.

One of the advantages of using a touchpad or tablet as an input device is that space is conserved. This means that the touchpad or tablet are not moved around, as is a mouse, in order to manipulate a cursor on a display screen. Instead, a finger is moved across a touch-sensitive surface, while the touchpad or tablet advantageously remains stationary. This characteristic is very important when space constraints are premium, such as on an airplane or a crowded desk.

With the advent of these new touchpad and tablet devices have also come enhancements to make them easier to use and to provide additional benefits over mice and other input devices. In particular, the Gerpheide patent application, Serial Number 08/413,199, teaches a SYSTEM AND METHOD FOR EXTENDING THE DRAG FUNCTION OF A COMPUTER POINTING DEVICE. This patent application is

particularly useful to touchpads and tablets because it makes optimum use of the available touchpad surface area. When a cursor is manipulated to drag an object across a display screen, typically the user cannot
5 complete the operation in a single continuous stroke of a finger. The reason is that although it is common practice to make a small finger movement on a touchpad correspond to a larger cursor movement on a display by magnifying relative motion, available touchpad surface
10 area is still finite. Therefore, in the middle of a drag operation during which the user is maintaining contact with a touchpad, the user is forced to lift the finger. In conventional computer input devices, lifting the finger terminates the drag operation. The user must
15 reselect the object which was being dragged by the cursor, and then continue movement. Depending upon the distance to be moved, this operation might be repeated several times.

The Gerpheide patent advantageously provides new
20 functionality to the touchpad by creating a delay in drag cancellation. Specifically, when dragging an object with a cursor, lifting the finger does not immediately result in termination of drag operation. Instead, a delay in termination provides sufficient time
25 for a user to lift the finger, move it to a new location on the touchpad, and resume dragging the object as if the finger had never been lifted.

Implementation of the drag extend function described above is accomplished by creating regions on
30 the touchpad surface which provide new functionality. For example, moving a finger into an appropriate region activates a desired function. With drag extend, the most logical location for a region which can activate the function is the perimeter of a touchpad. This is
35 because the user's finger is going to reach the edge of the touchpad. By creating a border region around the entire touchpad perimeter, the drag extend function can

be activated while dragging in any direction. It should be apparent from the explanation above that endowing a border region with extended functions such as drag extend can be advantageous for the user.

5 A problem which is not readily apparent from the description given above is that a user is not always aware of the location of their finger on the touchpad. A user is manipulating the position of a cursor on a display screen, and therefore is concentrating on
10 watching the display and not the touchpad. The problem arises when a user wants to use, for example, the drag extend function. The surface of a touchpad is typically uniformly smooth to the perception of human touch. Typically, there is no tactile indication to assist a
15 user in determining whether a finger is within the border region or not. Consequently, when the user executing the drag operation lifts the finger from the touchpad, the drag function might terminate. In essence, no way is readily provided for a user to know
20 when a finger has entered the border region.

 One attempt at a solution to this problem of inadequate tactile feedback is provided by Logan et al. in U.S. Patent No. 5,327,161. Generally, the Logan patent apparently addresses the issues of replacing an
25 ordinary mouse with a touchpad type device. Specifically, the patent teaches providing extended functionality to a touchpad by placing touch-sensitive sensor strips on a physically raised outer perimeter or bevel around the touchpad, but not actually on the
30 touchpad surface. When a finger comes in contact with the touch-sensitive strips, extended functionality is provided to the user.

 One of the several disadvantages of the Logan patent is that construction of the touchpad is
35 needlessly complicated. Specifically, Logan requires a raised bevelled edge to be created around the touchpad perimeter to provide the physical tactile feedback to

the user that an edge of the touchpad has been reached. The touch-sensitive strips are formed independent of the touchpad material, and they require additional circuitry, sensors, and a coordinating processor to
5 determine when the touchpad surface and the touch-sensitive strips are being activated simultaneously.

Another disadvantage is that Logan does not teach how nearing the perimeter of the touchpad can be useful. Instead, Logan only provides tactile feedback when the
10 user actually strikes the bevelled edges of the touchpad. The user is given no tactile warning that an edge is approaching.

Illustrated in FIG. 1 is a representation of a computer system 16 to which is attached a mouse 10 which
15 acts as a cursor locator input device. The movement of the mouse 10 is translated into movement of a cursor on a display 20 coupled to the computer 16 in real time. In many cases, it is desirable that any input device to be used with the computer 16 be compatible therewith.
20 Alternatively, a cursor locating device can interface directly with the computer 16, for example via an operating system or some other technique which does not require a mouse driver.

In order to be compatible with the computer 16, any
25 input device must provide "click", "drag" and "gesture" functions which can also be provided by the mouse 10. The click function entails depressing and releasing one of the mouse buttons 12 or 14. The click function may entail single, double, triple or even half clicks. For
30 example, a one and a half click is where the user uses a finger to press down on a button or surface, raises the finger to release, then presses down and holds the button or surface with the finger again. The drag function entails moving the cursor over text or an
35 object on the display 20, depressing a mouse button 12 or 14, keeping the mouse button depressed while "dragging" the text or object to a new location on the

display 20, and releasing the mouse button to position the text or object on the new location on the display 20. Finally, gestures are symbols or other figures created by tracing alphanumeric characters on the touchpad.

Also represented in FIG. 1 is a touch-sensitive positioning device, generally referred to at 26, which includes a position sensing surface 22 and a pointing object 24. Early versions of these touch-sensitive touch-pad type devices included mechanical buttons, such as those shown at 28 and 30 which provide the functions of mouse buttons 12 and 14, respectively.

However, advancements have made it possible to have a touch-sensitive device which no longer requires mechanical switch buttons to carry out the click function. Instead, the touch-sensitive devices require a user to simply lift a finger and tap once, twice, three times or with half-taps on the touch-sensitive surface. The tapping motion is detectable by the touch-sensitive circuitry which informs the driver or application software of the input action.

FIG. 2A is a schematic side elevational view of a touchpad input device 40 illustrating a touch-sensitive bezel 42 of the system of taught in U.S. Patent No. 5,327,161 by Logan et al. Logan has significant disadvantages which are overcome by the present invention. However, to understand the improvements, it is necessary to have a little background in order to illustrate them.

As shown, the touch-sensitive surface is recessed 44 down into a touchpad 40. At the borders of the touchpad 40 are four beveled edges 42 to which is attached a piezoelectric or some similar sensor device 46. When a user's finger presses against the beveled surface 42, the attached sensor 46 registers the contact and signals activation of a computer input function. This view also shows the mechanical switch 48 below the

touch-sensitive touchpad 40 which is activated by pressure on the surface 50 above. The touch-sensitive surface 50 has no other features, other than a dotted line 52 shown in FIG. 2B.

5 FIG. 2B is a top view of the touchpad 40 shown in FIG. 2A. The notable feature is the dotted line 52 defining a perimeter of the touchpad surface 50 already mentioned. With this complete view, an illustration of what Logan describes as continued cursor movement can
10 now be explained.

 The beveled edges 42, or alternatively the dotted line 52, can indicate to the user when continued cursor movement is activated. This occurs in Logan when a finger presses down on the touchpad surface 50 within
15 the dotted line 52, selects an object on a display screen, and closes the mechanical switch 48. When the user moves the finger to an edge 42 until it touches, or alternatively crosses the dotted line 52, the continued cursor movement mode is activated, and the cursor
20 continues to move in the same direction it was originally moving until the finger is removed from the beveled edge 42 or lifted from the touchpad surface 50.

 The method and apparatus has several shortcomings, some of which are described below. First, the touchpad
25 40 uses a mechanical switch 48 to indicate that a drag function is being activated. A mechanical switch 48 is inherently prone to failure because the physical components can become contaminated and the switch may fail due to wear.

30 Second, there is no warning to the user that a finger is approaching an edge 42 of the touchpad 40. Consequently, the user may not wish to activate the continued cursor movement mode, but may do so inadvertently.

35 Third, the sensors 46 on the beveled edges 42 are not part of the touchpad sensor array. Therefore they

require additional circuitry to decode signals received therefrom.

5 Fourth, the dotted line 52 around the perimeter of the touchpad surface 50 is only a visual indicator for where the continued cursor movement mode begins. The user is thus required to view the touchpad 40 anytime confirmation is required of the present location of the finger on the touchpad surface 50. This slows down a user of the touchpad 40.

10 The drawbacks of Logan et al. include insufficient tactile feedback indicating when a special function has been activated. They also include the additional circuitry which is required in a system which does not integrate sensing of movement into a perimeter of the touchpad with the already available touchpad circuitry.

15 Thus, it would be an advance in the art to provide a touch-sensitive finger actuable touchpad or tablet which provides tactile feedback to the user who is manipulating a cursor on a display screen, when a finger has passed into a special functions region of the surface, and without requiring additional circuitry or modification to existing designs.

OBJECTS AND SUMMARY OF THE INVENTION

25 In view of the above described state of the art, the present invention seeks to realize the following objects and advantages.

30 It is a primary object of the present invention to provide a method and apparatus for providing tactile feedback for an electronic touch-sensitive computer input and cursor manipulation device.

35 It is another object of this invention to provide a method and apparatus for providing tactile feedback for electronic touch-sensitive computer input devices which is particularly adapted for use with a touch-sensitive touchpad or tablet type computer input and pointing devices.

It is yet another object of this invention to provide a method and apparatus for providing tactile feedback for electronic touch-sensitive computer input devices which can operate with a user's finger as the only pointing object.

It is still a further object to provide a method and apparatus for providing tactile warning to a user that a finger moving on the touchpad surface is approaching an edge, but before reaching the edge.

These and other objects are realized in a method and apparatus for providing a tactile feedback response to a user moving their finger across the touch-sensitive surface of a touchpad or tablet. Different regions of the touch-sensitive surface are differentiated from each other by providing a different human perceptible textural surface within the regions. A different texture provides immediate tactile feedback to the user through the finger making contact with the touchpad. Increased functionality is important because it solves problems which are inherent to the small touchpad surfaces used as computer input devices. Particularly, it is a problem to drag an object from one side of a display to another without repeatedly raising a finger to repeat the dragging motion because of the limited surface area of the touchpad surface. Providing increased functionality such as a drag extend function solves the movement problem. The present invention then solves the problem of conveying to the user through touch, information about the location of the finger without having to look away from the display screen, thereby facilitating input and cursor manipulation for a computer. The apparatus of the present invention preferably includes an electronic touch-sensitive touchpad or tablet which can be actuated by a human finger, an associated processing device such as a computer, and a display screen whereon a cursor being manipulated by the touchpad is displayed.

The method of the present invention includes the step of creating a touchpad having regions of different textures. This is accomplished by either manufacturing the touchpad surface with the different textures, or
5 adhering differently textured materials to the touchpad surface after manufacture. It is also conceivable that the different regions could be manufactured separately, and then mounted together such that there is a generally continuous touchpad surface over which the user's finger
10 can slide. However, this approach is prohibitively more expensive and unnecessary.

These and other objects, features, advantages and alternative aspects of the present invention will become apparent to those skilled in the art from a
15 consideration of the following detailed description taken in combination with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a computer system
20 having as input devices a mouse and a touchpad;

FIG. 2A is a side elevational view representing the prior art in touchpad surfaces which attempt to provide tactile feedback to the user;

FIG. 2B is a top view of the touchpad device shown
25 in FIG. 2A;

FIG. 3 is a block diagram of a computer system having as an input device a touchpad with a non-mechanical electronic switch;

FIG. 4A is a top view of a touchpad touch-sensitive
30 device made in accordance with the principles of the present invention;

FIG. 4B is a side elevational view of a touchpad touch-sensitive device of FIG. 4A;

FIG. 4C is a top view of a touchpad touch-sensitive
35 device made in accordance with an alternate embodiment of the present invention;

FIG. 4D is an alternative embodiment showing a top view of a touchpad touch-sensitive device having two separate touch regions;

FIG. 5A is an alternative embodiment of a touch-sensitive surface which provides tactile feedback;

FIG. 5B is a modification of FIG. 5A; and

FIG. 5C is a modification of FIG. 5A.

DETAILED DESCRIPTION OF THE INVENTION

In order to better appreciate how the above-recited and other advantages and objects of the invention are obtained, reference will now be made to the drawings in which the various elements of the present invention will be given numerical designations and in which the invention will be discussed so as to enable one skilled in the art to make and use the invention.

FIG. 3 is a block diagram which shows the system of FIG. 1, but with two important changes. The mouse 10 has been removed, and the touch-sensitive device 26 is now replaced with a touch-pad 32 with no buttons. While a stylus can be used with touchpads, the present invention requires the enhanced tactile response which human fingers provide over a stylus. The touchpad has a position sensing surface which senses the position of a pointing object, such as a user's finger, which is manipulated by the user.

It is particularly preferred that the touch sensitive pointing device which is described in U.S. Patent No. 5,305,017 be used with the present invention. The touch sensitive pointing device described in U.S. Patent No. 5,305,017 is particularly advantageous in that the cursor positioning, clicking, and dragging functions can all be accurately carried out by a user using only a single finger as a pointing object. Other advantages of the touch sensitive pointing device described in U.S. Patent No. 5,305,017 are described therein or will be apparent from use of the invention.

U.S. Patent No. 5,305,017 is now incorporated herein by reference in its entirety. Using the information set forth in U.S. Patent No. 5,305,017, U.S. Patent Application No. 08/413,199, and the information set
5 forth herein, a system for carrying out the present invention can be readily arrived at by those skilled in the art. Importantly, the present invention is readily adaptable for use with numerous other pointing devices which can use a finger as the pointing device.

10 The touch-sensitive pointing device of the present invention is connected to the computer 16. The computer 16 is connected to a display 20 upon which various text and other objects are displayed and a cursor is located.

FIG. 4A is a top view of a touchpad 60 made in
15 accordance with the principles of the present invention in a preferred embodiment. The touchpad 60 has a generally planar touch-sensitive planar surface 62. However, in the preferred embodiment, the touchpad surface 62 is divided into two regions. The border
20 region 64 is defined as the area which makes a continuous loop around the perimeter of the surface 62. The inner region 66 is defined as the area of the surface which lies within the border region 64. It should be realized that although two regions are created
25 in a preferred embodiment, a plurality of regions can exist. The regions become useful if they are distinguishable by touch.

The regions should be considered to have a sharp boundary 68 which does not allow overlap. In this way,
30 the regions 64, 66 can be separated by a ridge 70 which runs along a boundary 69 between the regions 64, 66 in a preferred embodiment. More specifically, a thin material 70, but easily discernible to the touch, is slightly raised above the generally planar surface 62.
35 This feature is shown in the side elevational view of FIG. 3B.

FIG. 3B shows in a cut-away view that a ridge material 70 rises above the touchpad surface 62 along the lines X-X. Those skilled in the art will appreciate that the ridge material 70 can be pressed at the time of manufacture of the touchpad 60, or it can be applied to the touchpad surface 62 after said generally planar surface has been formed.

FIGS. 4C and 4D are all alternative touchpad surfaces 78, 80 with the ridged material defining a plurality of different shaped regions 64, 66. These regions 72, 74 define at least two different computer input and cursor manipulation functions. Therefore, it is possible but not required that different regions share the same functions, or that each region has a different function. FIG. 4C shows a touch-sensitive surface 78 of a touchpad 60 with a small area 90 of what was the inner region 66 in FIG. 3A now becoming part of the border region 72. This still means that the ridged material still defines the boundary 68 between regions. It is only the size of the regions which has been altered.

FIG. 4D shows a different alternative embodiment for a layout of the touchpad surface 80. Specifically, the two separate regions 84, 88 are created within the inner region 86. These two regions 84, 88 function so as to emulate right and left mouse buttons such as those shown in FIG. 1.

FIG. 5A is another alternative embodiment of the present invention which differs from FIG. 4 in the method of implementing tactile feedback to the user of a location of the finger on the touchpad surface, without having to glance at the touchpad. Specifically, the embodiment envisions implementing a human perceptible textured surface on the touch-sensitive surface.

To create the desired tactile response for the user, different regions 90, 92 have differently textured

surfaces. Typically, touchpad surfaces are manufactured with a generally uniformly smooth surface. FIG. 5A illustrates a top view of a touchpad 94 having a border region 90 similar in shape to the border region 64 in FIG. 4A, but with a relatively heavily textured surface compared to the inner region 92. Those skilled in the art will appreciate that texturing the border region 90 is easily accomplished during manufacture of the touchpad surface by using a die or other technique to press the textured surface. Alternatively, the textured surface might be applied to the border region 90 after manufacture.

FIG. 5B illustrates the same top view as shown in FIG. 5A, but modifies the embodiment by adding to the touchpad surface the ridged material of FIG. 4 along the boundary between different regions 94, 96.

FIG. 5C illustrates the same top view as shown in FIG. 5A, but with the relatively textured border region 90 now being smooth, and the relatively smooth inner region 92 now being textured.

So as to illustrate some of the most advantageous benefits of the present invention, a comparison of the Logan et al. drawbacks previously listed will now be compared to the present invention so as to understand why the method and apparatus is improved.

First, instead of a mechanical switch to indicate when a function is being activated, the present invention employs a non-mechanical electronic switch. In this way, there are fewer components, and no mechanical components to wear out.

Second, because the border region is textured differently from the inner region, the user knows instantly that the finger is in close proximity to a touchpad edge, but not yet in contact.

Third, the touchpad of the present invention has no sensors other than those coupled to the generally planar

surface. Therefore, complexity and cost of the present invention is kept lower than Logan et al.

Fourth, any visual indicator which might be included in the present invention might simply be to
5 color the textured material or the ridged material. Any visual indicator is then useful for the times when occasional glances are made at the touchpad surface.

To further explain the benefits of the present invention, it is helpful to walk through the continued
10 cursor movement mode of the prior art and compare it to the drag extend function which is incorporated by reference into this specification.

The present invention in a preferred embodiment provides a touch-sensitive input device surface having
15 at least one generally planar sensor surface. The finger of the user slides over the surface to thereby manipulate a cursor on an associated computer controlled display. Disposed on the surface are a plurality of spaced-apart regions separated by a ridge of material
20 which rises above the generally planar sensor surface. The user will begin the drag extend function by manipulating a cursor on the computer controlled display so as to select an object on the display while the user's finger is within an inner region such as inner
25 region 66 in FIG. 4A. After selection, the user moves the finger to drag the selected object across the display. When the user's finger crosses the ridge of material 70, the drag extend function is accessed by the touchpad microcontroller, and activated. The user's
30 finger can now stop and be raised off the surface 62 of the touchpad 60. Instead of the selected object being automatically deselected, a timer now begins to count. This countdown timer provides the user with time to move the finger back to the inner region 66 and place the
35 finger on the touchpad surface 62. If the countdown timer has not expired, the user can continue to drag the selected object across the display. If the countdown

timer has expired, the selected object is deselected, and the user must reselect the object in order to continue dragging it across the display.

Advantageously, the user was made aware that the
5 finger could be safely lifted off the touchpad surface because the finger slipped up and over the ridge 70. The user was not required to actually look at the touchpad surface 66 in order to determine the location of the finger because of the tactile feedback provided
10 by the ridge.

In an alternative embodiment, the time in which the countdown timer takes to expire is user selectable so as to customize the computer input device to user requirements.

15 It is important to remember that the drag extend function is not the only function which the touchpad can implement. The drag extend function is simply provided as an example of the increased functionality offered by the present invention. The invention simply improves
20 tactile feedback to make manipulation of a cursor on a computer-controlled display easier for the user.

An alternative to the method described above is using one of the alternative touchpad surfaces as described in the other figures. The tactile feedback is
25 provided by moving over regions whose surfaces are formed with different textures.

It is to be understood that the above-described embodiments are only illustrative of the application of the principles of the present invention. Numerous
30 modifications and alternative arrangements may be devised by those skilled in the art without departing from the spirit and scope of the present invention. The appended claims are intended to cover such modifications and arrangements.

CLAIMS

What is claimed is:

1. A method for providing human perceptible tactile differentiation to a human finger when using a touch-sensitive cursor manipulation device of a computer controlled display, thereby enabling a user to manipulate a cursor on the display without viewing the cursor manipulation device and determining a location of the finger, the method comprising the steps of:
- 5
- 10 (a) providing a touch-sensitive cursor manipulation device having at least one generally planar sensor surface for contact and movement thereover of a finger;
- (b) disposing on the generally planar sensor surface a plurality of spaced-apart regions separated by a ridge of material which rises above the generally planar sensor surface such that a finger moving over said surface from one of the spaced-apart regions to another will touch said ridge of material; and
- 15
- (c) providing a plurality of cursor manipulation functions in a stored program in the computer which controls the display, said functions being actuable through contact by the finger with the touch-sensitive cursor manipulation device, wherein at least one of the plurality of cursor manipulation functions is only actuable by moving the finger from a first region to a second region of the plurality of spaced-apart regions.
- 20
- 25
2. The method as defined in claim 1 wherein the step of providing the plurality of cursor manipulation functions in the stored program in the computer includes providing a drag extend function which comprises the steps of:
- 30
- (a) manipulating the touch-sensitive device such that a finger is caused to select an object on the display with a cursor;
- 35
- (b) sliding the finger across the surface of the touch-sensitive device from a first region to a second

region, thereby causing a corresponding movement of the selected object across the display and activation of the drag extend function in the stored program;

5 (c) lifting the finger off the surface, yet not deselecting the selected object;

(d) placing the finger in contact with the surface within the first region;

(e) sliding the finger across the surface; and

10 (f) repeating steps (b) through (e) until the selected object is dragged to a desired location on the display.

3. The method as defined in claim 1 wherein the step of disposing on the generally planar sensor surface
15 a plurality of spaced-apart regions on the touch-sensitive device further comprises the step of separating the first region from the second region by forming the ridge of material on a boundary between the first and second regions.

20

4. The method as defined in claim 3 wherein the step of disposing on the generally planar sensor surface a plurality of spaced-apart regions on the touch-sensitive device further comprises the steps of:

25 (a) disposing the first region about a first perimeter of the generally planar surface of the touch-sensitive device; and

30 (b) disposing the second region within the first perimeter of the generally planar surface so as not to overlap the first region.

5. The method as defined in claim 1 wherein the steps of disposing on the generally planar sensor surface a plurality of spaced-apart regions on the
35 touch-sensitive device further comprises the step of disposing at least a third region on the touch-sensitive

device so as to simulate a mouse button, said third region not overlapping the first or second regions.

5 6. The method as defined in claim 1 wherein the step of providing a touch-sensitive cursor manipulation device further comprises the step of providing a touchpad.

10 7. A method for providing human perceptible tactile differentiation to a human finger when using a touch-sensitive cursor manipulation device of a computer controlled display, thereby enabling a user to manipulate a cursor on the display without viewing the cursor manipulation device and determining a location of
15 the finger, the method comprising the steps of:

(a) providing a touch-sensitive cursor manipulation device having at least one generally planar sensor surface for contact and movement thereover of a finger;

20 (b) disposing on the generally planar sensor surface a plurality of spaced-apart textured regions in which the texture of each region is different from the texture of at least one other region; and

25 (c) providing a plurality of cursor manipulation functions in a stored program in the computer which controls the display, said functions being actuatable through contact by the finger with the touch-sensitive cursor manipulation device, wherein at least one of the plurality of cursor manipulation functions is only actuatable by moving the finger from a first textured
30 region to a second textured region of the plurality of spaced-apart textured regions.

8. The method as defined in claim 6 wherein the step of providing the plurality of cursor manipulation
35 functions in the stored program in the computer includes providing a drag extend function which comprises the steps of:

(a) manipulating the touch-sensitive device such that a finger is caused to select an object on the display with a cursor;

5 (b) sliding the finger across the textured surface of the touch-sensitive device from a first textured region to a second textured region, thereby causing a corresponding movement of the selected object across the display and activation of the drag extend function in the stored program;

10 (c) lifting the finger off the surface, yet not deselecting the selected object;

(d) placing the finger in contact with the surface within the first region;

(e) sliding the finger across the surface; and

15 (f) repeating steps (b) through (e) until the selected object is dragged to a desired location on the display.

9. The method as defined in claim 7 wherein the step of disposing on the generally planar sensor surface a plurality of spaced-apart textured regions on the touch-sensitive device further comprises the steps of:

20 (a) disposing the first textured region about a first perimeter of the generally planar surface of the touch-sensitive device; and

25 (b) disposing the second textured region within the first perimeter of the generally planar surface so as not to overlap the first region.

30 10. The method as defined in claim 7 wherein the step of disposing a plurality of textured regions on the touch-sensitive input device comprises the more specific step of disposing thereon a first perceptibly textured region and a differently textured and humanly distinguishable second perceptibly textured region.

35

11. The method as defined in claim 10 wherein the steps of disposing on the generally planar sensor surface a plurality of spaced-apart textured regions on the touch-sensitive device further comprises the step of
5 disposing at least a third textured region on the touch-sensitive device so as to simulate a mouse button, said third textured region not overlapping the first or second textured regions, and being differently textured and humanly distinguishable from the first and second
10 textured regions.

12. The method as defined in claim 7 wherein the step of providing a touch-sensitive cursor manipulation device further comprises the step of providing a
15 touchpad.

13. A system for providing human perceptible tactile differentiation to a human finger when using a touch-sensitive cursor manipulation device of a computer controlled display, said system comprising:
20

(a) sensing surface means for sensing contact by a human finger on the sensing surface means, said contact corresponding to a touch function sequence;

(b) a plurality of spaced-apart textured regions
25 disposed on the sensing surface means, the texture of each region being different from the texture of at least one other region; and

(c) a plurality of cursor manipulation functions stored in a memory of the computer which controls the display, said functions being actuatable through contact
30 by the finger with the sensing surface means, wherein at least one of the plurality of cursor manipulation functions is only actuatable by moving the finger from a first textured region to a second textured region of the
35 plurality of spaced-apart textured regions.

14. The system as defined in claim 13 wherein the sensing surface means is a touchpad.

5 15. A system for providing human perceptible tactile differentiation to a human finger when using a touch-sensitive cursor manipulation device of a computer controlled display, said system comprising:

10 (a) sensing surface means for sensing contact by a human finger on the sensing surface means, said contact corresponding to a touch function sequence;

15 (b) a plurality of spaced-apart regions disposed on the sensing surface means, said regions being separated by a ridge of material which rises above the sensing surface means such that a finger moving over said sensing surface means and moving from one of the spaced-apart regions to another will touch said ridge of material; and

20 (c) a plurality of cursor manipulation functions stored in a memory of the computer which controls the display, said functions being actuatable through contact by the finger with the sensing surface means, wherein at least one of the plurality of cursor manipulation functions is only actuatable by moving the finger from a first region to a second region of the plurality of
25 spaced-apart regions.

16. The system as defined in claim 13 wherein the sensing surface means is a touchpad.

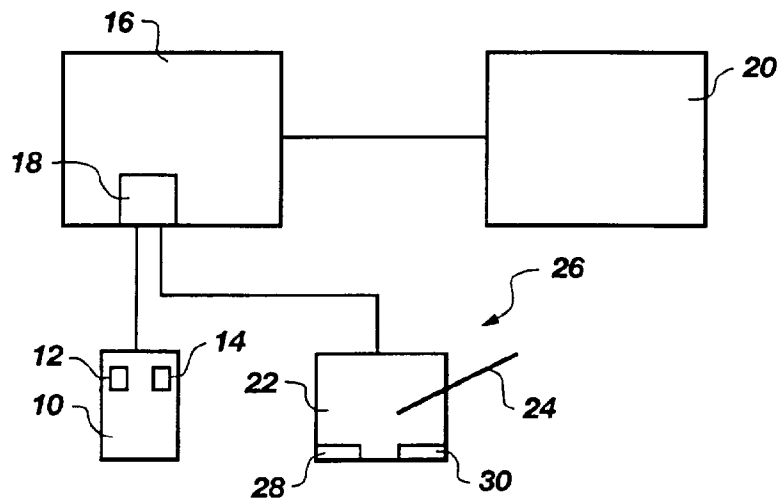


Fig. 1

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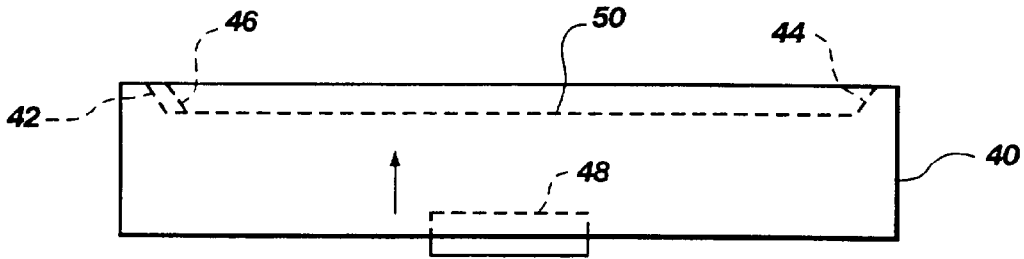


Fig. 2A

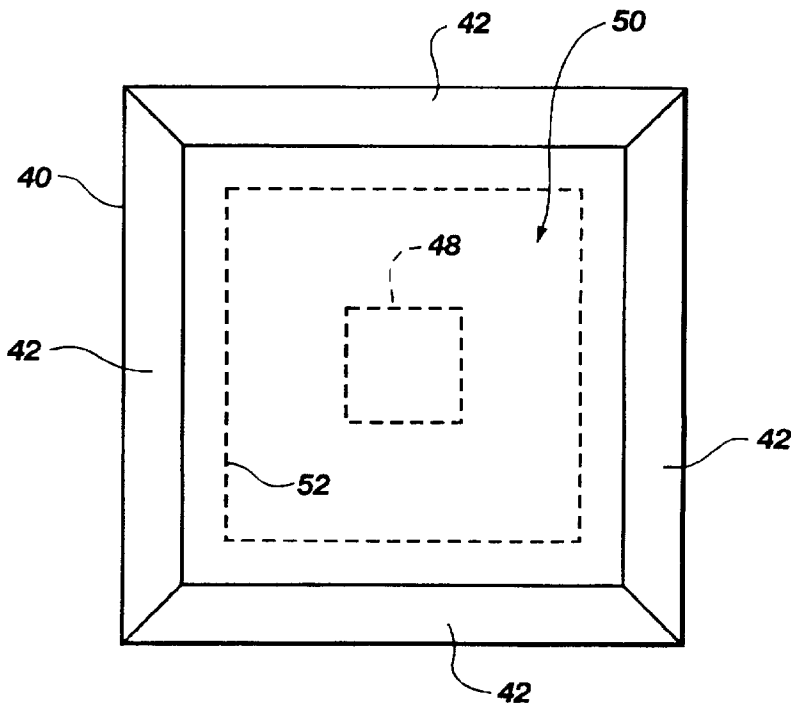


Fig. 2B

SUBSTITUTE SHEET (RULE 26)

3/5

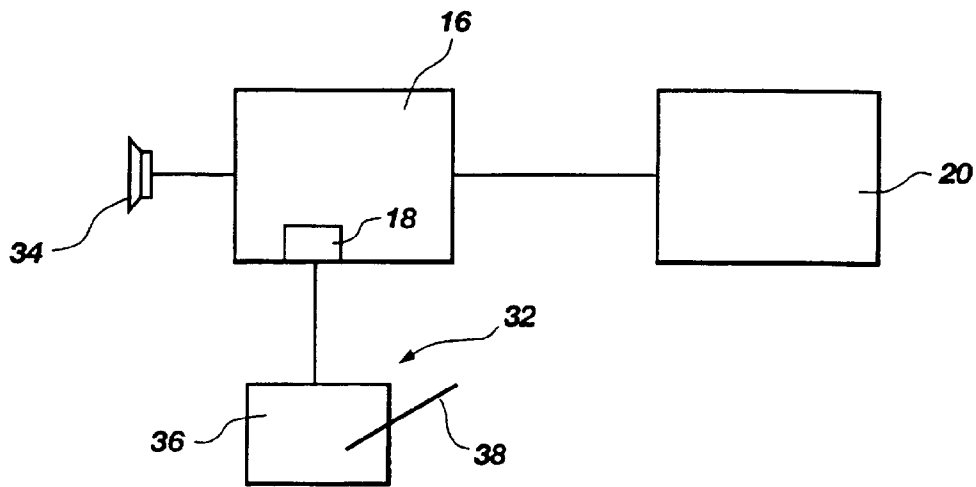


Fig. 3

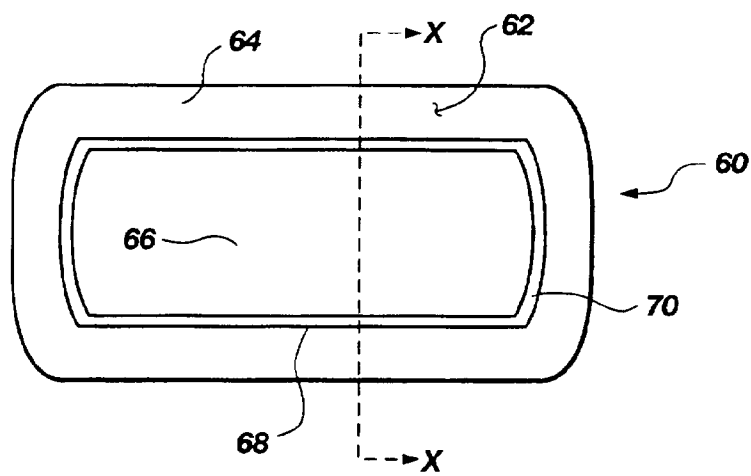


Fig. 4A

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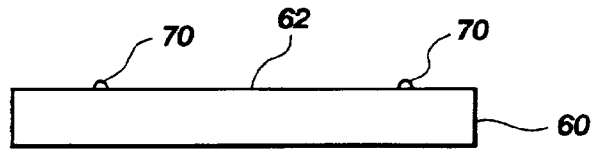


Fig. 4B

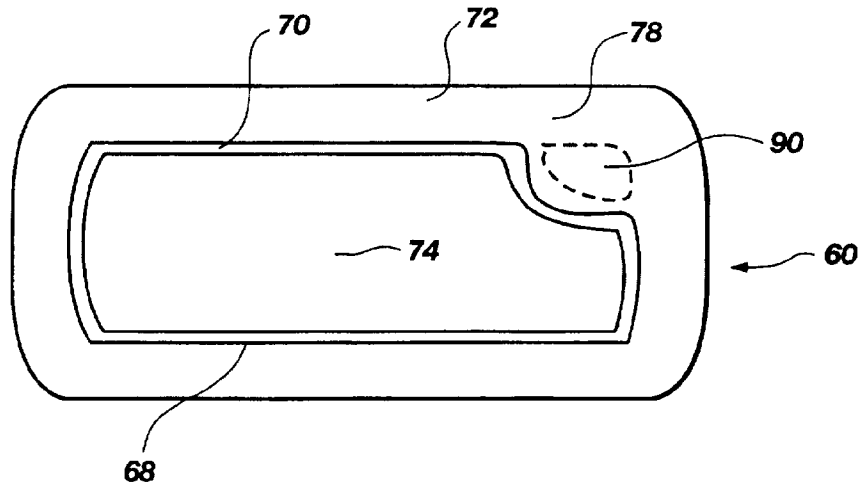


Fig. 4C

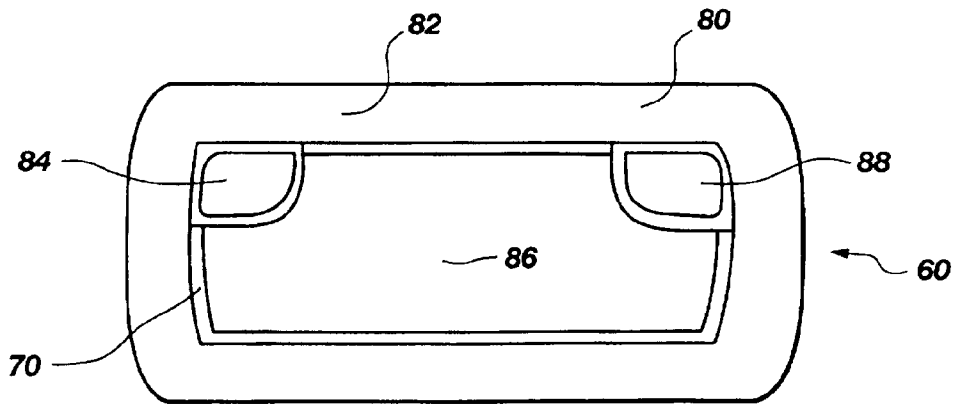


Fig. 4D
SUBSTITUTE SHEET (RULE 26)

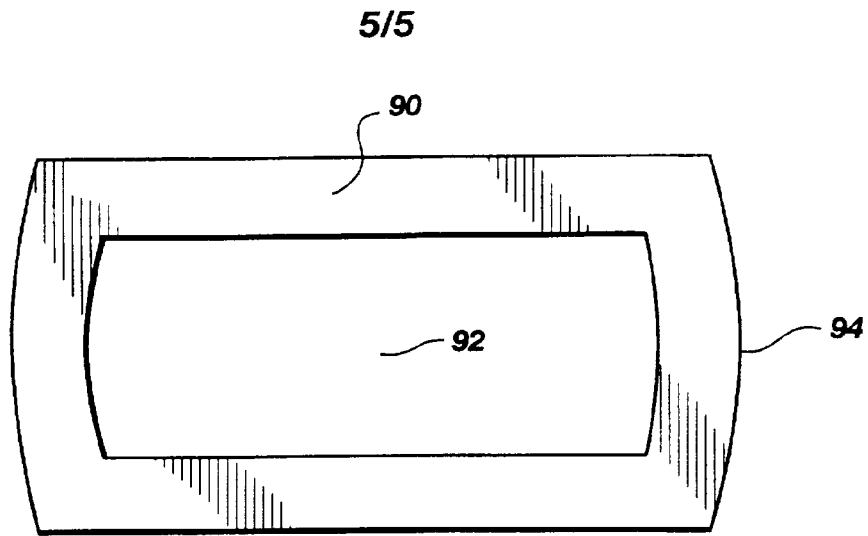


Fig. 5A

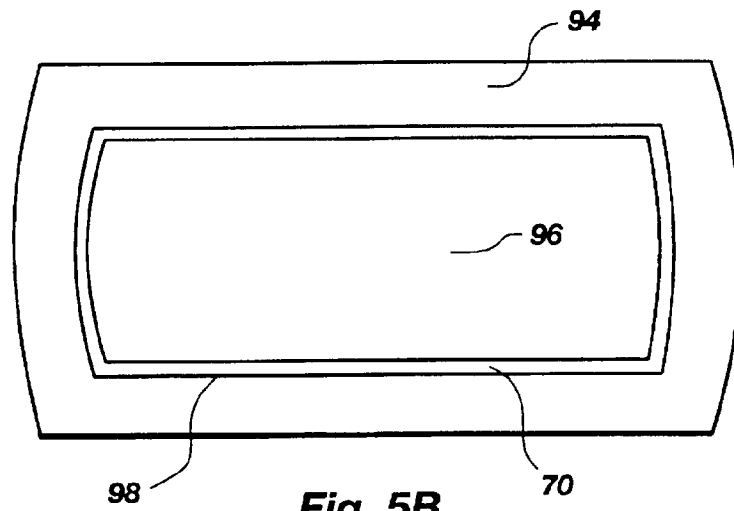


Fig. 5B

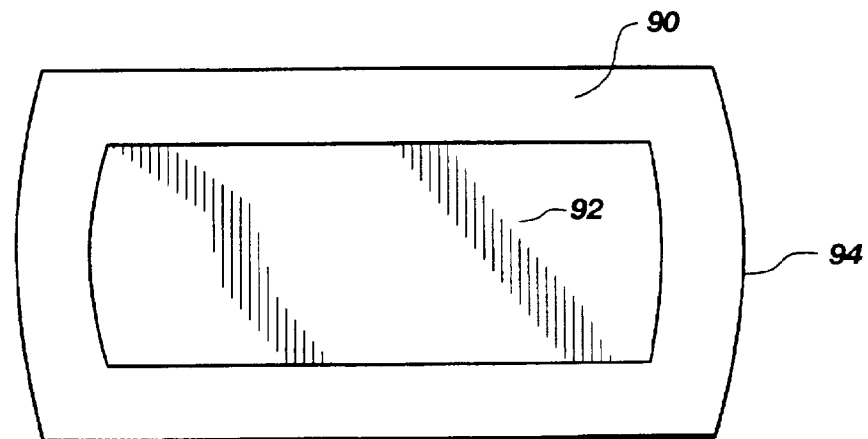


Fig. 5C SUBSTITUTE SHEET (RULE 26)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/18046

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G09G 3/02
US CL : 345/157, 173; 463/37; 341/21
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 345/157, 173, 156, 145, 163, 168, 169, 174; 463/37; 341/21; 178/18, 19; 340/825.19; 273/148B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,327,161 A (LOGAN et al) 05 JULY 1994, FIGURES 2B, 7, COLUMN 3, LINES 56-58, COLUMN 4, LINES 1-7, COLUMN 7, LINES 52-58, COLUMN 8 AND COLUMN 9, LINES 1-28.	1-16
Y	US 5,410,333 A (CONWAY) 25 APRIL 1995, COLUMN 3, LINES 37-44.	1-16
Y	US 4,891,777 A (LAPEYRE) 02 JANUARY 1990, COLUMN 4, LINES 8-14.	1-16
Y	US 5,231,380 A (LOGAN) 27 JULY 1993, COLUMN 3, LINES 21-27.	5 AND 11

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 03 JANUARY 1997	Date of mailing of the international search report 12 FEB 1997
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer <i>LUN-YI LAO</i> LUN-YI LAO Telephone No. (703) 305-4873

Electronic Acknowledgement Receipt

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Application Number:	11693117
International Application Number:	
Confirmation Number:	8743
Title of Invention:	Method and Apparatus for Providing Tactile Sensations
First Named Inventor/Applicant Name:	Kenneth M. Martin
Customer Number:	34300
Filer:	Christopher W. Bosken/Amber Johnson
Filer Authorized By:	Christopher W. Bosken
Attorney Docket Number:	IMM147.C1
Receipt Date:	17-OCT-2007
Filing Date:	29-MAR-2007
Time Stamp:	15:27:23
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement Letter	CertificateStatement.pdf	23796 <small>7cfd51da920970d327ad8e52d39fa96d672a0a94</small>	no	1

Warnings:

Information:					
2	Miscellaneous Incoming Letter	Transmittal.pdf	32048 5b7d680870a7260c6c049fcd2eed794b194ff2d7	no	1
Warnings:					
Information:					
3	Information Disclosure Statement (IDS) Filed	Supplemental08a.pdf	100111 def573128cbda6c81b52578bbe7b0cd8577905371	no	1
Warnings:					
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4	Foreign Reference	WO95020787A1.pdf	1252711 63c4942a25b29eb60ee08cace9eed47aad91e8b	no	34
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Warnings:					
Information:					
Total Files Size (in bytes):			2652280		
<p>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</p> <p><u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</p>					

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	:	Martin et al.
Serial No.	:	11/693,117
For	:	Method and Apparatus for Providing Tactile Sensations
Filed	:	March 29, 2007
Examiner	:	Unknown
Art Group	:	2817

Certification Statement

This Information Disclosure Statement is being submitted prior to the mailing date of a first Office Action in this application. Accordingly, no fee is believed to be required. However, should any fees be due, the Commissioner is authorized to charge such fees to Deposit Account No. 16-1435.

Respectfully submitted,

Date: 10/17/07

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EUROPEAN PATENT APPLICATION

Application number: 89201704.7

Int. Cl.: G05B 19/04

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Control system.

An electronic processing circuit 17 compares digital signals representing the position of a number of mutually connected operating members to the contents of an electronic memory 18. On detecting a difference indicating the adjustment of the position of one of the operating members, the circuit 17 actuates those motors of motors 4, 5, 6 which are associated with the non-adjusted operating members in order to make them follow the adjustment. Excessive adjustments indicating a disturbance are shown on an indicator 19.

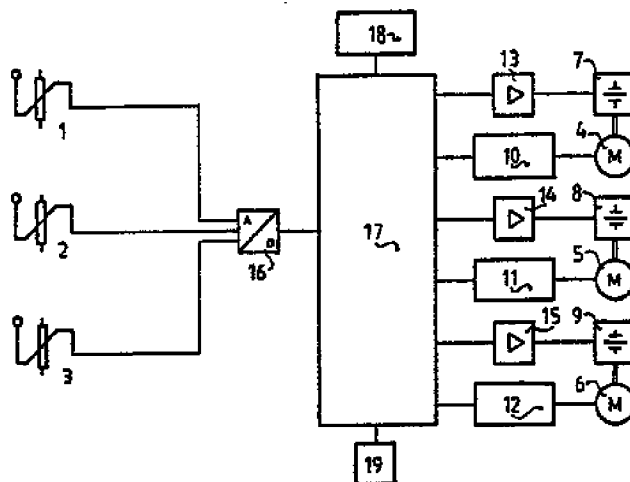


FIG. 1

Xerox Copy Centre

EP 0 349 086 A1

CONTROL SYSTEM

The invention relates to a control system consisting of a number of operating members that are connected mutually and to a device for operation, whereby each operating member is coupled to an associated feeding element in the form of a potentiometer, a follower member with an adjustable motor is added to each operating member to cause the other operating members to follow when an operating member is adjusted, and a memory for storing the position of the last adjusted operating member.

Such a control system is known from the Netherlands patent specification 179.421. In the known control system the memory is formed by a potentiometer added to each feeding element. The position of the potentiometer shows the position of the last adjusted operating member. Should an operating member be actuated the added potentiometers then follow the adjustment, which new position then serves as reference during a subsequent adjustment of one of the operating members. On the basis of the difference between the reference value and the momentary adjusted position of the operating member an error signal is formed which serves as control signal to bring about following of the remaining operating members and the associated potentiometers serving as memory.

Potentiometers are comparatively bulky and expensive, while the accuracy of the adjustment is also limited.

The invention has for its object to obviate these drawbacks. This is achieved according to the invention in that the memory is formed by an electronic memory recording a digital value and in that means are arranged for adapting the content of the memory to the position of an operating member.

As a result of the invention the stated drawbacks are overcome since the adapting of the reference value stored in the electronic memory can be performed rapidly while its size is moreover limited. Such a memory and the associated control circuits can furthermore be integrated into the circuit means, amplifiers and the like already available.

In order to obtain the digital signals each feeding element is connected to the memory via an analog-digital converter.

In the case of a control system whereby control signals for causing operating members to follow are first formed when a predetermined difference is exceeded between the value stored in the memory and the value representing the position of an adjusted operating member, in accordance with the invention the predetermined difference for the last adjusted operating member is

chosen smaller than that for the other operating members. A certain priority results which enables the possibility that the last adjusted operating member can still be adjusted for small differences by a fine-adjustment.

The electronic embodiment of the memory according to the invention also makes it possible to form control signals for a disturbance indicator when predetermined values are exceeded. When the formed signals display abnormal behaviour this indicates a disturbance and this can be indicated in a simple manner.

The invention will be elucidated with reference to a diagram of an embodiment as according to the annexed drawings.

Connected to each operating member is a feeding element in the form of the respective potentiometers 1, 2 and 3. Added to each operating member is a follower member in the form of the respective adjustable motors 4, 5 and 6. By means of the analog-digital converter 16 the position of the potentiometers 1, 2 and 3 is continually sampled and passed via the electronic processing circuit 17 to a suitable place in the memory 18. When one of the operating members is adjusted a difference will be detected by the electronic processing unit 17 between the momentary sampled value of the potentiometer added to the relevant operating member and the values stored in the memory 18. On the basis of this difference a control signal is formed which brings about rotation of the adjustable motors 4, 5 and 6 which are associated with the other operating members in the correct direction and over the correct distance. Because the couplings associated with the motors are energized, that is, those couplings of the couplings 7, 8 and 9 which are associated with the non-actuated operating members, the other operating members are adjusted through the relevant amplifiers. Associated with each operating member are the respective amplifiers 13, 14 and 15. The motors 4, 5 and 6 are coupled through the respective circuits 10, 11 and 12 to the electronic processing unit 17 in order to be able to feed the correct control signals to the relevant motors. During the control process the reference value in the memory 18 is also adapted to the adjustment of the operating members so that, as is usual in a control process, the error or control signal takes a continually smaller value until the differential value between feed potentiometer and feed back potentiometer lies below a set value ("dead" band).

When abnormal values are detected in the electronic processing unit 17, which indicates a disturbance, this is shown on the indicator 19 which

generates an audio or visual signal to the user.

Claims

1. Control system consisting of a number of operating members that are connected mutually and to a device for operation, whereby each operating member is coupled to an associated feeding element (1, 2, 3) in the form of a potentiometer, a follower member with an adjustable motor (4, 5, 6) is added to each operating member to cause the other operating members to follow when an operating member is adjusted, and a memory (18) for storing the position of the last adjusted operating member, characterized in that said memory (18) is formed by an electronic memory recording a digital value and in that means (17) are arranged for adapting the content of said memory to the position of an operating member.

2. Control system as claimed in claim 1, characterized in that each feeding element is connected to the memory through an analog-digital converter (16).

3. Control system as claimed in claim 1, whereby control signals for causing operating members to follow are first formed when a predetermined difference is exceeded between the value stored in the memory (18) and the value representing the position of an adjusted operating member, characterized in that the predetermined difference for the last adjusted operating member is smaller than that of the other operating members.

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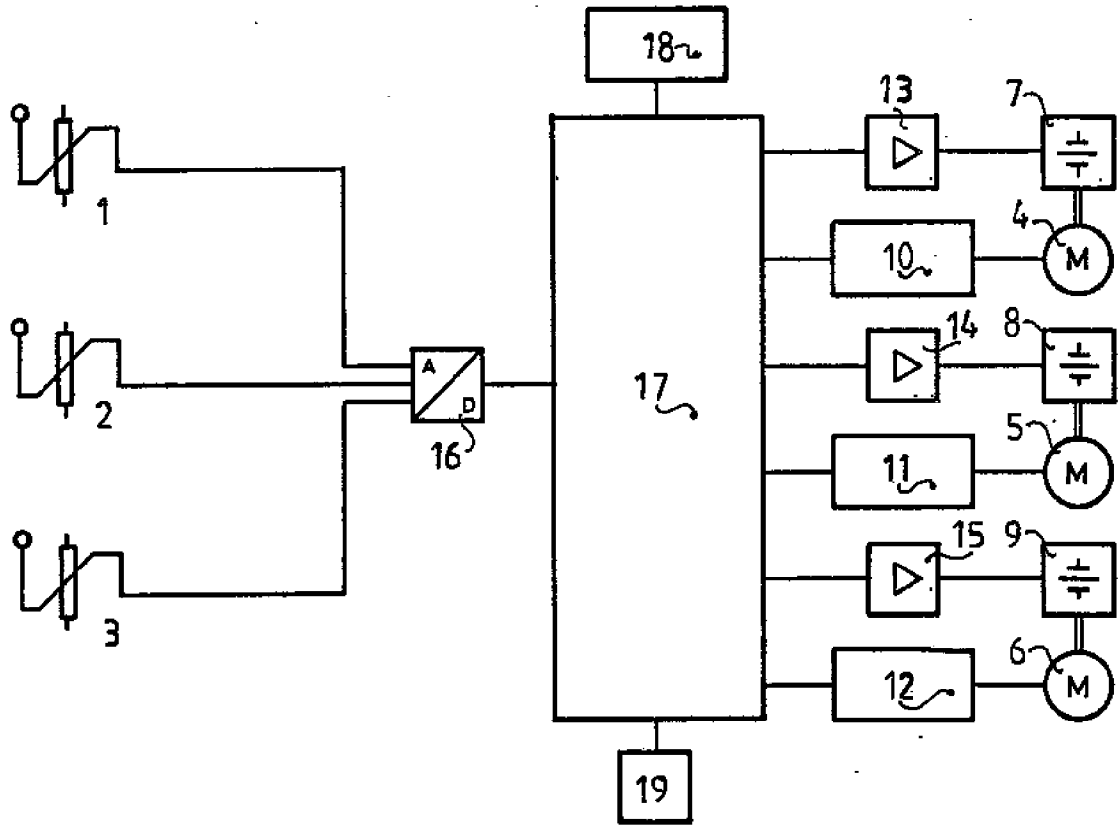


FIG. 1



DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y, D	NL-A-7601464 (STORK KWANT B.V.) * page 2, line 16 - page 3, line 29; figure 1 *	1-3	G05B19/04
Y	DE-A-1763450 (LICENCIA PATENT-VERWALTUNGS-GMBH) * page 2, line 13 - page 3, line 13; figure 1 *	1-3	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			G05B G05D
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 04 SEPTEMBER 1989	Examiner GOETZ P.A.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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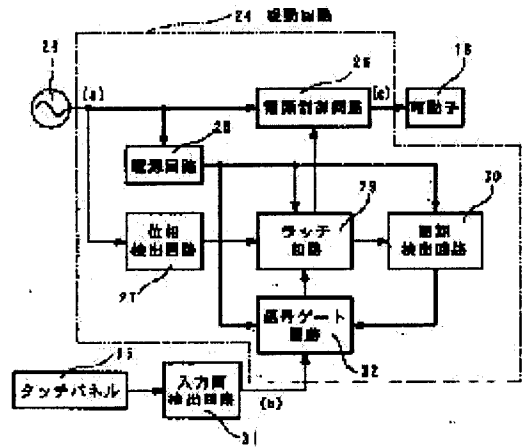
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 KUMAZAWA KIYOHICO
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(54) DEPRESSION SENSATION GENERATING DEVICE FOR TOUCH PANEL

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a depression sensation generating device for a touch panel which securely generates a depression sensation giving no shock, etc.

SOLUTION: This device is equipped with a needle 18 which is provided facing the touch panel 15, a driving waveform output circuit 25 which drives the needle 18, and a driving circuit 24 which moves the touch panel 15 by outputting a driving waveform for a 0.5 to 1.5 cycle, and the driving circuit 24 comprises a phase detecting circuit 27 for the start of operation, a latch circuit 29 which temporarily holds a detected phase, a cycle detecting circuit 30 for the driving waveform, a signal gate circuit 32 which generates a clear signal for a latch of the latch circuit 29, and a power source control circuit 26 which generates the driving waveform of a 0.5 to 1.5 cycle. The driving waveform output circuit 25 can be simplified by using the commercial AC power source.



LEGAL STATUS

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 DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to the feeling generator of press of the touch panel which was made to carry out the feel of having pressed to a direct fingertip in the touch panel which presses and carries out alter operation of the electrode sheet metal with a finger.

[0002]

[Description of the Prior Art] Conventionally, since the stroke when pressing electrode sheet metal with a finger in this kind of touch panel is very small as 0.1-0.5 etc.mm etc., it is unclear whether the switch turns on or not, it will surely press too much strongly and a substrate will bend. Therefore, when a switch turned on, there was a thing of making sound or the color of a press portion changing.

[0003] Some which are sensed by visual sense from which some which make such sound and are sensed by the acoustic sense have a possibility of it being unable to sense in the one hard of hearing, or mistaking for external noise, and a color changes had an oversight, and there was a not employable problem in small equipment. Therefore, when electrode sheet metal is pressed and a switch turns on recently, some which were made to carry out multiple-times vibration have a touch panel.

[0004]

[Problem(s) to be Solved by the Invention] Among these, in some which a touch panel vibrates and sense switch-on, when the vibration when touching electrode sheet metal with a finger continued two or more times, there was a problem that a shock which is receiving an electric shock to the user was given.

[0005] this invention aims at offering the feeling generator of press of the touch panel it was made to make generate certainly, without giving a shock which is receiving an electric shock in 1 time of the feeling of press similar to the feeling of a click at the time of switch-on.

[0006]

[Means for Solving the Problem] In the touch panel with which this invention is detected by the input-screen detector 31, and displayed press of the input screen of a touch panel 15 by the display panel 11 The needle 18 which the aforementioned touch panel 15 was made to face and was prepared, and the drive wave output circuit 25 which outputs the HARASHIN number wave for driving this needle 18, The drive circuit 24 which only 0.5 to 1.5 period outputs the output wave of this drive wave output circuit 25, and carries out movable [of the aforementioned touch panel 15] is provided. this drive circuit 24 The phase detector 27 for detecting the phase of a start of a drive wave of operation, and the latch circuit 29 which holds temporarily the phase detected by this phase detector 27, It is the feeling generator of press of the touch panel characterized by the bird clapper from the periodic detector 30 which detects the period of a drive wave, the signal gate circuit 32 which creates the clear signal of a latch of the aforementioned latch circuit 29, and the power control circuit 26 for making the drive wave of 0.5 to 1.5 period. A shock which is receiving an electric shock is not given by such composition.

[0007] The simplification of a circuit can do the drive wave output circuit 25 by using a commercial alternating current power supply. moreover, the phase detector 27 By detecting the abbreviation 0V point of the alternating current signal of a sine-wave form outputted from the drive wave output circuit

25, and starting a driving signal from this detecting point An injury is not done to a needle 18. further the signal gate circuit 32 After pressing a touch panel 15, when the signal has been sent from the input-screen detector 31 during fixed re-press prohibition time By making the function for canceling this provide, it can prevent that a needle 18 carries out incorrect differential by unstable press operation during re-press prohibition time.

[0008]

[Embodiments of the Invention] One example of the feeling generator of press of the touch panel by this invention is explained based on drawing 1 or drawing 4 . In drawing 3 and drawing 4 , 10 is plate-like housing. ON of the switch of the transparent touch panel 15 of the upper part attaches the plate-like display panel 11 as which a number, a character, a figure, etc. are displayed in the center of the upper surface of this housing 10. It is located in four corners of the periphery of this display panel 11, and the pillar base-like cushion plinth 16 is formed. Although this cushion plinth 16 is a thing made of the rubber for carrying a touch panel 15, if it is too soft not much, since the movement at the time of press of a touch panel 15 will be absorbed, that whose degree of hardness is 50 - 60 degrees is used. Moreover, some bending prevention plinths 17 which suppress the bending when pressing the touch panel 15 other than this cushion plinth 16 are formed in the inferior surface of tongue of a touch panel 15 with few crevices.

[0009] The aforementioned touch panel 15 consists of many insulating salients 13 which consist of an insulating material for making a crevice between the substrate 12 which consists of a transparent glass plate, the electrode sheet metal 14 of two sheets with the transparent upper surface, and these electrode sheet metal 14 of two sheets. The needle 18 which becomes the lower part of the end marginal part of the aforementioned touch panel 15 from the piezoelectric vibrator using the piezoelectric effect is formed. The end face section of this needle 18 is fixed by the susceptor 20, an interstitial segment is supported with the free support shaft 21, and contact 19 prepared in the upper surface of a point is further attached in contact with the inferior surface of tongue of the substrate 12 of a touch panel 15. The periphery enclosure of the upper surface of the aforementioned touch panel 15 has a crevice 23, and is protected by the periphery flange 22.

[0010] The drive circuit 24 which drives the aforementioned needle 18 is shown in drawing 1 . In this drawing 1 , 25 is the drive wave output circuit which used 50 or the 60Hz source-power-supply wave as it was. This drive wave output circuit 25 is connected to the phase detector 27 for detecting the power circuit 28 for supplying DC power supply to the power control circuit 26 for making a drive wave, and each circuit, and the phase of a start of a drive wave of operation. While the periodic detector to which the latch circuit which holds temporarily the wave which detected 29 by the phase detector 27, and 30 detect the period of a drive wave, and 32 create the clear signal of a latch of a latch circuit 29, the signal gate circuit for canceling the instant OFF by the chattering etc. and 31 are input-screen detectors which detect ON of the switch by the touch of a touch panel 15, and OFF.

[0011] Operation by the above circuitry is explained based on drawing 2 . The commercial alternating current power supply from the drive wave output circuit 25 is a power circuit 28, for example, is changed into DC5V and supplied to a latch circuit 29, the periodic detector 30, and the signal gate circuit 32. Moreover, in the phase detector 27, the phase of a 50 or the power supply wave of 60HZ(s) as shown in drawing 2 (a) from the drive wave output circuit 25 is monitored continuously, and the phase a2 when changing from + to - is detected and outputted.

[0012] Here, the upper surface of a touch panel 15 should be pressed with the finger at t 1:00, and the up-and-down electrode sheet metal 14 of two sheets should short-circuit. Then, it is detected by the input-screen detector 31, and a trigger signal is sent to the signal gate circuit 32. In the signal gate circuit 32, the first phase a2 which sent the signal as shown in drawing 2 (b) to the latch circuit 29 based on this trigger signal, and has been sent from the phase detector 27 is latched.

[0013] With the signal from a latch circuit 29, as shown in drawing 2 (c), the gate opens the power control circuit 26 at a 2:00. A signal is simultaneously sent to the periodic detector 30 from a latch circuit 29, for example, one period is detected. One period is set to 20ms when a source power supply is 50Hz. Moreover, one period is set to about 16.7ms when a source power supply is 60Hz. If the signal of

1 period progress outputs from the periodic detector 30, in the signal gate circuit 32, a clear signal will output, it will send to a latch circuit 29, and the gate of the power control circuit 26 will close by the signal from a latch circuit 29. Consequently, the voltage of the sine-wave type of one period as shown in drawing 2 (c) from the power control circuit 26 outputs, and a needle 18 carries out movable up and down only once.

[0014] Thus, although the voltage of - is first impressed to a needle 18 by the half period and the voltage of + is impressed to a needle 18 by the following half period, a needle 18 is set up so that it may be distorted below on the voltage of - and may be distorted upwards on the voltage of +. Thus, since the cushion plinth 16 will be crushed a little and a touch panel 15 will move below when a touch panel 15 is pressed with a finger if constituted, it follows in footsteps of distortion by the lower part by the voltage of - of the point of a needle 18. And a touch panel 15 is momentarily pushed up by the distortion to the upper part by the voltage of + of the following needle 18. This movement gets across to a finger and what the switch turned on is taken in.

[0015] Next, after pressing a touch panel 15, when the signal has been sent from the input-screen detector 31 during fixed re-press prohibition time at t 2:00 during 100ms, it is made for a needle 18 not to drive by unstable press operation by canceling this in the signal gate circuit 32.

[0016] If voltage like pulse shape which rises rapidly is impressed to a needle 18 or it impresses from the high voltage first also with a sine-wave form, a crack may be entered and damaged to the needle 18 which consists of a ceramic, and it is not desirable. Therefore, operation is made to perform a needle 18 by impressing the voltage of a sine-wave form started from 0V to a needle 18 by the aforementioned example smoothly. However, even if the starting potential impressed first is not necessarily from 0V, be made to let it be a certain low voltage. However, the voltage at the time of an end may be any between 0V - peak value.

[0017] In the aforementioned example, simplification of a circuit is enabled by using a source power supply as it is as a drive wave output circuit 25. However, you may be not the thing restricted to this but a separate oscillator circuit.

[0018] Although it is desirable that they are the half period or 1.5 periods which do not give feeling which received an electric shock, but begin from 0V in order to tell the flight readiness of a touch panel 15 certainly to a finger moreover, and return to 0V although used in the aforementioned example by one period which impresses 0V of the sine-wave type of source-power-supply 100V first, and returns to 0V, it can be set as which range between 0.5-1.5Hz.

[0019]

[Effect of the Invention] this invention can make a feeling of press generate certainly, without giving a shock which a touch panel 15 vibrates more than required, and is receiving an electric shock, since the drive wave output circuit 25 which outputs the HARASHIN number for driving a needle 18, and the drive circuit 24 which only 0.5 to 1.5 period outputs the output wave of this drive wave output circuit 25, and carries out movable [of the touch panel 15] were provided.

[0020] By using a commercial alternating current power supply, the drive wave output circuit 25 can simplify circuitry, and can offer cheap equipment.

[0021] The needle 18 which the touch panel 15 was made to face and was prepared, and the drive wave output circuit 25 which outputs the HARASHIN number wave for driving this needle 18, The drive circuit 24 which only 0.5 to 1.5 period outputs the output wave of this drive wave output circuit 25, and carries out movable [of the aforementioned touch panel 15] is provided. this drive circuit 24 The phase detector 27 for detecting the phase of a start of a drive wave of operation, and the latch circuit 29 which holds temporarily the phase detected by this phase detector 27, Since it consists of the periodic detector 30 which detects the period of a drive wave, a signal gate circuit 32 which creates the clear signal of a latch of a latch circuit 29, and a power control circuit 26 for making the drive wave of 0.5 to 1.5 period While being able to set up the phase corresponding to the starting potential of the optimal driving signal for the drive of a needle 18, the output period of a driving signal can be set as the most desirable length. The feeling generator of press of the touch panel characterized by things.

[0022] Since the phase detector 27 detects the abbreviation 0V point of the alternating current signal of a

sine-wave form outputted from the drive wave output circuit 25 and the driving signal was started from this detecting point, breakage of a needle 18 is prevented and operation can be smoothly performed in a needle 18.

[0023] The signal gate circuit 32 carries out operation which a needle 18 did not drive and was stabilized by unstable press operation during re-press prohibition time, such as a chattering, by providing the function for canceling this, when the signal has been sent from the input-screen detector 31 during fixed re-press prohibition time, after pressing a touch panel 15.

[Translation done.]

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 DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the block diagram showing one example of the drive circuit 24 for the feeling generator of press of the touch panel by this invention.

[Drawing 2] It is the output wave form chart of each part in drawing 1 .

[Drawing 3] It is drawing of longitudinal section showing one example of the feeling generator of press of the touch panel by this invention.

[Drawing 4] It is the plan which cut and lacked the part in drawing 3 .

[Description of Notations]

10 [-- A substrate, 13 / -- Insulating salient,] -- Housing, 11 -- A display panel, 12 14 [-- A cushion plinth, 17 / -- Bending prevention plinth,] -- Electrode sheet metal, 15 -- A touch panel, 16 18 [-- A susceptor, 21 / -- A free support shaft, 22 / -- Periphery flange,] -- A needle, 19 -- Contact, 20 23 [-- A drive wave output circuit 26 / -- A power control circuit, 27 / -- A phase detector, 28 / -- A power circuit, 29 / -- A latch circuit, 30 / -- A periodic detector, 31 / -- An input-screen detector, 32 / -- Signal gate circuit.] -- A crevice, 24 -- A drive circuit, 25

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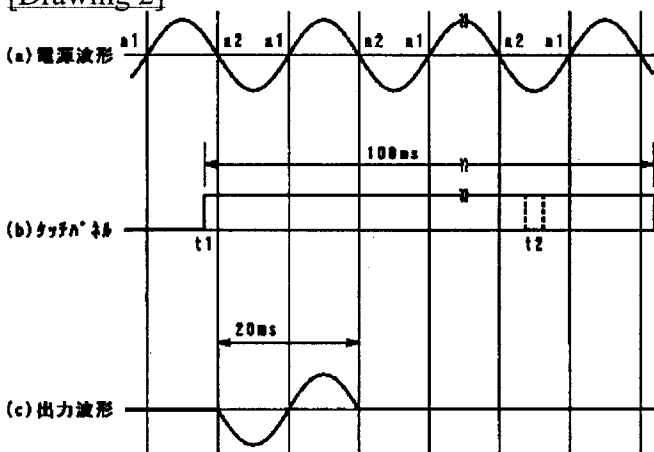
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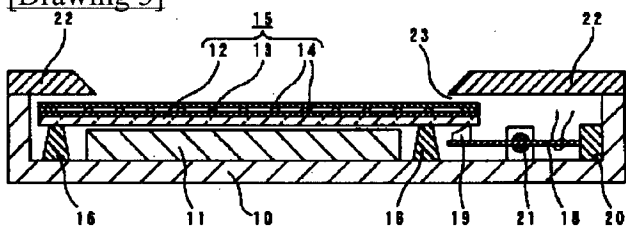
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DRAWINGS

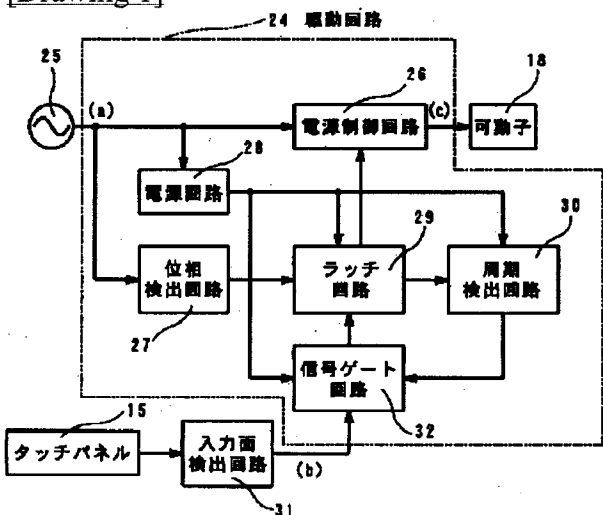
[Drawing 2]



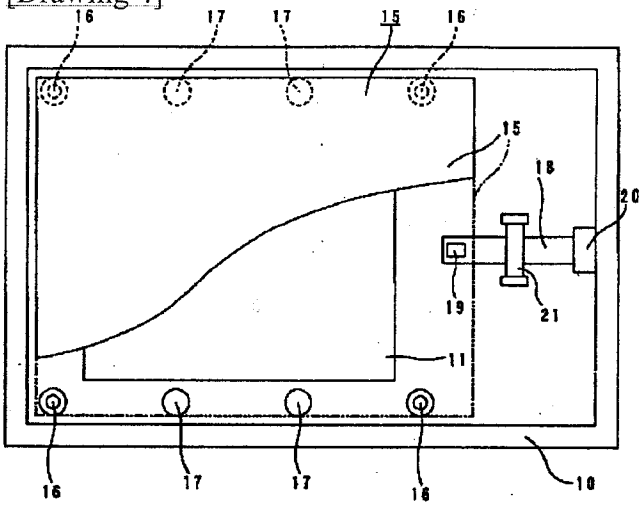
[Drawing 3]



[Drawing 1]



[Drawing 4]



[Translation done.]

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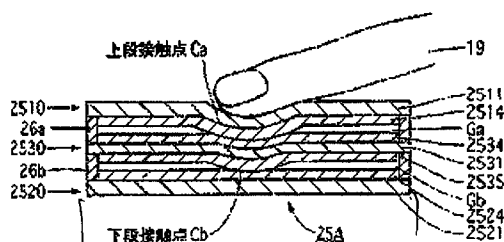
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(54) 【発明の名称】 入力装置

(57) 【要約】

【課題】 使用者が入力操作を行う場合に混乱を来すことなく確実に入力でき、しかも複雑な機能に対しても、簡単な操作、少ない指動作によって入力でき、また、使用者の指の感覚に力覚による帰還を可能にした入力装置を提供すること。

【解決手段】 本発明の入力装置 1 に組み込まれている第 1 実施形態の 2 段型タッチパネル 2 5 A は、両面に透明電極 2 5 3 4、2 5 3 5 が成膜されている透明な可撓性のある中間電極シート 2 5 3 0 を挟んで、前記両透明電極からそれぞれ所定の均一な間隙 G a、G b を開けて、入力操作側に透明電極 2 5 3 4 に対面した透明電極 2 5 1 4 が成膜された透明な可撓性のある上側電極シート 2 5 1 0 が、そして表示装置 2 4 側の透明電極 2 5 3 5 に対面した透明電極 2 5 2 4 が成膜された透明な下側電極シート 2 5 2 0 がそれぞれ積層されて構成されている。



voice coil

(2) 特開2002-259059

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【特許請求の範囲】

【請求項1】 平面座標系において、同一座標軸上に少なくとも2つの接点が形成されているタッチパネルを備えた入力装置。

【請求項2】 前記少なくとも2つの接点のそれぞれに厚み方向に間隙が形成されているタッチパネルであることを特徴とする請求項1に記載の入力装置。

【請求項3】 前記タッチパネルはその少なくとも被入力領域が透明で、表示装置の表示面に重ね合わされていることを特徴とする請求項1または請求項2に記載の入力装置。

【請求項4】 前記各接点の少なくとも1つの接点の通電に連動して作動するアクチュエータ及びそのドライバ回路を備えていることを特徴とする請求項1乃至請求項3に記載の入力装置。

【請求項5】 前記アクチュエータは同一座標上の各接点の動作にตอบสนองして動作態様に変化する力覚を帰還させることを特徴とする請求項4に記載の入力装置。

【請求項6】 両面に透明電極が成膜されている所定の厚みの透明な可撓性のある中間電極シートを挟んで、前記両透明電極からそれぞれ所定の均一な間隙を開けて、入力操作側に前記一方の透明電極に対面した透明電極が成膜された透明な可撓性のある上側電極シートが、そして表示装置側に前記他方の透明電極に対面した透明電極が成膜された透明な下側電極シートがそれぞれ積層されて構成されているタッチパネルを備えた入力装置。

【請求項7】 前記中間電極シートが複数枚、所定の間隙を開けて配設されているタッチパネルであることを特徴とする請求項6に記載の入力装置。

【請求項8】 前記中間電極シートと前記前記上側電極シートとで1段目タッチパネルが、前記中間電極シートと前記下側電極シートとで最終段目タッチパネルが構成されているタッチパネルであることを特徴とする請求項6に記載の入力装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、入力装置に係り、特に押圧による入力操作が確実に行われたことを使用者が実感できる入力装置に関するものである。

【0002】

【従来の技術】先ず、図13乃至図20を参照しながら、従来の技術の入力装置を説明する。

【0003】図13は入力装置の正面図、図14は図13に示した入力装置の一部拡大正面図、図15は図13に示した入力装置の表示部の分解斜視図、図16は図13に示した入力装置の表示部の断面側面図、図17は図16に示した表示部を構成する従来の技術の1段タッチパネルの分解斜視図、図18は図16に示した1段タッチパネルの断面側面図、図19は図17に示した1段タッチパネルの動作を説明するための図16に示した表示部

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の断面側面図、そして図20は図16に示した従来技術の1段タッチパネルの押圧力P-変位δ特性曲線である。

【0004】図13において、符号1は従来技術の入力装置を指す。この入力装置1は、情報端末等の小型携帯型情報入力装置、カーナビゲーションシステム、コンピュータ等に用いられている。

【0005】この入力装置1は、扁平な直方体状をなす外筐10を備えるとともに、外筐10の両側端にはそれぞれフレーム11が結合されて補強されている。そして外筐10の上面にはタッチパネルを兼用する表示部12が設けられている。この表示部12の下側には入力パネル13が設けられると共に、入力パネル13の下方に複数の操作部14が配されている。

【0006】入力装置1はその表示部12上にタッチパネル機能を具備し、表示部12の表示によって映出されたメニュー、アイコンなどと座標系が1対1で対応しており、図14、図16に示したように、使用者が選択したい項目の箇所のタッチパネル（後記）を指示具18または指19などで押圧することによって入力イベントを受付けるようになっている。

【0007】表示部12は、図15及び図16に示すように、下から表示パネル24、タッチパネル25から構成されている。その表示パネル24は所定の表示を行なうようになされており、液晶ディスプレイ、有機ELディスプレイ、CRT（Cathode Ray Tube）ディスプレイ等、平面ディスプレイや曲面ディスプレイ等がある。タッチパネル25は入力操作を伴ってスイッチング動作を行なうように構成されており、抵抗膜式、その他の方式がある。このような表示パネル24及びタッチパネル25は、図16に示したように、重ね合わされ、外筐10に収められて使用される。

【0008】なお、表示パネル24には、配線引き出しの為の、例えば、フレキシブル配線板、ディスプレイを駆動する為のドライバ回路、更に、特にLCDパネルに関しては、発光部、導光板、拡散板、昇圧回路などのバックライト部が接続されるが、ここでは、それらの図示を省略した。

【0009】従来技術のタッチパネル25は1段階の入力機能のみしか備えていない。即ち、抵抗膜式タッチパネルを例に挙げて、その構造を説明すると、図17及び図18に示したように、上側電極シート2510と下側電極シート2520とがスペーサ26（図19）により均一に僅かな間隙Gを開けて構成されている。

【0010】上側電極シート2510は可撓性を持った透明プラスチック製のシート基材2511の外側、内側両面に反射防止膜2512、2513が成膜されており、その内の内側反射防止膜2513の表面に透明電極2514が成膜されている。この透明電極2514としては、例えば、ITO（Indium Tin Oxide）

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de:インジウム錫酸化物)薄膜などが好ましい、同様に、下側電極シート2520も可撓性を持った透明プラスチック製のシート基材2521の外側、内側両面に反射防止膜2522、2523が成膜されており、その内の内側反射防止膜2523の表面に透明電極2524が成膜されている。なお、反射防止膜2512、2513、2522、2523は透過光の反射を抑制するための膜である。それぞれの透明電極2514、2524にはそれぞれ引出線2515、2525が導出されている(図17)。そして前記タッチパネル25は両透明電極2514、2524を向き合わせ、前記のように、スペーサ26を用いて僅かな間隙Gを開けて上側電極シート2510と下側電極シート2520とを配置した構造のものである。

【0011】次に、このタッチパネル25の動作及びその特性を図19及び図20を用いて説明する。

【0012】前記のように、使用者が指示具18または指19で表示パネル24で表示部12に表示された項目、ファイルなどを選択、押圧することにより入力される。即ち、この入力操作によって、タッチパネル25の特定位置の上側電極シート2510が押圧されて、その透明電極2514が下側電極シート2520の透明電極2524に接触する。この両者の接触点Pまでの抵抗値を測定することで入力位置座標を特定することができる。

【0013】

【発明が解決しようとする課題】とところが、このような入力操作の際に、従来技術のタッチパネル25では、そのタッチパネル25自体の押し下げ力Pに対する上側電極シート2510の変位 δ をグラフで示すと、図20に示すようなP- δ 曲線1になる。即ち、押し始めの際、先ず上側電極シート2510の弾性により、曲線の傾きが小さい1を辿り、屈折点2において双方のシート2510、2520が接触する。更に押し込むと、下側電極シート2520を押し込むことになり、直線3のように曲線1の傾きがより大きくなる。しかし、このような入力操作の場合に、使用者にはどの時点でタッチパネル25がONになって入力イベントが発生したか判り難い。

【0014】また、このような1段階の入力装置を用いる限り、前記のように項目やファイルなどを選択することはできるが、これに実行などの指示を与えたり、異なった操作を加える時には、時系列的な入力の組み合わせ、例えば、或る一定時間以上押し続けたり、或いは或る一定時間内に同一箇所を2回以上連続して押す操作が必要であった。

【0015】このような方法は、小型携帯機器における小さな表示画面上では難しく、また、一定の実時間を要するため、素早い操作が難しくなる。また、実時間を測定するタイマーからの割り込み処理が信号処理作業に負荷を掛けることになる。

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【0016】更にまた、タッチパネル25には入力操作を行なう使用者の指19などに対して、反力を帰還(フイードバック)させる機能が無く、音声出力から出力される音であったり、表示部12の一部の表示を変化させることで、入力操作受付の帰還を行っていた。しかし、使用者が表示部12を見ないで行なう入力操作や素早い入力操作に対し、操作自体が機器側に受け入れられたのかどうか、使用者には判りづかった。

【0017】本発明はこのような問題点に鑑みてなされたものであって、使用者の入力操作に対して、使用者が入力操作を行う場合に復乱を来すことなく確実に入力でき、しかも複雑な機能に対しても、簡単な操作、少ない指動作によって入力でき、また、使用者の指の触覚に力覚による帰還を可能にした入力装置を提供することを目的とする。

【0018】

【課題を解決するための手段】従って、本願の主発明の入力装置は、平面座標系において、同一座標軸上に少なくとも2つの接点が形成されているタッチパネルを備えた入力装置に関するものである。

【0019】そのタッチパネルには、2つの接点のそれぞれに厚み方向に間隙が形成されており、そして、そのタッチパネルはその少なくとも被入力領域が透明で、表示装置の表示面に重ね合わせて用いて好適である。

【0020】また、本願の他の主発明の入力装置では、前記タッチパネルが前記各接点の通電に連動して作動するアクチュエータ及びそのドライバ回路を備えており、更にまた、前記アクチュエータは同一座標上の各接点毎に応じて動作態様が変化する力覚を帰還させることである。

【0021】更にまた、本願に含まれる発明の好ましい実施態様の入力装置は、両面に透明電極が成膜されている所定の厚みの透明な可撓性のある中間電極シートを挟んで、前記両透明電極からそれぞれ所定の均一な間隙を開けて、入力操作側に前記一方の透明電極に対面した透明電極が成膜された透明な可撓性のある上側電極シートが、そして表示装置側に前記他方の透明電極に対面した透明電極が成膜された透明な下側電極シートがそれぞれ積層されて構成されているタッチパネルを備えており、その中間電極シートは複数枚、所定の間隙を開けて配設されて多段のタッチパネルとしてもよい。また、この多段タッチパネルは前記中間電極シートと前記上側電極シートとで1段目タッチパネルが、前記中間電極シートと前記下側電極シートとで最終段目タッチパネルが構成されるものである。

【0022】従って、本発明によれば、指示具或いは指が接触する表面の電極シートを指示具或いは指で押圧すると、先ず、その表面の電極シートが押し込まれて直下の間隙を潰し、対面する両透明電極が接触し、更に押圧すること中間の電極シートも押し込まれて、その直下の

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間隙も潰され、対面する中間電極シートの透明電極と対向する下側電極シートの透明電極とが接触する。中間電極シートが多層積層されておれば、以下同様に多段にわたって間隙を潰し、対向する両透明電極を接触させることができ、同一座標上で透明電極を複数接触させることができる。

【0023】このような多段タッチパネルに構成すれば、各段の接点に力覚帰還機構を具備させることができ、従って、各接点毎に動作態様を異ならせることもできる。

【0024】

【発明の実施の形態】以下、本発明の入力装置の実施形態を図を用いて説明する。

【0025】図1は本発明に用いて好適な第1実施形態の2段型タッチパネルの分解斜視図、図2は図1に示した2段型タッチパネルの一部の断面側面図、図3は図1に示した2段型タッチパネルを組み立てた状態で、指で最初の段階の入力を行った状態を示す断面側面図、図4は図3の状態から指で更に押圧した状態の2段型タッチパネルの断面側面図、図5は図1に示した第1実施形態の2段型タッチパネルの押圧力特性曲線、図6は第2実施形態の力覚帰還機構を付加した2段型タッチパネルの断面側面図、図7は図6に示した第2実施形態の2段型タッチパネルの押圧力特性曲線、図8は図6に示した第2実施形態の2段型タッチパネルの他の押圧力特性曲線、図10は2段型タッチパネルで入力した場合のフローチャート、図10は本実施形態の2段型タッチパネルと力覚帰還も含めた使用者への帰還を行うための処理回路のブロック図、図11は図10に示した処理回路の変形を示した他の処理回路のブロック図、そして図12は図11に示した処理回路の動作を説明するためのタイムチャートである。

【0026】先ず、図1乃至図3を用いて、本発明の入力装置に用いて好適な一実施形態の多段タッチパネルを説明する。

【0027】なお、以下の実施形態においては、多段タッチパネルの一形態として2段型タッチパネルを例示して説明する。そして、従来技術の1段タッチパネルの構成部分と同一の構成部分には同一の符号を付して説明する。

【0028】また、本多段タッチパネルも【従来の技術】の項で説明したように、情報端末等の小型携帯型情報入力装置、カーナビゲーションシステム、コンピュータ等に用いられる入力装置であって、その装置の一例は図13に示したものと同様である。従って、以下の説明では、図13、図14、図15に相当する図面は省略する。

【0029】図1において、符号25Aは全体として2段型タッチパネルを指す。この2段型タッチパネル25Aは、上側電極シート2510、下側電極シート2520

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0、中間電極シート2530、及び上段スペーサ26aと下段スペーサ26bとからなる。なお、上側電極シート2510と下側電極シート2520の構造は従来技術のものと同じであるので、それらの説明は省略する。

【0030】中間電極シート2530は、これも可撓性を持った透明プラスチック製のものであって、シート基材2531の外側、内側両面に反射防止膜2532、2533が成膜されており、更に、それらの反射防止膜2532、2533の表面に透明電極2534、2535が成膜されている。そしてそれぞれの透明電極2534、2535にはそれぞれ引出線2536、2537が導出されている。なお、反射防止膜2522、2523は反射防止膜2512、2513、2522、2523と同様に透過光の反射を抑制するための膜である。

【0031】シート基材2511、2521、2531の透明プラスチックとしては、PET（ポリエチレンテレフタレート）、PMMA（アクリル：ポリメタクリル酸メチル）、PI（ポリイミド）、PE（ポリエチレン）、ポリウレタンのような軟質のプラスチックを用いることができる。また、下側のシート基材2521にはガラスなどの透明な材料を用いてもよい。更にまた、透明電極2534、2535としては、透明電極2514、2524と同様に、例えば、ITO（Indium Tin Oxide：インジウム錫酸化物）薄膜などを用いることができる。

【0032】このような3枚の上側電極シート2510、下側電極シート2520及び中間電極シート2530は、図3に示したように、下側電極シート2520の上に下段スペーサ26bを用いて中間電極シート2530を支持し、両者間に所定の間隙を形成し、同様に中間電極シート2530の上に上段スペーサ26aを用いて上側電極シート2510を支持し、両者間に所定の間隙を形成して組み立てることにより2段型タッチパネル25Aを構成することができる。上側電極シート2510と中間電極シート2530とギャップGaで1段目タッチパネルを構成し、中間電極シート2530と下側電極シート2520とギャップGbとで2段目タッチパネルを構成し、従って、透明電極2514と透明電極2534とが1段目タッチパネルの接点であり、透明電極2535と透明電極2524とが2段目タッチパネルの接点となる。なお、図3では全ての反射防止膜2512、2513、2522、2523、2532、2533の図示を省略した。

【0033】次に、図3乃至図5を用いて、本実施形態の2段型タッチパネル25Aの動作機構を説明する。

【0034】先ず、使用者が、例えば、指19による入力に際して、入力箇所近傍を中心に上側電極シート2510の表面を押圧することにより、その押圧部分が押下げられて窪み、上側電極シート2510の透明電極2514が中間電極シート2530の上側の透明電極253

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4に接触する(上段接点Ca)。更に、押し込むと、図4に示したように、中間電極シート2530が上側電極シート2510に押されて屈曲し、その透明電極2535が下側電極シート2520の透明電極2524に接触する(下段接点Cb)。

【0035】この第1実施形態の2段型タッチパネル25Aは、使用者が指19で押下すると、図5に示したような押圧力特性曲線2を持つ。符号2の時点では、上側電極シート2510の透明電極2514が中間電極シート2530の透明電極2534に接触して通電が起こり、更に、上側電極シート2510を押圧すると、符号4で示す過程で、中間電極シート2530が押圧され、符号5で示す時点で、その下側の透明電極2535が下側電極シート2520の透明電極2524に接触し、通電する。ここから更に押し込むと、符号6で示した過程で大きな傾きを持たせることで、使用者に2段目が接触したことを知らせることができる。なお、図5には、参考までに、図20に示した従来技術の1段型タッチパネル25の押圧力特性曲線1を点線で併せて示した。

【0036】この2段型タッチパネル25Aは、従来技術の1段型タッチパネル25と異なり、同一の座標軸上に2つの接点を設けた構造のものであって、使用者は入力操作に混乱を来すことなく入力操作を行うことができるなど、優れた効果を得られるものではあるが、押圧力特性曲線2における符号2及び符号5の接触時点が使用者には感覚的に明確に判然としない。この課題を解消するために、視覚的作用、聴覚的作用、或いは力覚的作用を使用者に帰還させれば一層効果的になる。中でも力覚的作用を使用者の指などに帰還させれば、視覚や聴覚と異なり、使用者に入力がか確かに行われたことを伝えることができる。

【0037】その力覚帰還機構を備えた第2実施形態の2段型タッチパネル25Bを図6に示した。その2段型タッチパネル25Bの構造を図6を用いて説明する。

【0038】この2段型タッチパネル25Bは前記の2段型タッチパネル25Aが筐体10(平面が長方形)の一部分の表面に固定されており、その下方の筐体10内部に表示パネル24が収容、固定され、そして筐体10の外周面にアクチュエータの一つである角形ボビンに巻回されたボビンコイル35Aがはめ込まれている。なお、本図においても、2段型タッチパネル25Aには反射防止膜2512、2513、2522、2523、2532、2533の図示を省略した。

【0039】ボビンコイル35Aは1段目タッチパネルを構成する透明電極2514と透明電極2534とからなる接点及び2段目タッチパネルを構成する透明電極2534と透明電極2524とからなる接点の通電に連動して作動するように接続されており(後記の図10、図11)、2段型タッチパネル25Bに組み込まれている。

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【0040】2段型タッチパネル25Bをこのように構成することにより、使用者に力覚感覚が伝えられる。その力覚感覚を図7を用いて説明すると、使用者が、例えば、図3に示したように、指19で1段目タッチパネルである上側電極シート2510を押圧すると、その押圧した当初は上側電極シート2510の弾性により、曲線の傾きが小さい符号1を辿り、屈折点2において上側電極シート2510の透明電極2514と中間電極シート2530の透明電極2534とが接触すると、力覚機構であるボビンコイル35Aが作動し、使用者の指19は使用者側に押し戻され、この押し戻し力に抗して、図4に示したように、更に押し込むと、屈折点4において2段目タッチパネルである中間電極シート2530の透明電極2535と下側電極シート2520の透明電極2524と接触し、同時にボビンコイル35Aが更に作動して、符号5で示したように、使用者の指19は使用者側に押し戻され、使用者は入力されたことを力覚として知覚できる。そして、この押し戻し力に抗して更に押し続けると、符号6で示した大きな傾きの過程を辿って2つの入力が終了したことを知らせることができる。

【0041】図6及び図7に示した2段型タッチパネル25B例では、1段目及び2段目のタッチパネルの各段に力覚帰還機構(ボビンコイル35Aなど)を付加して力覚帰還応答があるように構成したが、この力覚帰還機構は何れか一方のタッチパネルに付加してもよい。図8は1段目タッチパネルには力覚帰還機構を付加せず、2段目タッチパネルに力覚帰還機構を付加した場合の押圧力特性曲線である。このような構成の場合は、使用者が指19で上側電極シート2510を押圧して1段目タッチパネルの接点が接触しても、ボビンコイル35Aは作動せず、更に押圧して1段タッチパネルの前記接点が接触した場合に、ボビンコイル35Aが作動し、指19に符号5で示したような押し戻し力が発生するようにしたものである。

【0042】前記1段目タッチパネルと2段目タッチパネルの力覚帰還応答の種類としては、振動周波数、振幅、波形及び波形プロファイルの異なる振動を帰還させる方がよい。このようにすると、各段が確実に入力されたことがより一層知覚し易くなる。

【0043】これら2段型タッチパネル25A、25Bからの入力情報として、ON・OFF及び座標情報取得するサブルーチンにおけるフローチャートを図10に示した。機構上、必ず上側電極シート2510から入力信号が入るため、まず、上側電極シート2510の入力信号待ちを行なう(S1)。1段目タッチパネル(上側電極シート2510と中間電極シート2530との組合せ)から入力信号が入ると、まず、その抵抗値から座標の特定を行ない(S2)。座標情報をRAM(Random Access Memory:読み書き可能な記録素子)に書き込む。更に、2段目タッチパネル(中間電

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種シート2530と下側電極シート2520との組合せ)からの入力待機を開始し(S3)。ここに入力があった場合、その抵抗値から入力座標を特定し(S4)、RAM内の1段目座標データを2段目座標データに書き換える。また、現在、メモリー上に書き込まれている座標が2段目の入力であることを表すために、フラグを書きこむ(S5)。

【0044】次に、図10を用いて、前記のサブルーチンワークを含めて第2実施形態の2段型タッチパネル25Bと力覚も含めた使用者への帰還を行なうための処理回路を説明する。

【0045】この処理回路30Aは、前記の2段型タッチパネル25B及び駆動用ドライバ回路31、32に加え、例えば、マイクロコンピュータなどを含む中央処理装置33及びデータを格納するためのRAM、ROMと言ったメモリー34、出力装置35から構成されている。出力装置35は聴覚的出力としての、例えば、スピーカ、視覚的出力としての、例えば、ディスプレイ、そして力覚的出力としてのアクチュエータ、例えば、ホビンコイル35Aから構成されている。これらの出力は入力された操作項目に応じて、適切な出力装置35を選択しながら、使用者に対し帰還を行なうシステムとなっている。

【0046】図10では、各段のタッチパネルに対してそれぞれドライバ回路31、32が必要であるが、図11に示したように、2段型タッチパネル25Bと共通のドライバ回路37の間に切替器36を配し、中央処理装置33によって2段型タッチパネル25Bの1段目タッ

*チパネルと2段目タッチパネルの切替を制御することによって、ドライバ回路37が1つで済む。この切替器36は、中央処理装置33のベースクロックを元に、或る一定周期で切替信号を出力するトリガ回路38からの切替情報を受け、時系列的な切替を行なうことができる。この時の各段階でのタイムチャートを図12に示した。トリガ回路38の出力電圧がVHの時は、例えば、1段目タッチパネルがドライバ回路37と接続される。逆に、トリガ回路38の出力電圧がVLの時は、2段目タッチパネルがドライバ回路37と接続される。これらの接続状態が比較的短い時間、例えば、数m秒の周期で繰り返されるため、使用者には、実時間上、支障無く2段型タッチパネル25Bを使用することができる。

【0047】この2段型タッチパネル25A(或いは25B)を使用して、各段のタッチパネルがON及びOFFとなったそれぞれの時点に対し、特定のイベントを割り当てることで、使用者はより直感的な操作により機器を扱うことができる。表1に各ON/OFF時点でのイベント割り当ての例を列挙した。これらの機能はディスプレイ画面上のGUI(Graphical User Interfaceの略)環境と組み合わせるとより効果的である。ここで挙げた機能の組合せはあくまでも一例であり、これ以外の機能も付加することが可能である。また、アプリケーションソフトウェア上では、プログラム作成者がソフトウェアの形態、ツール、機能項目に合わせて機能を割り当てることができる。

【表1】

操作	1段目の割り当て機能		2段目の割り当て機能	
	押下	解放	押下	解放
電気的状態	OFF →ON	ON →OFF	OFF →ON	ON →OFF
	座標指定、選択	選択解除	-	指定された座標が指し示すプログラムを実行
	座標指定、選択	選択解除	指定された座標が指し示す項目の一覧を表示	一覧表示の解除、選択項目の実行
	座標指定、選択	選択解除	ドラッグ操作	ドロップ操作
	前方スクロール	前方スクロール解除	後方スクロール	後方スクロール解除
	画像の連続拡大	画像の連続拡大終了	画像の連続縮小	画像の連続縮小終了
	音量の連続増大	音量の連続増大終了	音量の連続縮小	音量の連続縮小終了
	項目の連続順送り	項目の連続順送り終了	項目の連続逆送り	項目の連続逆送り終了
	文字順列の連続順送り	文字順列の連続順送り終了	音量の連続逆送り	文字順列の連続逆送り終了
	メモリーアドレス番地の連続インクリメント	メモリーアドレス番地の連続インクリメント終了	メモリーアドレス番地の連続デクリメント	メモリーアドレス番地の連続デクリメント終了
	メモリー値の連続インクリメント	メモリー値の連続インクリメント終了	メモリー値の連続デクリメント	メモリー値の連続デクリメント終了

以上、本発明を図示の複数の実施形態によって説明したが、本発明はこれらの実施形態のみに限定されるものではなく、本願に含まれる発明の技術的思想の範囲内で各

種の変更が可能である。例えば、前記の各実施形態では、同一の座標軸上に2つの接点を設けた構造のものであるが、中間電極シート2530の枚数を増やすことに

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より、3以上の接点を形成できる多段タッチパネルを構成できることが容易に理解されよう。

【0048】また、アクチュエータはボビンコイルのみに限定されるものではなく、ソレノイド、圧電素子、モータなどであってもよい。

【0049】更にまた、前記第2実施形態の2段型タッチパネル25Bにおいては、力覚帰還機構を各段に設けたが、どちらかの段のタッチパネルのみに設けるだけでもよい。

【0050】

【発明の効果】本願の主要な発明は、既存の機器の形態を保ち、1段目タッチパネルをこれまでの入力手順に準拠させることで、使用者は入力操作に混乱をきたすことがなくなる。更に、2段タッチパネルに表1の機能を割り当てることによって、使用者は複雑な機能に対しても、簡単な操作、少ない指動作によって指示することができる。

【0051】これら2点により、使用者は素早い入力操作ができるようになり、ストレスを感じる数が少なくなる。また、力覚による帰還機構と組み合わせることにより、使用者は画面の確認が少なくなり、特に手馴れた一連の操作に関しては、各段に素早い入力操作を行うことができるようになる。

【0052】また、本願の他の主要な発明では、力覚帰還機構は処理装置の指令により制御されている。従って、ソフトウェアドライバにより画一化することで、オペレーションシステム及びアプリケーションソフトウェアからの制御が可能となる。よって、ソフトウェア製作者は既存の感覚及び視覚による出力機構に加え、力覚機構を活用したソフトウェアを作成することができ、より広い表現力を持ったソフトウェアを提供することができる。また、使用者は機器に対し、より友好的な感覚でソフトウェアを使用することができる。

【図面の簡単な説明】

【図1】 本発明に用いて好適な第1実施形態の2段型タッチパネルの分解斜視図である。

【図2】 図1に示した2段型タッチパネルの一部の断面側面図である。

【図3】 図1に示した2段型タッチパネルを組み立てた状態で、指で最初の段階の入力を行った状態を示す断面側面図である。

【図4】 図3の状態から指で更に押圧した状態の2段型タッチパネルの断面側面図である。

【図5】 図1に示した第1実施形態の2段型タッチパネルの押圧力特性曲線である。

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【図6】 第2実施形態の力覚帰還機構を付加した2段型タッチパネルの断面側面図である。

【図7】 図6に示した第2実施形態の2段型タッチパネルの押圧力特性曲線である。

【図8】 図6に示した第2実施形態の2段型タッチパネルの他の押圧力特性曲線である。

【図9】 2段型タッチパネルで入力した場合のフローチャートである。

【図10】 本実施形態の2段型タッチパネルと力覚帰還も含めた使用者への帰還を行うための処理回路のブロック図である。

【図11】 図10に示した処理回路の変形を示した他の処理回路のブロック図である。

【図12】 図11に示した処理回路の動作を説明するためのタイムチャートである。

【図13】 一般的な入力装置の正面図である。

【図14】 図13に示した入力装置の一部拡大正面図である。

【図15】 図13に示した入力装置の表示部の分解斜視図である。

【図16】 図13に示した入力装置の表示部の断面側面図である。

【図17】 図16に示した表示部を構成する従来技術の1段タッチパネルの分解斜視図である。

【図18】 図16に示した1段タッチパネルの断面側面図である。

【図19】 図17に示した1段タッチパネルの動作を説明するための図16に示した表示部の断面側面図である。

【図20】 図16に示した従来技術の1段タッチパネルの押圧力P-変位 δ 特性曲線である。

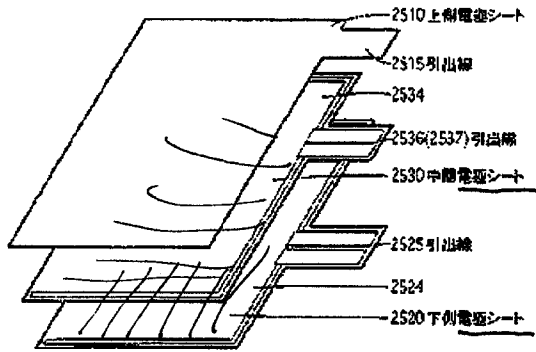
【符号の説明】

10…筐体、11…フレーム、12…表示部、13…入力パネル、14…操作部、18…支持具、19…指、24…表示パネル、25A…本発明の第1実施形態の2段型タッチパネル、2510…上側電極シート、2511、2521、2531…シート基材、2520…下側電極シート、2530…中間電極シート、26a…上段スペーサ、26b…下段スペーサ、2514、2515、2524、2525、2534、2535…透明電極、25B…本発明の第2実施形態の2段型タッチパネル、33…処理部、34…メモリー、35…出力装置、35A…ボビンコイル、36…切換器、Ga、Gb…ギャップ

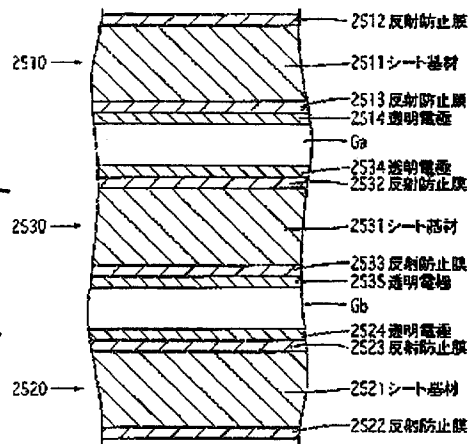
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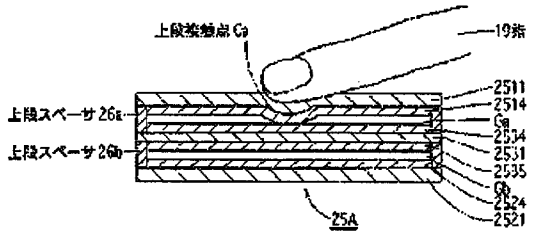
【図1】



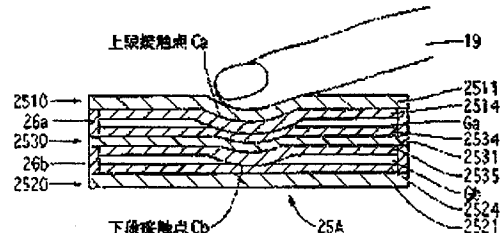
【図2】



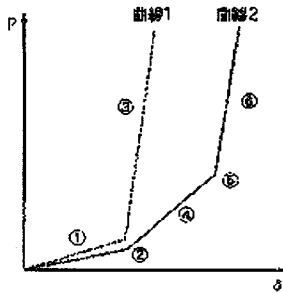
【図3】



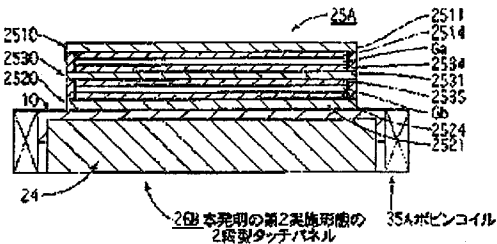
【図4】



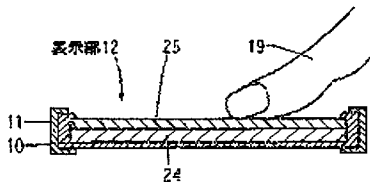
【図5】



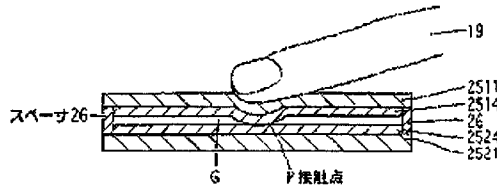
【図6】



【図16】



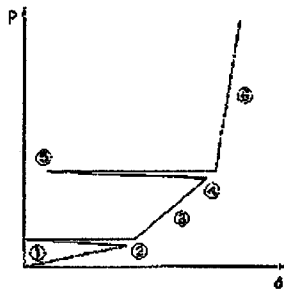
【図19】



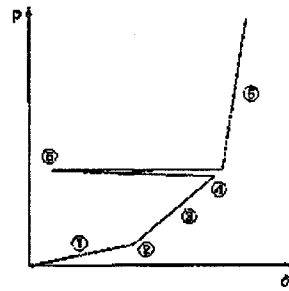
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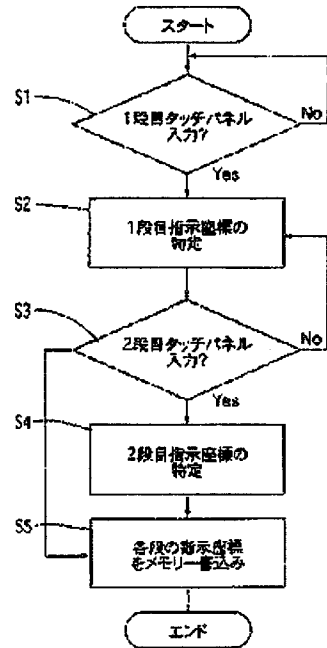
【図7】



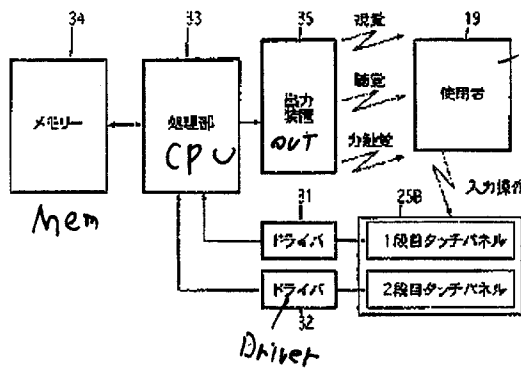
【図8】



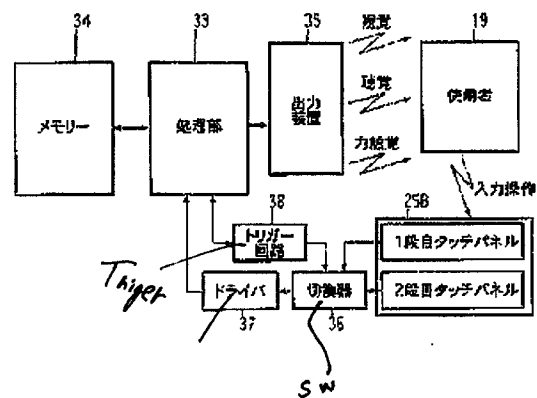
【図9】



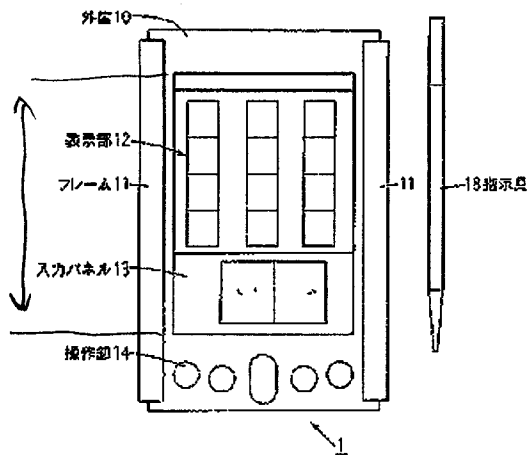
【図10】



【図11】



【図13】



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【図12】

【図20】

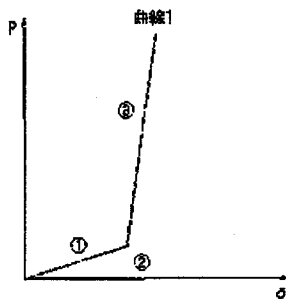
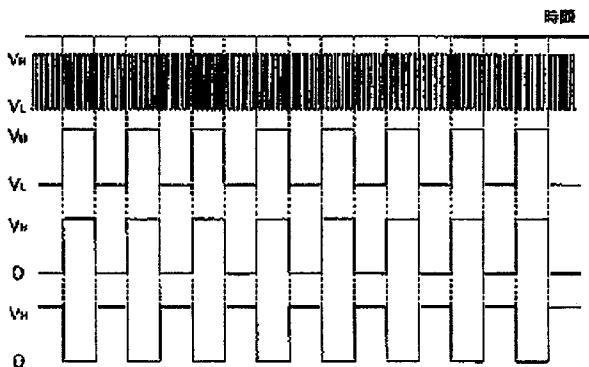
Base Clock
ベースクロック

Trigger
トリガー回路
出力電圧

1st
2nd

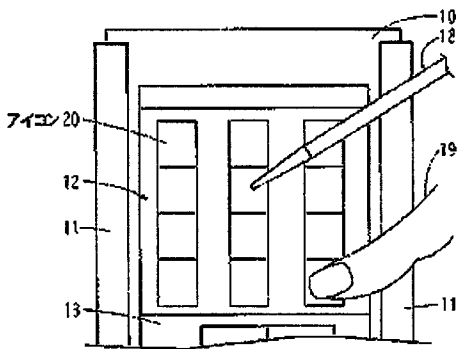
1段目タッチパネル
供給電圧

2段目タッチパネル
供給電圧

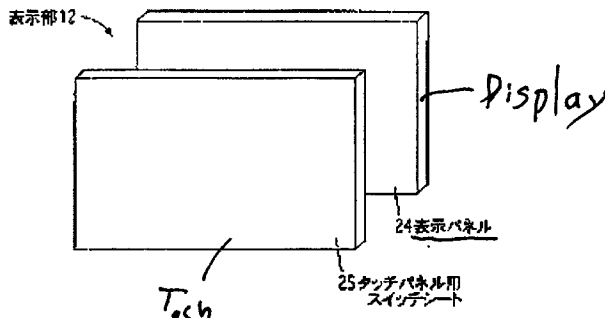


【図14】

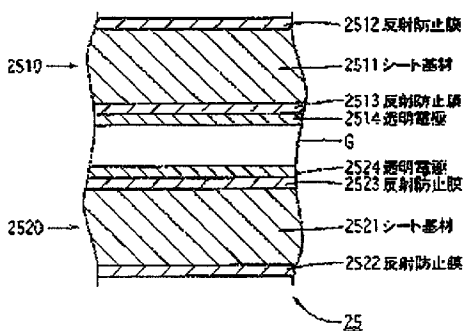
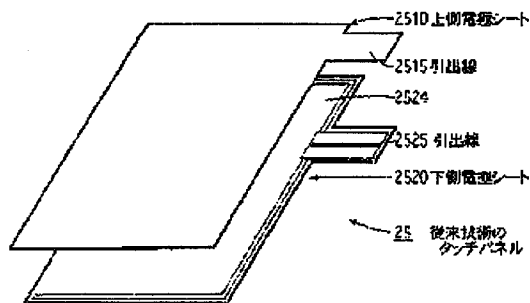
【図15】



【図17】



【図18】





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TECHNICAL FIELD

[The technical field to which invention belongs] this invention relates to the input unit with which a user can realize that started the input unit, especially alter operation by press was performed certainly.

[Translation done.]

JP Patent Application
P2002-259059A

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 DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to the input unit with which a user can realize that started the input unit, especially alter operation by press was performed certainly.

[0002]

[Description of the Prior Art] First, the input unit of the conventional technology is explained, referring to drawing 13 or drawing 20.

[0003] The input unit which showed drawing 13 in the front view of an input unit, and showed drawing 14 to drawing 13 a part Expansion front view, The decomposition perspective diagram of the display of the input unit which showed drawing 15 to drawing 13, the cross-section side elevation of the display of the input unit which showed drawing 16 to drawing 13, The decomposition perspective diagram of the one-step touch panel of the conventional technology which constitutes the display which showed drawing 17 to drawing 16, The cross-section side elevation of a display shown in drawing 16 for the cross-section side elevation of the one-step touch panel which showed drawing 18 to drawing 16, and drawing 19 explaining operation of the one-step touch panel shown in drawing 17, and drawing 20 are the press force P-displacement delta characteristic curves of the one-step touch panel of the conventional technology shown in drawing 16.

[0004] In drawing 13, a sign 1 points out the input unit of the conventional technology. This input unit 1 is used for small carrying type information input units, such as an information terminal, the car-navigation system, the computer, etc.

[0005] A frame 11 is combined by the both-sides edge of outside ** 10, and this input unit 1 is reinforced at it, respectively, while it is equipped with outside ** 10 which makes the shape of a flat rectangular parallelepiped. And the display 12 which makes a touch panel serve a double purpose is formed in the upper surface of outside ** 10. While the input panel 13 is formed in this display 12 bottom, two or more operating buttons 14 are allotted under the input panel 13.

[0006] A touch-panel function is provided on the display 12, **, the switch, the menu, the icon, etc. and system of coordinates which the display of a display 12 projected correspond by 1 to 1, and an input unit 1 receives an input event by pressing the touch panel (postscript) of the part of the item which a user wants to choose with the directions implement 18 or a finger 19, as shown in drawing 14 and drawing 16.

[0007] The display 12 consists of a lower shell display panel 24 and a touch panel 25, as shown in drawing 15 and drawing 16. The display panel 24 is made as [perform / a predetermined display], and has flat-surface displays, such as a liquid crystal display, an organic EL display, and a CRT (Cathode Ray Tube) display, a curved-surface display, etc. The touch panel 25 is constituted so that switching operation may be performed with alter operation, and it has a resistance film type and other methods. As shown in drawing 16, such a display panel 24 and a touch panel 25 are piled up, and are used, being stored in outside ** 10.

[0008] in addition, the driver circuit for driving the flexible patchboard for a wiring drawer, and a

display to a display panel 24 -- although the pack light sections, such as the luminescence section, a light guide plate, a diffusion board, and a booster circuit, were connected further especially about the LCD panel, those illustration was omitted here

[0009] The touch panel 25 of the conventional technology is equipped only with one step of input functions. That is, if a resistance film type touch panel is mentioned as an example and the structure is explained, as shown in drawing 17 and drawing 18 , the top electrode sheet 2510 and the bottom electrode sheet 2520 open few [uniformly] gaps G with a spacer 26 (drawing 19), and are constituted.

[0010] Antireflection films 2512 and 2513 are formed by the outside of the sheet base material 2511 made of a transparent plastic in which the top electrode sheet 2510 had flexibility, and inside both sides, and the transparent electrode 2514 is formed by the front face of the inside antireflection film 2513 of them. As this transparent electrode 2514, an ITO (Indium Tin Oxide:indium stannic-acid ghost) thin film etc. is desirable, for example. Similarly, antireflection films 2522 and 2523 are formed by the outside of the sheet base material 2521 made of a transparent plastic in which the bottom electrode sheet 2520 also had flexibility, and inside both sides, and the transparent electrode 2524 is formed by the front face of the inside antireflection film 2523 of them. In addition, antireflection films 2512, 2513, 2522, and 2523 are films for suppressing reflection of the transmitted light. Leader lines 2515 and 2525 are drawn by each transparent electrode 2514 and 2524, respectively (drawing 17). And the aforementioned touch panel 25 is the thing of the structure which both the transparent electrodes 2514 and 2524 were opposed, opened few gaps G as mentioned above using the spacer 26, and has arranged the top electrode sheet 2510 and the bottom electrode sheet 2520.

[0011] Next, operation of this touch panel 25 and its property are explained using drawing 19 and drawing 20 .

[0012] As mentioned above, it is inputted when a user chooses and presses an item, a file, etc. which were displayed on the display 12 by the display panel 24 with the directions implement 18 or a finger 19. That is, the top electrode sheet 2510 of the specific position of a touch panel 25 is pressed by this alter operation, and the transparent electrode 2514 contacts the transparent electrode 2524 of the bottom electrode sheet 2520 by it. An input position coordinate can be specified by measuring the resistance to these both point of contact P.

[0013]

[Problem(s) to be Solved by the Invention] However, in the case of such alter operation, by the touch panel 25 of the conventional technology, if a graph shows the displacement delta of the top electrode sheet 2510 to the push-down force P of the touch-panel 25 very thing, it will become the P-delta curve 1 as shown in drawing 20 . That is, in case beginning pushes, first, with the elasticity of the top electrode sheet 2510, 1 with a curved small inclination is followed and both sheets 2510 and 2520 contact in an inflection point 2. Furthermore, if it pushes in, the bottom electrode sheet 2520 will be pushed and the inclination of a curve 1 will become larger like a straight line 3. However, it is unclear in whether in the case of such alter operation, the touch panel 25 was turned on [it] at the user at which time, and the input event occurred.

[0014] Moreover, the operation which continues pushing beyond the combination of a serial input, for example, a certain fixed time, when giving this directions of execution etc. or adding different operation, or continues the same part twice or more within a certain fixed time, and is pushed although an item, a file, etc. can be chosen as mentioned above as long as one step of such input units are used was required.

[0015] Quick operation becomes difficult in order for such a method to require the fixed real time difficultly on the small display screen in a small pocket device. Moreover, the interruption processing from the timer which measures the real time will apply a load to signal-processing work.

[0016] Furthermore, there was no function to return reaction force to a touch panel 25 to the finger 19 of the user who performs alter operation etc. again (feedback), it was the sound outputted from a voice output, and the alter operation receptionist was returned by changing the display of a part of display 12. However, it was unclear for the user whether it was that the operation itself was accepted in the device side to the alter operation and the quick alter operation which are performed without a user's looking at a

display 12.

[0017] this invention can be inputted certainly, without causing derangement, when it is made in view of such a trouble and a user performs alter operation to a user's alter operation, and, moreover, it can input by easy operation and few finger operation also to a complicated function, and aims at offering the input unit which enabled feedback by the inner force sense to the tactile sense of a user's finger.

[0018]

[Means for Solving the Problem] Therefore, the input unit of the main patent of this application is related with the input unit equipped with the touch panel with which at least two contacts are formed on the same axis of coordinates in a plane-coordinates system.

[0019] two contacts resemble the touch panel, respectively, and a gap forms in the thickness direction -- having -- **** -- and the touch panel -- the -- at least, an input area-ed is transparent, and suitable for the screen of display [pile up, use and]

[0020] Moreover, it has the actuator with which the aforementioned touch panel is interlocked with energization of each aforementioned contact, and operates in the input unit of other main patents of this application, and its driver circuit, and the aforementioned actuator is returning the inner force sense from which it responds for every contact on the same coordinate, and a mode of operation changes further again.

[0021] Furthermore, the input unit of the desirable embodiment of invention included in this application again A bipolar-electrode sheet with flexibility with the transparent predetermined thickness by which the transparent electrode is formed by both sides is inserted. The transparent top electrode sheet with flexibility with which the transparent electrode which opened the uniform predetermined gap from both the aforementioned transparent electrodes, respectively, and met the alter operation side at aforementioned one transparent electrode was formed And the transparent bottom electrode sheet with which the transparent electrode which met the transparent electrode of aforementioned another side was formed equips the display side with the touch panel which a laminating is carried out, respectively and is constituted, and the bipolar-electrode sheet opens two or more sheets and a predetermined gap, is arranged, and is good also as a multi-stage touch panel. Moreover, the 1st step touch panel consists of an aforementioned bipolar-electrode sheet and an aforementioned top electrode sheet, and, as for this multi-stage touch panel, the last stage touch panel consists of an aforementioned bipolar-electrode sheet and an aforementioned bottom electrode sheet.

[0022] Therefore, if the electrode sheet of the front face where a directions implement or a finger contacts is pressed with a directions implement or a finger according to this invention, the electrode sheet of the front face will be pushed in first, a gap [directly under] is crushed, both the transparent electrodes that meet contact, the electrode sheet of pressing-further middle is also pushed in, the gap of it is also crushed, and the transparent electrode of the bipolar-electrode sheet which meets, and the transparent electrode of the bottom electrode sheet which counters contact. If the multilayer laminating of the bipolar-electrode sheet is carried out, a gap can be crushed covering multi-stage like the following, both the transparent electrodes that counter can be contacted, and two or more transparent electrodes can be contacted on the same coordinate.

[0023] If constituted on such a multi-stage touch panel, the contact of each stage can be made to be able to possess an inner-force-sense feedback mechanism, therefore a mode of operation can also be changed for every contact.

[0024]

[Embodiments of the Invention] Hereafter, the operation gestalt of the input unit of this invention is explained using drawing.

[0025] Some cross-section side elevations of the two-step type touch panel which used drawing 1 for this invention and showed the suitable decomposition perspective diagram of the two-step type touch panel of the 1st operation gestalt and drawing 2 to drawing 1 , and drawing 3 are in the state which assembled the two-step type touch panel shown in drawing 1 . The cross-section side elevation showing the state where the first stage was inputted with the finger, the cross-section side elevation of the two-step type touch panel in the state where drawing 4 was further pressed with the finger from the state of

drawing 3 , The press force characteristic curve of the two-step type touch panel of the 1st operation gestalt which showed drawing 5 to drawing 1 , The cross-section side elevation of the two-step type touch panel with which drawing 6 added the inner-force-sense feedback mechanism of the 2nd operation gestalt, The press force characteristic curve of the two-step type touch panel of the 2nd operation gestalt which showed drawing 7 to drawing 6 , Other press force characteristic curves of the two-step type touch panel of the 2nd operation gestalt which showed drawing 8 to drawing 6 , The block diagram of the processing circuit for the flow chart at the time of inputting drawing 10 by the two-step type touch panel and drawing 10 performing feedback to a user also including the two-step type touch panel of this operation gestalt, and inner-force-sense feedback, The block diagram of other processing circuits having shown deformation of the processing circuit which showed drawing 11 to drawing 10 , and drawing 12 are the timing diagrams for explaining operation of the processing circuit shown in drawing 11 .

[0026] First, using drawing 1 or drawing 3 , it uses for the input unit of this invention, and the multi-stage touch panel of 1 suitable operation gestalt is explained.

[0027] In addition, in the following operation gestalten, a two-step type touch panel is illustrated and explained as one gestalt of a multi-stage touch panel. And the same sign is attached and explained to the same component as the component of the one-step touch panel of the conventional technology.

[0028] Moreover, as the term of [Description of the Prior Art] also explained this multi-stage touch panel, it is the input unit used for small carrying type information input units, such as an information terminal, a car-navigation system, a computer, etc., and an example of the equipment is the same as that of what was shown in drawing 13 . Therefore, in the following explanation, the drawing equivalent to drawing 13 , drawing 14 , and drawing 15 is omitted.

[0029] In drawing 1 , sign 25A points out a two-step type touch panel as a whole. This two-step type touch-panel 25A consists of the top electrode sheet 2510, the bottom electrode sheet 2520, the bipolar-electrode sheet 2530 and upper case spacer 26a, and lower-berth spacer 26b. In addition, since the structure of the top electrode sheet 2510 and the bottom electrode sheet 2520 is the same as that of the thing of the conventional technology, those explanation is omitted.

[0030] The bipolar-electrode sheet 2530 is the thing made of a transparent plastic in which this also had flexibility, antireflection films 2532 and 2533 are formed by the outside of the sheet base material 2531, and inside both sides, and transparent electrodes 2534 and 2535 are further formed by the front face of those antireflection films 2532 and 2533. And leader lines 2536 and 2537 are drawn by each transparent electrode 2534 and 2535, respectively. In addition, antireflection films 2522 and 2523 are films for suppressing reflection of the transmitted light like antireflection films 2512, 2513, 2522, and 2523.

[0031] As a transparent plastic of the sheet base materials 2511, 2521, and 2531, elastic plastics like PET (polyethylene terephthalate), PMMA (acrylic : polymethyl methacrylate), PI (polyimide), PE (polyethylene), and polyurethane can be used. Moreover, you may use transparent material, such as glass, for the lower sheet base material 2521. Furthermore, as transparent electrodes 2534 and 2535, an ITO (Indium Tin Oxide:indium stannic-acid ghost) thin film etc. can be used like transparent electrodes 2514 and 2524 again.

[0032] Such a top electrode sheet 2510 of three sheets, the bottom electrode sheet 2520, and the bipolar-electrode sheet 2530 As shown in drawing 3 , use lower-berth spacer 26b on the bottom electrode sheet 2520, and the bipolar-electrode sheet 2530 is supported. A predetermined gap is formed among both, upper case spacer 26a can be similarly used on the bipolar-electrode sheet 2530, the top electrode sheet 2510 can be supported, and two-step type touch-panel 25A can be constituted by forming and assembling a predetermined gap among both. The 1st step touch panel is constituted from a top electrode sheet 2510, a bipolar-electrode sheet 2530, and a gap Ga, and the 2nd step touch panel is constituted from a bipolar-electrode sheet 2530, a bottom electrode sheet 2520, and a gap Gb, therefore a transparent electrode 2514 and a transparent electrode 2534 are the contacts of the 1st step touch panel, and a transparent electrode 2535 and a transparent electrode 2524 serve as a contact of the 2nd step touch panel. In addition, in drawing 3 , illustration of all the antireflection films 2512, 2513, 2522, 2523, 2532, and 2533 was omitted.

[0033] Next, the mechanism of two-step type touch-panel 25A of this operation gestalt of operation is

explained using drawing 3 or drawing 5 .

[0034] First, when a user presses the front face of the top electrode sheet 2510 centering on near the input part on the occasion of an input with a finger 19, the press portion is depressed, and becomes depressed and the transparent electrode 2514 of the top electrode sheet 2510 contacts the transparent electrode 2534 of the bipolar-electrode sheet 2530 top (upper case point of contact calcium).

Furthermore, if it pushes in, as shown in drawing 4 , the bipolar-electrode sheet 2530 will be pushed on the top electrode sheet 2510, and will be crooked, and the transparent electrode 2535 will contact the transparent electrode 2524 of the bottom electrode sheet 2520 (lower-berth point of contact Cb).

[0035] When a user does the depression of the two-step type touch-panel 25A of this 1st operation gestalt with a finger 19, it has the press force characteristic curve 2 as shown in drawing 5 . At the time of a sign 2, the transparent electrode 2514 of the top electrode sheet 2510 contacts the transparent electrode 2534 of the bipolar-electrode sheet 2530, energization takes place, and further, if the top electrode sheet 2510 is pressed, when the bipolar-electrode sheet 2530 is pressed and a sign 5 shows, the transparent electrode 2535 of the bottom will contact the transparent electrode 2524 of the bottom electrode sheet 2520, and will energize in the process shown with a sign 4. If it pushes in further from here, it can tell that the two-step side contacted the user by giving a big inclination in the process shown with the sign 6. In addition, the dotted line showed collectively the press force characteristic curve 1 of the one-step type touch panel 25 of the conventional technology shown in drawing 20 to drawing 5 by reference.

[0036] the contact time of the sign [in / the press force characteristic curve 2 / in **] 2 although the outstanding effect is acquired, and a sign 5 -- this two-step type touch-panel 25A is the thing of structure which established two contacts on the same axis of coordinates unlike the one-step type touch panel 25 of the conventional technology, and a user can perform alter operation, without causing derangement to alter operation -- a user -- sensuous -- clear -- being distinct -- it does not carry out In order to cancel this technical problem, if a visual operation and acoustic-sense-operation or an inner-force-sense-operation is returned to a user, it will become much more effective. If an inner-force-sense-operation is returned to a user's finger etc. especially, unlike a visual sense or an acoustic sense, it can tell that surely the input was given to the user.

[0037] Two-step type touch-panel 25B of the 2nd operation gestalt equipped with the feeling feedback mechanism of the force was shown in drawing 6 . The structure of the two-step type touch-panel 25B is explained using drawing 6 .

[0038] Bobbin coil 35A which the aforementioned two-step type touch-panel 25A was being fixed to some front faces of a case 10 (a flat surface is a rectangle), the display panel 24 was held in the case 10 interior of the lower part, and this two-step type touch-panel 25B was fixed to it, and was wound around the square shape bobbin which is one of the actuators in the periphery side of a case 10 is inserted in. In addition, also in this view, illustration of antireflection films 2512, 2513, 2522, 2523, 2532, and 2533 was omitted to two-step type touch-panel 25A.

[0039] It connects so that energization of the contact which consists of a transparent electrode 2534 which constitutes the contact and the 2nd step touch panel which consist of a transparent electrode 2514 which constitutes the 1st step touch panel, and a transparent electrode 2534, and a transparent electrode 2524 may be interlocked with and it may operate (after-mentioned drawing 10 , drawing 11), and bobbin coil 35A is included in two-step type touch-panel 25B.

[0040] Inner-force-sense feeling is told to a user by constituting two-step type touch-panel 25B in this way. If the inner-force-sense feeling is explained using drawing 7 , as shown in drawing 3 , a user When the top electrode sheet 2510 which is the 1st step touch panel is pressed with a finger 19, at the beginning [the] which was pressed with the elasticity of the top electrode sheet 2510 If the sign 1 with a curved small inclination is followed and the transparent electrode 2514 of the top electrode sheet 2510 and the transparent electrode 2534 of the bipolar-electrode sheet 2530 contact in an inflection point 2 As bobbin coil 35A which is an inner-force-sense mechanism operated, and a user's finger 19 is put back to a user side, resists this putting-back force and was shown in drawing 4 Furthermore, if it pushes in, in an inflection point 4, will contact the transparent electrode 2535 of the bipolar-electrode sheet 2530 and the

transparent electrode 2524 of the bottom electrode sheet 2520 which are the 2nd step touch panel, and bobbin coil 35A will operate further simultaneously. As the sign 5 showed, a user's finger 19 is put back to a user side, and a user can perceive having been inputted as an inner force sense. And it can tell that followed this process of the big inclination shown with the sign 6 when it put back, the force was resisted and it continued pushing further, and two inputs were completed.

[0041] Although it constituted from 2 step mold touch-panel 25B example shown in drawing 6 and drawing 7 as inner-force-sense feedback mechanisms (bobbin coil 35A etc.) were added to each stage of the 1st step and the 2nd step of touch panel and there was an inner-force-sense feedback response, you may add this inner-force-sense feedback mechanism to one of touch panels. Drawing 8 is a press force characteristic curve at the time of not adding an inner-force-sense feedback mechanism to the 1st step touch panel, but adding an inner-force-sense feedback mechanism to the 2nd step touch panel. When it does not operate, but it presses further and the aforementioned contact of an one-step touch panel contacts, bobbin coil 35A operates and it is made for the putting-back force as shown in the finger 19 with the sign 5 to generate bobbin coil 35A, even if, as for the case of such composition, a user presses the top electrode sheet 2510 with a finger 19 and the contact of the 1st step touch panel contacts.

[0042] Make it better for vibration from which oscillation frequency, an amplitude, a wave, and a wave profile differ to return as a kind of inner-force-sense feedback response of the aforementioned 1st step touch panel and the 2nd step touch panel. If it does in this way, it will much more become easy to perceive that each stage was inputted certainly.

[0043] The flow chart in the sub routine which acquires ON-OFF and coordinate information was shown in drawing 10 as input from these two-step type touch panels 25A and 25B. On a mechanism, in order that an input signal may surely enter from the top electrode sheet 2510, input signal waiting of the top electrode sheet 2510 is performed first (S1). If an input signal enters from the 1st step touch panel (put together as the top electrode sheet 2510 and the bipolar-electrode sheet 2530), first, a coordinate will be specified from the resistance (S2), and coordinate information will be written in RAM (Random Access Memory : record element which can be written). Furthermore, when the input standby from the 2nd step touch panel (put together as the bipolar-electrode sheet 2530 and the bottom electrode sheet 2520) is started (S3) and an input is here, an input coordinate is specified from the resistance and (S4) and the 1st step coordinate data in RAM are rewritten to the 2nd step coordinate data. Moreover, since it expresses that the coordinate currently written in on memory is the 2nd step of input now, a flag is written in (S5).

[0044] Next, the processing circuit for performing feedback to the user who also includes two-step type touch-panel 25B of the 2nd operation gestalt and an inner force sense including the aforementioned sub routine work using drawing 10 is explained.

[0045] This processing circuit 30A consists of the memory 34 and the output units 35 which were called RAM for storing the central processing unit 33 and data containing a microcomputer etc. in addition to the aforementioned two-step type touch-panel 25B and the driver circuits 31 and 32 for a drive, and ROM. The output unit 35 consists of, the actuator as a display and an inner-force-sense-output, for example, bobbin coil 35A, as the loudspeaker as an acoustic-sense-output, and a visual output. These outputs serve as a system which returns to a user, choosing the suitable output unit 35 according to the inputted operation item.

[0046] At drawing 10 , although driver circuits 31 and 32 were required respectively, as it was shown in drawing 11 to the touch panel of each stage, a driver circuit 37 can be managed with one by allotting a switcher 36 between two-step type touch-panel 25B and the common driver circuit 37, and controlling 1st step the touch panel of two-step type touch-panel 25B, and the 2nd step switching of a touch panel with a central processing unit 33. This switcher 36 can receive the change information from the trigger circuit 38 which outputs a change signal a certain fixed period based on the base clock of a central processing unit 33, and can perform a serial change. The timing diagram in each stage at this time was shown in drawing 12 . When the output voltage of a trigger circuit 38 is VH, the 1st step touch panel is connected with a driver circuit 37. On the contrary, when the output voltage of a trigger circuit 38 is VL, the 2nd step touch panel is connected with a driver circuit 37. Since these connection states are repeated in comparatively short time, for example, the period of several m seconds, two-step type touch-panel

25B can be used for a user without trouble on the real time.

[0047] This two-step type touch-panel 25A (or 25B) can be used, and a user can treat a device by more nearly intuitive operation by assigning a specific event to each time of the touch panel of each stage serving as ON and OFF. The examples of the event assignment in each ON/OFF time were enumerated to Table 1. If these functions are used combining the GUI (the abbreviation for Graphical User Interface) environment on a display screen, they are more effective. The combination of the function mentioned here is an example to the last, and it is possible to also add functions other than this. Moreover, on application software, a programming person can assign a function according to the gestalt of software, a tool, and a functional item.

[Table 1]

操作	1段目の割り当て機能		2段目の割り当て機能	
	押下	解放	押下	解放
電氣的状態	OFF →ON	ON →OFF	OFF →ON	ON →OFF
	座標指定、選択	選択解除	—	指定された座標が指し示すプログラムを実行
	座標指定、選択	選択解除	指定された座標が指し示す項目の一覧を表示	一覧表示の解除、選択項目の実行
	座標指定、選択	選択解除	ドラッグ操作	ドロップ操作
	前方スクロール	前方スクロール解除	後方スクロール	後方スクロール解除
	画像の連続拡大	画像の連続拡大終了	画像の連続縮小	画像の連続縮小終了
	音量の連続増大	音量の連続増大終了	音量の連続縮小	音量の連続縮小終了
	項目の連続順送り	項目の連続順送り終了	項目の連続逆送り	項目の連続逆送り終了
	文字順列の連続順送り	文字順列の連続順送り終了	音量の連続逆送り	文字順列の連続逆送り終了
	メモリーアドレス番地の連続インクリメント	メモリーアドレス番地の連続インクリメント終了	メモリーアドレス番地の連続デクリメント	メモリーアドレス番地の連続デクリメント終了
	メモリー値の連続インクリメント	メモリー値の連続インクリメント終了	メモリー値の連続デクリメント	メモリー値の連続デクリメント終了

As mentioned above, although two or more operation gestalten of illustration explained this invention, various kinds of change by within the limits of the technical thought of invention which is not limited only to these operation gestalten and included in this application is possible for this invention. For example, with each aforementioned operation gestalt, although it is the thing of structure which established two contacts on the same axis of coordinates, it will be easily understood by increasing the number of sheets of the bipolar-electrode sheet 2530 that the multi-stage touch panel which can form three or more contacts can be constituted.

[0048] Moreover, an actuator may not be limited only to a bobbin coil and may be a solenoid, a piezoelectric device, a motor, etc.

[0049] Furthermore, although the inner-force-sense feedback mechanism was prepared in each stage in two-step type touch-panel 25B of the aforementioned 2nd operation gestalt, it is also good to prepare only in the touch panel of one of stages again.

[0050]

[Effect of the Invention] It is main invention of this application maintaining the gestalt of the existing device, and making the 1st step touch panel based on an old input procedure, and a user loses causing derangement to alter operation. Furthermore, a user can direct by easy operation and few finger operation also to a complicated function by assigning the function of Table 1 to a two-step touch panel.

[0051] A user coming to be able to do quick alter operation and sensing stress according to these two points, decreases. Moreover, by combining with the feedback mechanism by the inner force sense, a

user's check of a screen decreases and he can perform quick alter operation now in each stage about a series of operations to which it got used especially.

[0052] Moreover, the inner-force-sense feedback mechanism is controlled by main invention of everything but this application by instructions of a processor. Therefore, it becomes controllable from an operation system and application software by forming drawing 1 with a software driver. Therefore, in addition to the output device by an existing acoustic sense and an existing visual sense, a software manufacturer can create the software which utilized the inner-force-sense mechanism, and can offer the software which had latus power of expression more. Moreover, a user can use software with more nearly friendly feeling to a device.

[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

 PRIOR ART

[Description of the Prior Art] First, the input unit of the conventional technology is explained, referring to drawing 13 or drawing 20 .

[0003] The input unit which showed drawing 13 in the front view of an input unit, and showed drawing 14 to drawing 13 a part Expansion front view, The decomposition perspective diagram of the display of the input unit which showed drawing 15 to drawing 13 , the cross-section side elevation of the display of the input unit which showed drawing 16 to drawing 13 , The decomposition perspective diagram of the one-step touch panel of the conventional technology which constitutes the display which showed drawing 17 to drawing 16 , The cross-section side elevation of a display shown in drawing 16 for the cross-section side elevation of the one-step touch panel which showed drawing 18 to drawing 16 , and drawing 19 explaining operation of the one-step touch panel shown in drawing 17 , and drawing 20 are the press force P-displacement delta characteristic curves of the one-step touch panel of the conventional technology shown in drawing 16 .

[0004] In drawing 13 , a sign 1 points out the input unit of the conventional technology. This input unit 1 is used for small carrying type information input units, such as an information terminal, the car-navigation system, the computer, etc.

[0005] A frame 11 is combined by the both-sides edge of outside ** 10, and this input unit 1 is reinforced at it, respectively, while it is equipped with outside ** 10 which makes the shape of a flat rectangular parallelepiped. And the display 12 which makes a touch panel serve a double purpose is formed in the upper surface of outside ** 10. While the input panel 13 is formed in this display 12 bottom, two or more operating buttons 14 are allotted under the input panel 13.

[0006] A touch-panel function is provided on the display 12, **, the switch, the menu, the icon, etc. and system of coordinates which the display of a display 12 projected correspond by 1 to 1, and an input unit 1 receives an input event by pressing the touch panel (postscript) of the part of the item which a user wants to choose with the directions implement 18 or a finger 19, as shown in drawing 14 and drawing 16 .

[0007] The display 12 consists of a lower shell display panel 24 and a touch panel 25, as shown in drawing 15 and drawing 16 . The display panel 24 is made as [perform / a predetermined display], and has flat-surface displays, such as a liquid crystal display, an organic EL display, and a CRT (Cathode Ray Tube) display, a curved-surface display, etc. The touch panel 25 is constituted so that switching operation may be performed with alter operation, and it has a resistance film type and other methods. As shown in drawing 16 , such a display panel 24 and a touch panel 25 are piled up, and are used, being stored in outside ** 10.

[0008] in addition, the driver circuit for driving the flexible patchboard for a wiring drawer, and a display to a display panel 24 -- although the pack light sections, such as the luminescence section, a light guide plate, a diffusion board, and a booster circuit, were connected further especially about the LCD panel, those illustration was omitted here

[0009] The touch panel 25 of the conventional technology is equipped only with one step of input functions. That is, if a resistance film type touch panel is mentioned as an example and the structure is

explained, as shown in drawing 17 and drawing 18 , the top electrode sheet 2510 and the bottom electrode sheet 2520 open few [uniformly] gaps G with a spacer 26 (drawing 19), and are constituted. [0010] Antireflection films 2512 and 2513 are formed by the outside of the sheet base material 2511 made of a transparent plastic in which the top electrode sheet 2510 had flexibility, and inside both sides, and the transparent electrode 2514 is formed by the front face of the inside antireflection film 2513 of them. As this transparent electrode 2514, an ITO (Indium Tin Oxide:indium stannic-acid ghost) thin film etc. is desirable, for example. Similarly, antireflection films 2522 and 2523 are formed by the outside of the sheet base material 2521 made of a transparent plastic in which the bottom electrode sheet 2520 also had flexibility, and inside both sides, and the transparent electrode 2524 is formed by the front face of the inside antireflection film 2523 of them. In addition, antireflection films 2512, 2513, 2522, and 2523 are films for suppressing reflection of the transmitted light. Leader lines 2515 and 2525 are drawn by each transparent electrode 2514 and 2524, respectively (drawing 17). And the aforementioned touch panel 25 is the thing of the structure which both the transparent electrodes 2514 and 2524 were opposed, opened few gaps G as mentioned above using the spacer 26, and has arranged the top electrode sheet 2510 and the bottom electrode sheet 2520.

[0011] Next, operation of this touch panel 25 and its property are explained using drawing 19 and drawing 20 .

[0012] As mentioned above, it is inputted when a user chooses and presses an item, a file, etc. which were displayed on the display 12 by the display panel 24 with the directions implement 18 or a finger 19. That is, the top electrode sheet 2510 of the specific position of a touch panel 25 is pressed by this alter operation, and the transparent electrode 2514 contacts the transparent electrode 2524 of the bottom electrode sheet 2520 by it. An input position coordinate can be specified by measuring the resistance to these both point of contact P.

[Translation done.]

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EFFECT OF THE INVENTION

[Effect of the Invention] It is main invention of this application maintaining the form of the existing device, and making the 1st step touch panel based on an old input procedure, and a user loses causing confusion to alter operation. Furthermore, a user can direct by easy operation and few finger operation also to a complicated function by assigning the function of Table 1 to a two-step touch panel.

[0051] A user coming to be able to do quick alter operation and sensing stress according to these two points, decreases. Moreover, by combining with the feedback mechanism by the inner force sense, a user's check of a screen decreases and he can perform quick alter operation now in each stage about a series of operations to which it got used especially.

[0052] Moreover, the inner-force-sense feedback mechanism is controlled by main invention of everything but this application by instructions of a processor. Therefore, it becomes controllable from an operation system and application software by forming drawing 1 with a software driver. Therefore, in addition to the output device by an existing acoustic sense and an existing visual sense, a software manufacturer can create the software which utilized the inner-force-sense mechanism, and can offer software with larger power of expression. Moreover, a user can use software with more nearly friendly feeling to a device.

[Translation done.]

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, in the case of such alter operation, by the touch panel 25 of the conventional technology, if a graph shows the displacement delta of the top electrode sheet 2510 to the push-down force P of the touch-panel 25 very thing, it will become the P-delta curve 1 as shown in drawing 20 . That is, in case beginning pushes, first, with the elasticity of the top electrode sheet 2510, 1 with a curved small inclination is followed and both sheets 2510 and 2520 contact in an inflection point 2. Furthermore, if it pushes in, the bottom electrode sheet 2520 will be pushed and the inclination of a curve 1 will become larger like a straight line 3. However, it is unclear in whether in the case of such alter operation, the touch panel 25 was turned on [it] at the user at which time, and the input event occurred.

[0014] Moreover, the operation which continues pushing beyond the combination of a serial input, for example, a certain fixed time, when giving this directions of execution etc. or adding different operation, or continues the same part twice or more within a certain fixed time, and is pushed although an item, a file, etc. can be chosen as mentioned above as long as one step of such input units are used was required.

[0015] Quick operation becomes difficult in order for such a method to require the fixed real time difficultly on the small display screen in a small pocket device. Moreover, the interruption processing from the timer which measures the real time will apply a load to signal-processing work.

[0016] Furthermore, there was no function to return reaction force to a touch panel 25 to the finger 19 of the user who performs alter operation etc. again (feedback), it was the sound outputted from a voice output, and the alter operation receptionist was returned by changing the display of a part of display 12. However, it was unclear for the user whether it was that the operation itself was accepted in the device side to the alter operation and the quick alter operation which are performed without a user's looking at a display 12.

[0017] this invention can be inputted certainly, without causing derangement, when it is made in view of such a trouble and a user performs alter operation to a user's alter operation, and, moreover, it can input by easy operation and few finger operation also to a complicated function, and aims at offering the input unit which enabled feedback by the inner force sense to the tactile sense of a user's finger.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It uses for this invention and is the decomposition perspective diagram of the two-step type touch panel of the suitable 1st operation gestalt.

[Drawing 2] They are some cross-section side elevations of the two-step type touch panel shown in drawing 1 .

[Drawing 3] It is in the state which assembled the two-step type touch panel shown in drawing 1 , and is the cross-section side elevation showing the state where the first stage was inputted with the finger.

[Drawing 4] It is the cross-section side elevation of the two-step type touch panel in the state where it pressed further with the finger from the state of drawing 3 .

[Drawing 5] It is the press force characteristic curve of the two-step type touch panel of the 1st operation gestalt shown in drawing 1 .

[Drawing 6] It is the cross-section side elevation of the two-step type touch panel which added the inner-force-sense feedback mechanism of the 2nd operation gestalt.

[Drawing 7] It is the press force characteristic curve of the two-step type touch panel of the 2nd operation gestalt shown in drawing 6 .

[Drawing 8] They are other press force characteristic curves of the two-step type touch panel of the 2nd operation gestalt shown in drawing 6 .

[Drawing 9] It is a flow chart at the time of inputting by the two-step type touch panel.

[Drawing 10] It is the block diagram of the processing circuit for performing feedback to a user also including the two-step type touch panel of this operation gestalt, and inner-force-sense feedback.

[Drawing 11] It is the block diagram of other processing circuits having shown deformation of the processing circuit shown in drawing 10 .

[Drawing 12] It is a timing diagram for explaining operation of the processing circuit shown in drawing 11 .

[Drawing 13] It is the front view of a common input unit.

[Drawing 14] some input units shown in drawing 13 -- it is expansion front view

[Drawing 15] It is the decomposition perspective diagram of the display of the input unit shown in drawing 13 .

[Drawing 16] It is the cross-section side elevation of the display of the input unit shown in drawing 13 .

[Drawing 17]

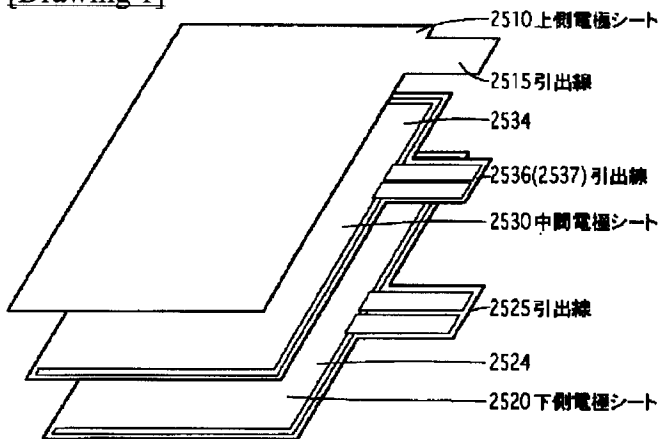
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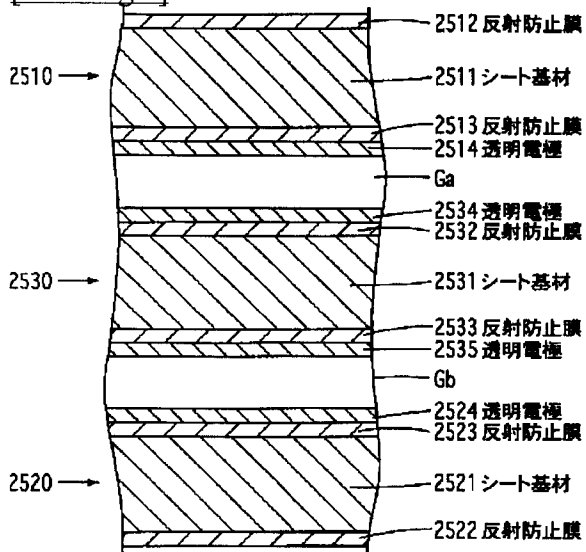
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DRAWINGS

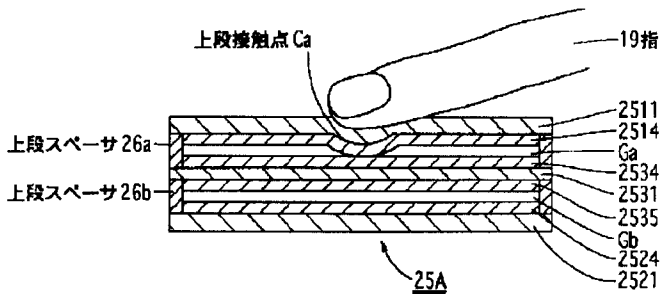
[Drawing 1]



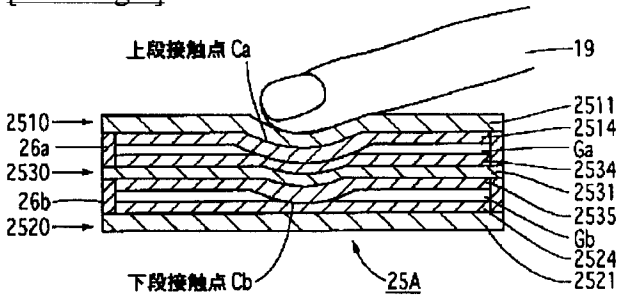
[Drawing 2]



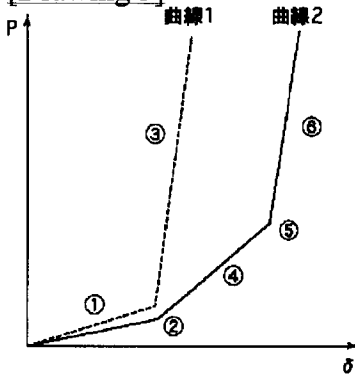
[Drawing 3]



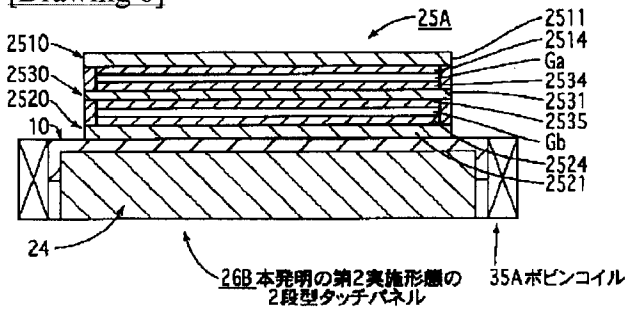
[Drawing 4]



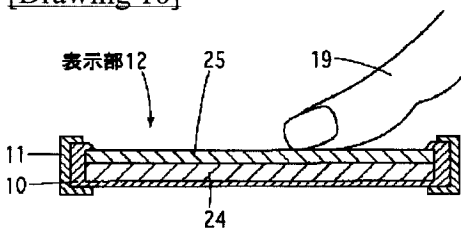
[Drawing 5]



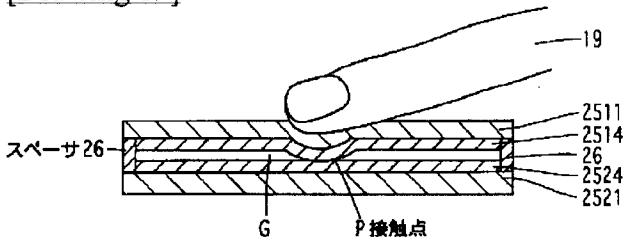
[Drawing 6]



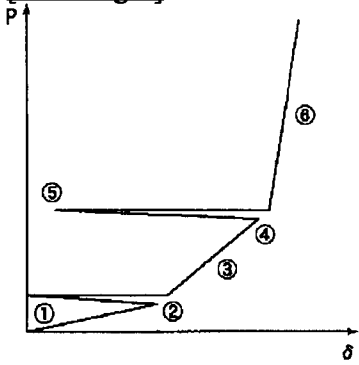
[Drawing 16]



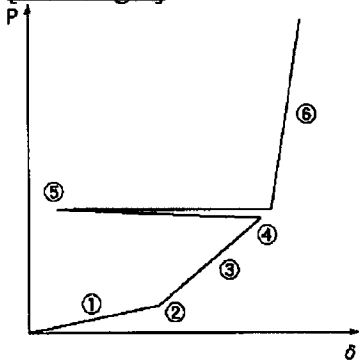
[Drawing 19]



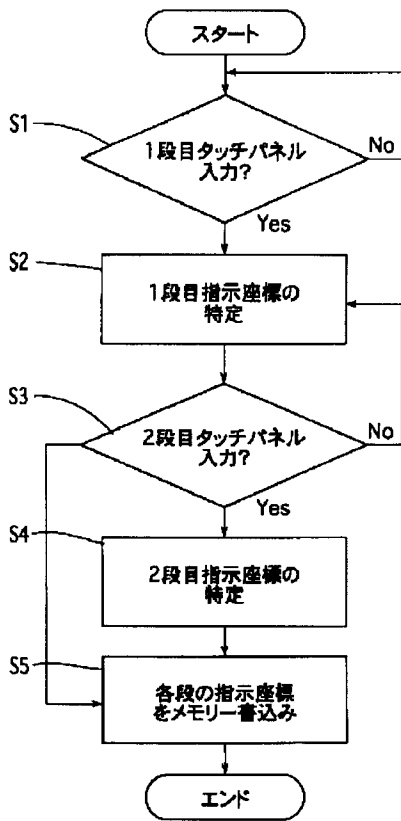
[Drawing 7]



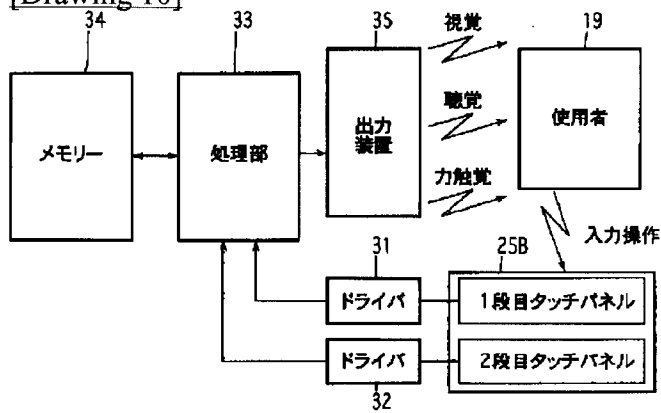
[Drawing 8]



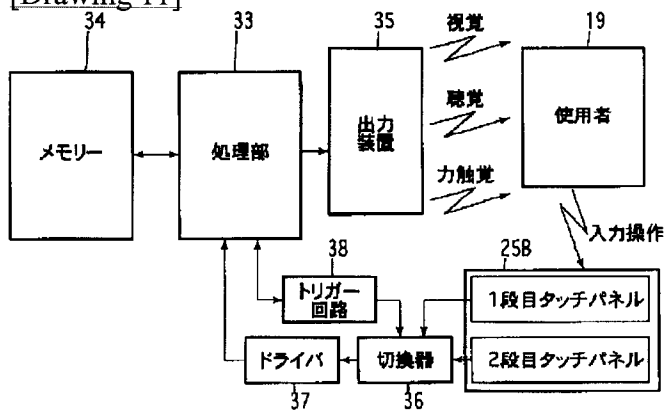
[Drawing 9]



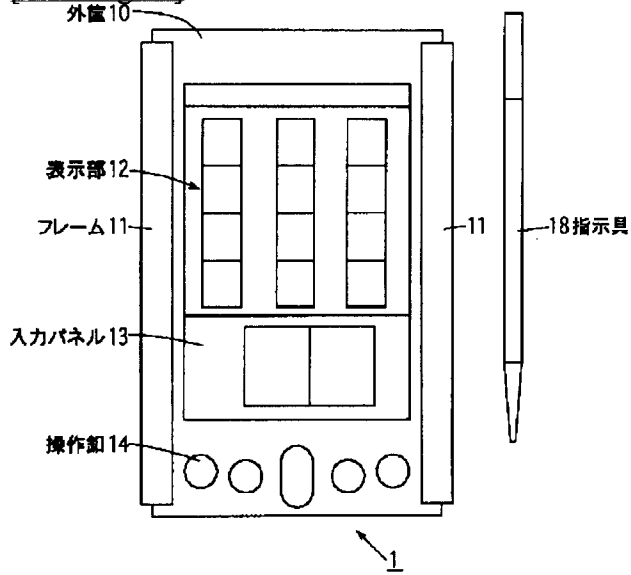
[Drawing 10]



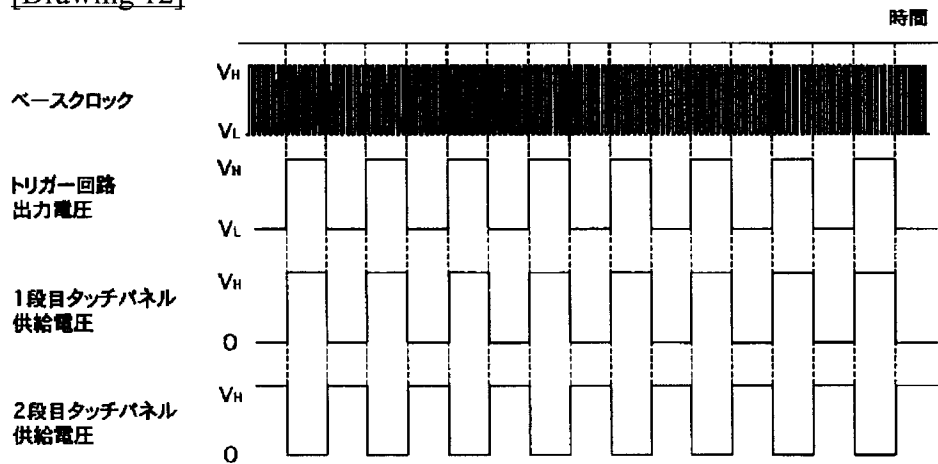
[Drawing 11]



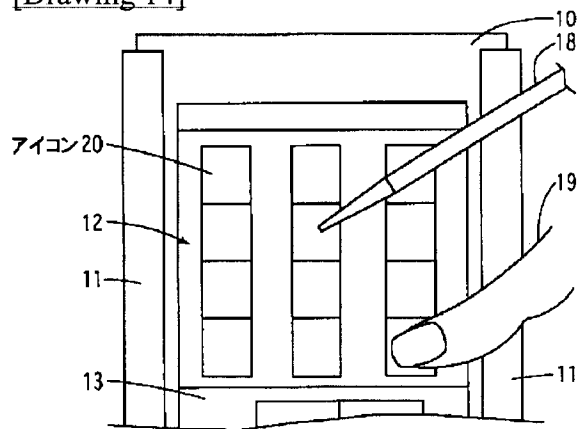
[Drawing 13]



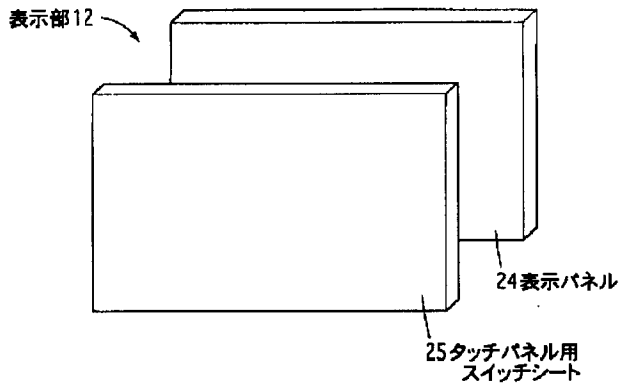
[Drawing 12]



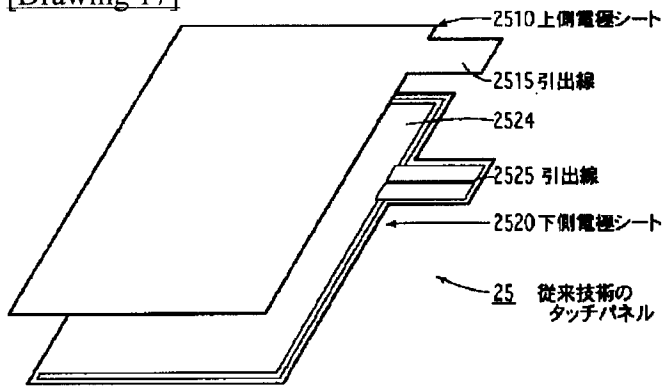
[Drawing 14]



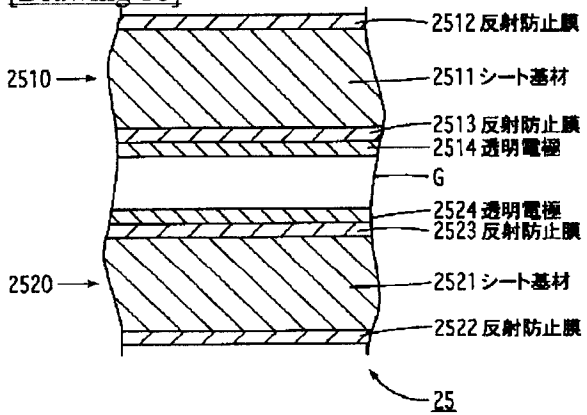
[Drawing 15]



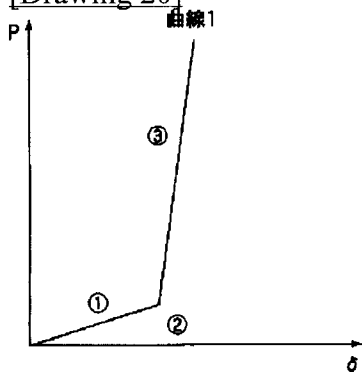
[Drawing 17]



[Drawing 18]



[Drawing 20]



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SPECIFICATION

1. TITLE OF INVENTION

Tactile Sensation Game Machine

2. CLAIMS

A tactile sensation game machine, wherein a target image screen is provided at the front surface of a base mounted inside an outside spherical surface's mounting cylinder and a hit switch for generating vibration when hits occur is provided at the rear surface and they can oscillate vertically and laterally respectively; a pursuit scope corresponding to said target image screen and a tactile sensation lever having a trigger member linked to said switch are respectively provided at a control body that can oscillate along the mounting cylinder's outside spherical surface; and the vibration amplitude of the tactile sensation lever is changed by an amplitude variation means when firing and when hitting.

3. DETAILED DESCRIPTION OF THE INVENTION

Industrial Field of Utilization

The present invention pertains to a tactile sensation game machine that simulates controlling and operating a spacecraft fighter or automobile or the like and makes it possible to enjoy the sensation of controlling them.

Prior Art

A tactile sensation game machine performs predetermined control in response to a changing screen that simulates high-speed driving or space battles, for example, and enables one to enjoy control techniques and the sensation of shooting and so forth, so in recent years it has become popular as a game machine enjoyed by young and old.

In this type of tactile sensation game machine, a mechanical vibration transmitted via a control lever, handle, steering wheel, etc. (hereinafter "tactile sensation member") when controlling/operating or shooting is an important factor in providing a feeling of being there that corresponds to the screen. Therefore so-called game centers and the like have implemented devices that incorporate large-size screens into cockpits that are almost as big as the real thing and provide tactile sensation vibration by means of large-size motors or hydraulic devices. Meanwhile, tactile sensation game machines [played] on a desktop that enable one to enjoy a game overflowing with the feeling of being there are continuing to spread in the field of everyday toys. In this case, particularly in space battle games and so forth that incorporate combat scenes, it is sometimes the case that the characteristics of the tactile sensation vibration that impart a feeling of gravity and a feeling of speed determine its appeal as a game machine.

Therefore various means have been proposed to provide change to mechanical vibration. For example, an improvement that has been considered is linking a plurality of motors to a tactile sensation member and suitably switching the vibration characteristics of the tactile sensation member when changing the control mode, thus generating a more realistic tactile sensation vibration.

Problems the Invention Is to Solve

Item 2 is a mounting cylinder; the mounting cylinder 2 consists of a shell body whose outside has a spherical surface and having apertures 2a and 2b at the front and back. Its two ends are mounted on the aforesaid stand 1's support columns 1a. Item 3 is a base. The base 3 is provided with a bracket-shaped frame body 31 mounted inside the aforesaid mounting cylinder 2; a target image screen 4 is provided in the front end of the member 31 and a hit switch 5 is provided in the back end with an oscillation mechanism 6 therebetween respectively. The target image screen 4 consists of a rotary disk made of transparent plastic; printed thereon are images corresponding to the application's game machine to be stably supported on a desktop.

In the drawings, 1 is a stand. The stand 1 houses a battery accommodation chamber and sound-generating circuits, etc. (not shown in the drawing); support columns 1a are provided at both sides. The stand 1 permits the main body 100 of this application's game machine to be stably supported on a desktop.

FIG. 1 is an oblique view of the entirety of this application's tactile sensation game machine. FIG. 2 is an oblique view with a partial cut-out of the same. FIG. 3 is an oblique view showing the structure of the base and oscillation mechanism. FIG. 4 is an oblique view showing the structure of the tactile sensation vibration switch's pressing means. FIG. 5 is a sectional view showing the relationship between the base and pursuit body. FIG. 6 is a sectional view showing the relationship between the tactile sensation vibration switch's pressing means and the base. FIG. 7 is an oblique view showing the structure of the amplitude variation means. FIGS. 8(a) and (b) are drawings explaining the cam's amplitude variation principle.

Below, the present invention shall be explained based on the embodiment shown in the attached drawings.

Embodiment

In order to achieve the aforesaid object, the present invention is constituted so that a target image screen is provided at the front surface of a base mounted inside an outside spherical surface's mounting cylinder and a hit switch for generating vibration when hits occur is provided at the rear surface and they can oscillate vertically and laterally respectively; a pursuit scope corresponding to the aforesaid target image screen and a tactile sensation lever having a trigger member linked to the aforesaid switch are respectively provided at a control body that can oscillate along the mounting cylinder's outside spherical surface; and the vibration amplitude of the tactile sensation lever is changed by an amplitude variation means when firing and when hitting. A plurality of tactile sensation vibrations can be generated with a single vibration generating means, and it is possible to implement a tactile sensation game machine that is small and simple.

Means for Solving the Problems

The present invention considered these points. Its object is to provide a tactile sensation game machine provided with a vibration generating means that can generate various vibration modes with a simple mechanism.

Nevertheless, the aforesaid conventional tactile sensation game machine requires individual mechanisms consisting of motors and vibration generating members linked to the motors for each type of tactile sensation vibration mode, so the device may become large, complicated, and expensive.

game contents: for example, target image M₁ of silhouettes of fighters flying in formation, etc. The hit switch 5 is for operating the sound and vibration generating circuit when there is a hit; it oscillates vertically and laterally relative to the body 3, so it goes on only when it matches the same straight line as a trigger member 9 to be described later.

The aforesaid oscillation mechanism 6 is provided with two oscillation arms and two drive cams; it is constituted so that it can oscillate the aforesaid target image screen 4 and hit switch 5. That is, in FIG. 3, 61 is a first oscillation arm; the first oscillation arm 61 consists of a nearly bracket-shaped frame body whose upper piece 61a is longer than the lower piece 61b, and is disposed in a nested manner with the aforesaid bracket-shaped frame body's base 3 and pivotally supported by shafts J₁ and J₂ so that it can oscillate. The oscillation arm 61's upper piece 61a is provided with a long hole N₁ in the front part; an eccentric rotary disk 62 is fitted into the long hole N₁. Also, the first oscillation arm 61 is constituted so that it can oscillate laterally in response to the rotation of the eccentric rotary disk 62.

Item 63 is a second oscillation arm; the second oscillation arm 63 also consists of a nearly bracket-shaped frame body, and is pivotally supported by a shaft J₂ at a center piece 61c of the aforesaid first oscillation arm 61 so that it can oscillate. The second oscillation arm 63 is respectively provided with the aforesaid target image screen 4 at its front end and the aforesaid hit switch 5 at its back end, with a pin P₁ and long hole N₂ interposed, and a pin P₂ parallel to the aforesaid shaft J₂ at the side of the center piece 61c. The pin P₂ is for driving the second oscillation arm 63, so it is fitted into an indentation 64a in a cam follower 64 that is pivotally supported at the upper part of the base 3 by the aforesaid shaft J₁. The cam follower 64 is anchored to an irregularly curved cam 65 that is capable of forming a complicated oscillation pattern. Here, the irregularly curved cam 65 is pivotally supported and integrated with a gear G₁; it is driven via a gear G₂, which is integrated with the aforesaid eccentric rotary disk 62 and meshes with the curved cam 65. Also, the gear G₁ and irregularly curved cam 65 rotate due to the rotation of the eccentric rotary disk 62 and gear G₂, as a result of which the cam follower 64 oscillates irregularly, and furthermore the pin P₂ is driven forward and in reverse (relative to the base 3) via the cam follower 64's indentation 64a. Therefore the second oscillation arm 63 oscillates irregularly in a vertical direction relative to the base 3 centered on the shaft J₂.

The lateral oscillation of the first oscillation arm 61 and the vertical oscillation of the second oscillation arm 63 are combined in this manner, so the target image screen 4 at the front end of the second oscillation arm 63 is constituted so that it oscillates irregularly in both vertical and lateral directions.

Furthermore, a light-emitting lamp L is provided behind the target image screen 4 (inside the aforesaid base 3), and is constituted so that the image screen 4 is illuminated by the light-emitting lamp L. Also, a transparent disk T, for example, printed with a background image such as the entirety of a space city, etc., is provided between the target image screen 4 and light-emitting lamp L; it rotates at a constant speed and creates an constantly changing background.

The aforesaid hit switch 5 is for generating the sound and vibration when there is a hit, so it consists of a plate-like member 51 provided at the back end of the aforesaid second oscillation arm 63 with the pin P₁ and long hole N₂ interposed. A pressing part 5a is provided at its back end and a reflecting mirror 5b is provided at its front end. The switch 5 oscillates irregularly and laterally due to the combined oscillation of the first oscillation arm 61 and second oscillation arm 63 as described earlier, so it is constituted so that it is operable only when a pressing member 9f to be described later is set on the same line. Then, when pressing occurs, a sound and vibration generating circuit (not shown in the drawing) is connected to a predetermined mode, the aforesaid reflecting mirror 5b is brought near the light-emitting lamp L, and the backlight of the target image screen 4 rapidly becomes bright. Item B is a spring that tensions the member 51 in the projecting direction.

Item 7 is a control body; the control body 7 is provided with a guide part 7a along the outer spherical surface of the aforesaid mounting cylinder 2, and consists of a shell body 71 covering the outside of the mounting cylinder 2. Oscillation (in polar coordinates) is possible in any direction relative to the mounting cylinder 2 via this guide part 7a (FIG. 4, FIG. 5, FIG. 6). Also, the control body 7's shell body 71 is provided with a pursuit scope 8 corresponding to the aforesaid target image screen 4 and with a tactile sensation lever 10 that has a trigger member 9 that can be linked to the aforesaid switch 5 and with a vibration generating part 11. They are constituted so that the vibration of the tactile sensation lever 10 changes when firing and when hitting.

The aforesaid pursuit scope 8 is positioned at the front surface of the game machine main body, and consists of a window-shaped semi-transparent plate incised with an aiming mark M₂ in its center. It is constituted so that it freely oscillates integrally with the aforesaid control body 7. The scope 8's aiming mark M₂ overlaps the aforesaid target image screen 4's target image M₁ when the aforesaid trigger member 9 at the rear surface of the control body 7 and the aforesaid tactile sensation switch 5 match on the same line.

The aforesaid trigger member 9 sequentially links the pressing operation of a firing button 9a provided at the front of the aforesaid tactile sensation lever 10, and the aforesaid switch 5's pressing part 5a is pressed by a pressing member 9f at the rear. That is, when the firing button 9a, which is provided at the front of the tactile sensation lever 10 at the right side so that it can freely extend and sink, is pressed,

(1) A curved member 9b passing through the inside of the lever 10 is pressed to the interior,

(2) Because of this, a pin P₃ projectingly provided at its end causes an oscillating piece 9c to rotate relative to a shaft J₃,

(3) Because of this, the oscillating piece 9c's pin P₄ moves a plate-shaped member 9d toward the rear of the game machine,

(4) Because of this, the plate-shaped member 9d causes a moveable plate 9e to oscillate relative to a shaft J₄,

(4)[sic] Because of this, the pressing member 9f is moved to the front (toward the front of the game machine),

and the aforesaid pressing part 5a is pressed.

The aforesaid tactile sensation levers 10 and 10 are grip members for transmitting sound and vibration when a missile is launched and sound and vibration when there is a hit to the user of the game machine. They resemble the control lever of a fighter and are provided at both sides of the aforesaid control body 7. That is, the tactile sensation levers 10 and 10 consist of grip parts 10a and 10a projecting at the outside of the outer shell body 100, while fitted into long holes N₃ and N₃ provided at their ends is an amplitude variation cam 12 (amplitude variation means) of the aforesaid vibration generating part 11 provided inside the outer shell body of the main body 100; it can oscillate in response to the rotation of the amplitude variation cam 12 centered on the shaft J₁. Here the vibration generating part 11 is provided with an angular tube body 11a having a drive motor (not shown in the drawing) inside; it is provided in the center of the control body 7 along the direction toward the inside of the aforesaid mounting cylinder 2.

Here, the amplitude variation cam 12, as shown in FIG. 7 and FIG. 8, consists of a fan-shaped moveable piece 13 and a driven rotary body 14. The aforesaid tactile sensation levers 10 and 10 are oscillated at different amplitudes according to the forward and reverse movement of the drive piece 13.

The fan-shaped moveable piece 13 is provided with a standing drive pin P₃ that is linked to a motor in the aforesaid vibration generating part 11's angular tube body 11a at an eccentric location equivalent to the fan's "pivot"; it is constituted so that it can be rotated forward or in reverse by the motor (in the drawing, forward is direction a and reverse is direction b). In contrast to this, the driven rotary body 14 has a long hole N₄ to ensure a different eccentricity at each end; the drive pin P₃ [sic] of the drive piece 13 passes through it. The driven rotary body 14 is also provided with a bracket-shaped receiving member U that can lock with the front part of the rotation direction regardless of whether the drive piece 13 rotates forward or in reverse. Here, the long hole N₄ and the receiving member U are eccentrically provided relative to the center of the driven rotary body 14. Therefore they are constituted so that when rotating forward (direction a) as shown in FIG. 8(a), the center of the drive piece 13's pin P₃ [sic] and the center of the driven rotary body 14 establish eccentricity S₁ corresponding to one end of the long hole N₄, and when rotating in reverse (direction b) the center of the drive piece 13's pin P₃ [sic] and the center of the driven rotary body 14 (however, S₁ > S₂). That is, [this constitution] generates a small-amplitude vibration corresponding to small eccentricity S₁ when rotating forward and generates a large-amplitude vibration corresponding to large eccentricity S₁ [sic] when rotating in reverse, and this can be transmitted to the aforesaid tactile sensation levers 10 and 10.

Item 21 is a shoot-down counter. The counter 21 is provided at the front surface of the game machine main body 100 near the aforesaid vibration generating part 11; it is constituted so that is linked to the motor inside the vibration generating part 11 via a catch 20. The counter can rotate via the catch 20 only when the motor runs in reverse; moreover, it can rotate only by a fixed angle. That is, it is constituted so that it operates each time this application's game machine switches hit modes; the number of hits is incremented one by one, and displayed on the front surface of the main body 100.

Furthermore, this embodiment is constituted so that the small vibration when rotating forward imitates the firing vibration when firing a missile and the large vibration

The present invention, as described above, is characterized as being constituted so that a target image screen is provided at the front surface of a base mounted inside an outside spherical surface's mounting cylinder and a hit switch for generating vibration when hits occur is provided at the rear surface and they can oscillate vertically and laterally respectively; a pursuit scope corresponding to the aforesaid target image screen and a tactile sensation lever having a trigger member linked to the aforesaid switch are respectively provided at a control body that can oscillate along the mounting cylinder's outside spherical surface; and the vibration amplitude of the tactile sensation lever is changed by an amplitude variation means when firing and when hitting. Therefore the tactile sensation vibration can be changed in each mode—when pursuing, when firing, and when hitting—and interest in the game machine can be increased. Moreover, the amplitude variation means has a simple structure consisting of an eccentric member and a cam, so the device structure is also simple.

Effect of the Invention

On the other hand, if the centerlines of the member 9f and the member 5a successfully match, the member 5l moves toward the front and switches on in hit mode, and the reflecting mirror 5b moves near the light-emitting lamp L, and the background image T and target image 4 rapidly brighten; an explosion sound is simultaneously created. Then the motor in the vibration generating part 1l rotates in reverse, the driven rotary body 14 rotates with eccentricity S₂, and a large-amplitude [vibration] is transmitted to the tactile sensation levers 10 and 10 via the drive pin P₄ positioned at the other end of the long hole N₄. In addition, each time reverse rotation begins, the shoot-down marker 20 [sic] rotates the counter 2l by exactly the predetermined angle, and the number of shoot-downs is incremented one by one.

When this happens, if the centerlines of the member 9f and the member 5a do not match, the missile launch sound is created and the vibration generating part 1l's motor rotates forward, and the fan-shaped rotary member 13 rotates the driven rotary body 14 via drive pin P₄ positioned at one end of the long hole N₄ by the receiving member U, and a small-amplitude vibration of eccentricity S₁ is transmitted to the tactile sensation levers 10 and 10.

In the aforesaid embodiment, when the stand 1 is set on a desktop, the pursuit scope 8 is positioned so that it is directly before the player and at an angle that is easy to see. When a power switch 15 is turned on, BG sounds suitable for a space game are generated, and the oscillation means 6 makes the target image screen 4 oscillate irregularly vertically and laterally in front of the background image T, which is rotating at a constant speed. Now the player grasps the tactile sensation levers 10 and 10 with both hands, and appropriately oscillates the pursuit body 7 [sic] so that the aiming mark M₁ on the pursuit scope 8 and the target mark M₂ on the target image 4 match. Then, when the mark M₁ and mark M₂ match, if the firing button 9a of the trigger member 9 is pressed with the right thumb, the member 9f is pressed toward the switch 5's pressing member 5a via members 9b, 9c, 9d, and 9e.

When rotating in reverse imitates the shock vibration of a hit, and an imitation sound is simultaneously created, but of course the characteristics of this vibration and sound can be suitably modified according to the contents of the game.

1	Stand
2	Mounting cylinder
3	Base
4	Target image screen
5	Hit switch
5a	Pressing part
5b	Reflecting mirror
6	Oscillation mechanism
7	Control body
8	Pursuit scope
9	Trigger member
10	Tactile sensation lever
11	Oscillation generating means
11a	Angular tube body
12	Amplitude variation cam (vibration variation means)
13	Fan-shaped moveable piece
14	Driven rotary body
15	Power switch
20	Catch
21	Counter
31	Frame body
61	First oscillation arm
62	Eccentric rotary disk

FIG. 1 is an oblique view of the entirety of this application's tactile sensation game machine. FIG. 2 is an oblique view with a partial cut-out of the same. FIG. 3 is an oblique view showing the structure of the base and oscillation mechanism. FIG. 4 is an oblique view showing the structure of the tactile sensation vibration switch's pressing means. FIG. 5 is a sectional view showing the relationship between the base and pursuit body. FIG. 6 is a sectional view showing the relationship between the tactile sensation vibration switch's pressing means and the base. FIG. 7 is an oblique view showing the structure of the amplitude variation cam. FIGS. 8(a) and (b) are drawings explaining the cam's amplitude variation principle.

4. BRIEF DESCRIPTION OF THE DRAWINGS

As a result, [the present invention] has an excellent effect in making it possible to provide a tactile sensation game machine that provides varied and realistic tactile sensation modes while keeping a simple and inexpensive device structure.

Agent: Yukihiro Hamura, Patent Attorney [seal]

- 64 Cam follower
- 65 Irregularly curved cam
- 71 Shell body
- L Light-emitting lamp
- P₁, P₂, P₃, P₄ Pin
- N₁, N₂, N₃, N₄ Long hole
- J₁, J₂, J₃, J₄ Shaft
- S₁, S₂ Eccentricity
- M₁ Target image
- M₂ Aiming mark
- U Receiving member
- G₁, G₂ Gear
- B Spring
- T Transparent disk



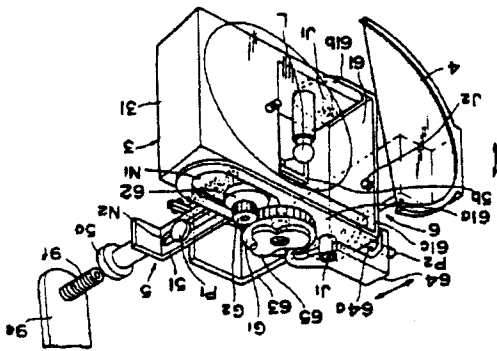


Figure 3

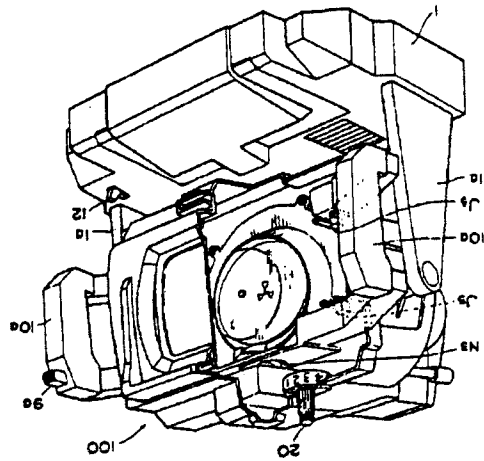
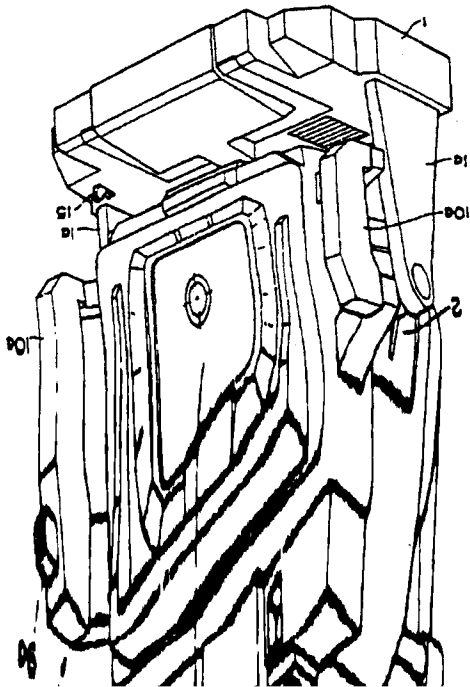
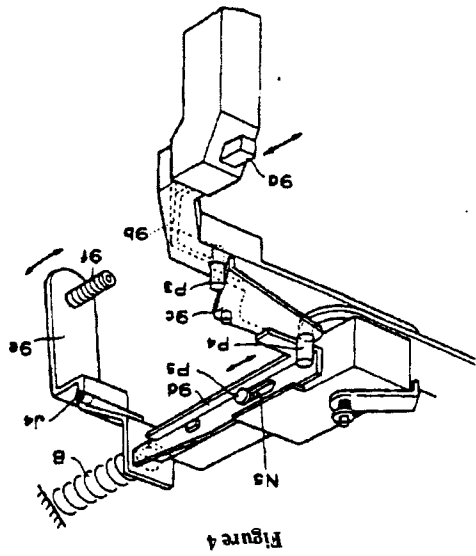
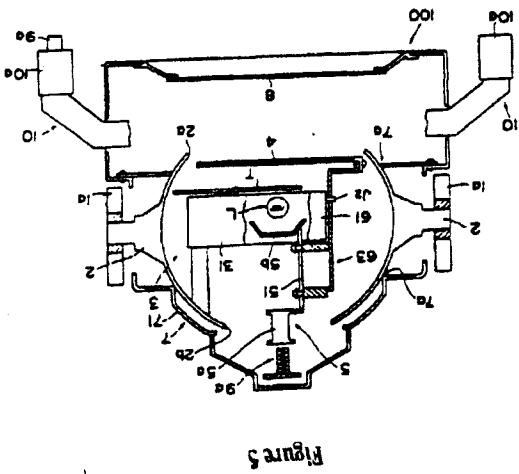
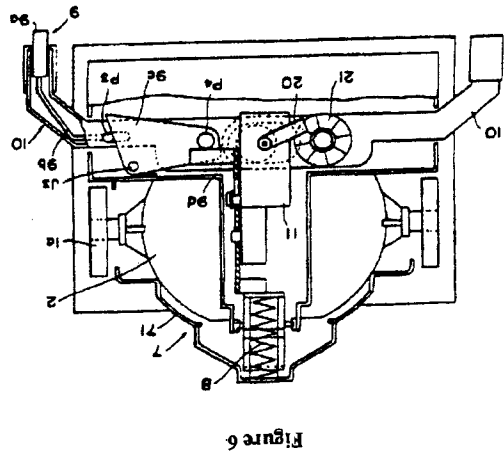
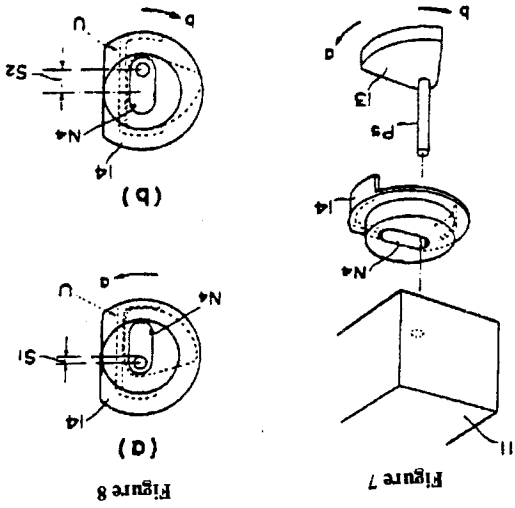


Figure 2





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Request for Examination: Not yet submitted

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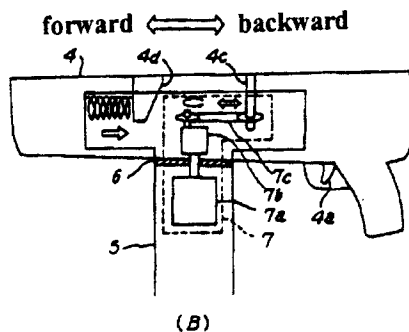
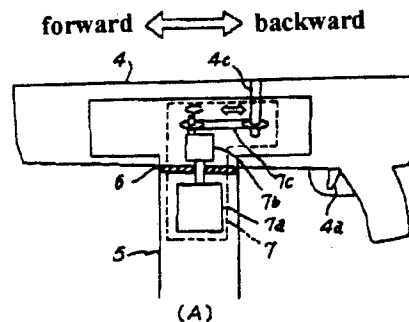
(74) Agent: Yuzo Yasukata, Patent Attorney

(54) [Title of the Invention] Gun Unit for Game Machine Equipped with Sliding Vibration Mechanism

(57) [Abstract]

[Object] To obtain a gun unit used for an electronic game machine or other such game machine, which makes a player feel as if he is actually firing a machine gun.

[Constitution] A support shaft 5 of a gun unit is equipped with a slider 6 for carrying a gun body 4 of the gun unit and sliding it back and forth, and a reciprocating vibrating mechanism 7 for vibrating the gun body 4 carried by the slider 6 back and forth according to an operating command from the game machine. The reciprocating vibrating mechanism 7 comprises, as shown in the drawings for example, a motor 7a, an eccentric cam 7b inserted into a rotor of the motor 7a, and a link 7c for coupling a coupler 4c provided inside the gun body 4 and a coupler of the eccentric cam 7b, and generates reciprocating motion.



[Claims]

[Claim 1] A gun unit for an electronic game machine or other such game machine equipped with sliding vibration mechanism, wherein said game machine gun unit is characterized in that a support shaft of the gun unit is equipped with a slider for carrying a gun body of the gun unit and sliding it back and forth, and a reciprocating vibrating mechanism for vibrating the gun body carried by the slider back and forth according to an operating command from the main body of the game machine.

[Claim 2] The gun unit for a game machine equipped with sliding vibration mechanism according to Claim 1, wherein the gun body is coupled with the support shaft, and there is provided an elastic member disposed such that tensile force or restoring force acts in the rearward direction of the gun body.

[Detailed Description of the Invention]

[0001]

[Field of Industrial Utilization]

The present invention relates to a gun unit used in an electronic game machine or other such game machine, and more particularly relates to a game machine gun unit equipped with a vibrating mechanism for simulating the recoil when a bullet is fired.

[0002]

[Prior Art]

Electronic game machines installed in amusement centers and so forth include so-called gun games, in which the player uses a simulated gun (such as a pistol) to fire at a target displayed on the screen of a display device. In general, with a gun game, the firing direction and position are detected by a position detector at the point when the player pulls the trigger of the gun, a firing sound or other such sound effect is outputted by the electronic game machine, and whether the bullet hit its target or not is determined on the basis of the detection information in the position detector. If the shot was a hit, a hit scene is displayed on the screen and a hit sound is outputted. Since the gun used with such games does not actually fire any bullets, the game is given a more realistic feel by vibrating the gun unit with a vibrating mechanism inside the gun unit at the point when the gun trigger is pulled, so as to simulate the recoil produced when a gun is fired.

[0003] Figs. 2 A and B are cross sections of first and second structure examples for a game machine gun unit equipped with a conventional vibrating mechanism. The gun unit consists of an integrally molded gun 1 and support shaft 2, and a vibrating mechanism 3 is provided inside the gun 1. The rotatable support shaft 2 can be tilted in the directions of the arrows L1 and L2 around a pivot point C of a turning mechanism (not shown) located underneath, which allows the player to aim the gun at the target.

[0004] Fig. 2A is an example in which a solenoid magnet is used as the vibrating mechanism 3. The solenoid magnet 3S consists of an electromagnet composed of a cylindrical coil that generates a magnetic field, and an armature (rotor) that moves reciprocally along the center axis of this coil. When the player pulls the trigger 1a of the gun 1, the solenoid magnet 3S is actuated, and the reciprocal motion of the armature

causes the distal end thereof to hit a protrusion 1S. This striking of the protrusion 1S tilts the gun unit in the direction of arrow L2 around the pivot point C, and the continuous tilting caused by repeated firing results in vibration. This vibration is transmitted to the player's hand from a grip 1b linked directly to the support shaft 2, which allows the player to physically feel the firing recoil.

[0005] Fig. 2B is an example of a gun unit in which the vibrating mechanism 3 provided inside the gun 1 is made up of a motor 3M and an eccentric weight 3W. In this example, when the player pulls the trigger 1a of the gun 1, the motor 3M inside the vibrating mechanism 3 is actuated, and the rotational movement of the eccentric weight 3W attached to the rotating shaft of the motor 3M causes the gun unit to vibrate in a circle with respect to the rotational axis. This vibration is transmitted from the grip 1b to the player's hand, and this gives the player the sensation of firing a gun, produced by gentle vibrations.

[0006]

[Problems Which the Invention is Intended to Solve]

However, with the conventional gun unit described above, the gun and the support shaft were integrated, with the support shaft itself serving as the grip. Since the grip was vibrated indirectly by vibrations from a source provided inside the gun, only gentle vibrations were transmitted to the player. Also, since the vibration direction was different from that of a real gun, the sensation was far removed from that produced by the recoil of an actual hand gun or machine gun.

[0007] The present invention was conceived in light of the above situation, and it is an object thereof to eliminate the above-mentioned drawbacks and provide a gun unit for a game machine, equipped with a sliding vibrating mechanism that feels as if an actual gun is being fired.

[0008]

[Means Used to Solve the Above-Mentioned Problems]

The present invention relates to a gun unit equipped with a sliding vibrating mechanism and used in electronic game machines and other such game machines. The stated object of the present invention is achieved by equipping a support shaft of a gun unit with a slider for carrying a gun body of the gun unit and sliding it back and forth, and a reciprocating vibrating mechanism for vibrating the gun body carried by the slider back and forth according to an operating command from the main body of the game machine.

[0009]

[Operation of the Invention]

With the present invention, a support shaft is equipped with a sliding vibrating mechanism, and the gun body is vibrated by being slid back and forth according to a drive command from the main body of the game machine, so the vibrations produced by the reciprocal movement of the gun are transmitted directly to the hand holding the gun. Furthermore, the gun body and the support shaft are coupled, and an elastic member is disposed such that tensile force or restoring force acts in the rearward direction of the gun body. As a result, the movement speed is faster in the direction opposite the direction in

which the bullet is fired, so the movement of a recoiling gun body can be accurately reproduced.

[0010]

[Examples]

An example of the present invention will now be described in detail through reference to the drawings. Fig. 1A is a cross section of a first structure example of a game machine gun unit equipped with the sliding vibrating mechanism of the present invention. As shown in Fig. 1A, the gun body 4 and the support shaft 5 are separate parts in this gun unit. The support shaft 5 of the gun unit is provided with a slider 6 for sliding the gun body 4 back and forth, and a reciprocating vibrating mechanism 7 for vibrating the gun body 4 carried by the slider 6 back and forth according to an operating command from the main body of the game machine (not shown).

[0011] The reciprocating vibrating mechanism 7 comprises, as shown in Fig. 1A for example, a motor 7a, an eccentric cam 7b inserted into a rotor of the motor 7a, and a link 7c for coupling a coupler 4c provided inside the gun body 4 and a coupler of the eccentric cam 7b. The slider 6 comprises, for example, a slider unit that carries the gun body 4, and a track rail, and is designed so that the gun body 4 can slide back and forth along the track rail. The vibrating mechanism 7 here is not limited to the structure shown in Fig. 1A, and may employ a solenoid magnet instead.

[0012] The following is an example of how the gun unit of the present invention operates with a structure such as this. When the player pulls the trigger 4a of the gun body 4, the motor 7a is driven according to a command from the main body of the game machine (not shown), the rotation motion of an eccentric cam 5c becomes reciprocal motion and is transmitted through the link 7c to the coupler 4c inside the gun body 4, and the gun body 4 reciprocally moves a specific distance back and forth along the track rail inside the slider 6. The stroke is controlled by the drive command from the main body of the game machine, and the speed of the reciprocal motion can be varied according to the type of gun and how the game develops.

[0013] Fig. 1B is a cross section in which a speed changing means for changing the movement speed in the forward and rearward directions of the gun body 4 is added to the vibrating mechanism 7 shown in Fig. 1A. This allows the movement of the gun body to be modulated. An elastic member receiver 4d is provided inside the gun body 4, and the gun body 4 and the support shaft 5 are coupled via an elastic member 5e at the forward position of the vibration source. With this structure, when the gun body 4 slides forward along the track rail inside the slider 6, the elastic member 5e is compressed, and the restoring force thereof is exerted to the rear. As a result, the gun body 4 moves quickly in the rearward direction and slowly in the forward direction. Generating action such as this allows the movement of a gun body as it recoils when fired to be reproduced more accurately.

[0014] Further, in the above example, an electric actuator was used as the sliding vibrating mechanism for vibrating the gun body back and forth, but a "pneumatic actuator" or "hydraulic actuator," which controls the output of an energy accumulator (such as an air compressor or a hydraulic power unit) with valves and pneumatically or

hydraulically drives a cylinder, may be used instead. From the standpoints of response, momentum, durability, cost, and so forth, however, the sliding vibrating mechanism shown in Fig. 1 is superior in overall performance. Also, the elastic member 5e in Fig. 1B was a cylindrical coil spring, but is not limited to this, and may instead be a spiral spring, flat spring, or the like. Also, the disposition of the elastic member 5e is not limited to acting compressively, and may instead act in tensile fashion.

[0015]

[Effect of the Invention]

As discussed above, with the game machine gun unit equipped with a sliding vibrating mechanism of the present invention, a sliding vibrating mechanism is provided to a support shaft, and the gun is slid back and forth according to drive commands from the main body of the game machine, so vibration produced by the reciprocal motion of the gun is transmitted directly to the hand holding the gun, allowing the player to experience a powerful sensation of firing a gun. Furthermore, a speed changing means is provided so that the movement speed is faster in the direction opposite the direction in which a bullet is fired, so it feels as if a real machine gun is being fired.

[Brief Description of the Drawings]

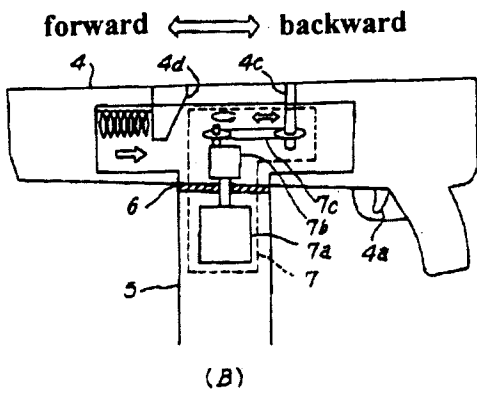
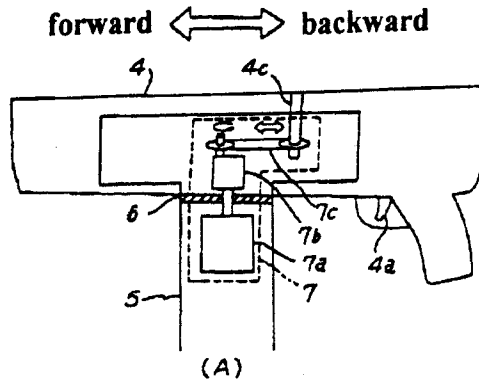
Fig. 1 consists of cross sections of first and second structure examples for a game machine gun unit equipped with the sliding vibrating mechanism of the present invention.

Fig. 2 consists of cross sections of first and second structure examples for a game machine gun unit equipped with a conventional vibrating mechanism.

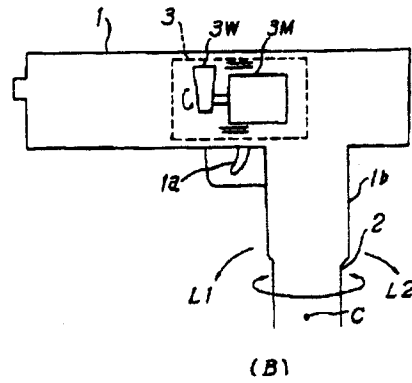
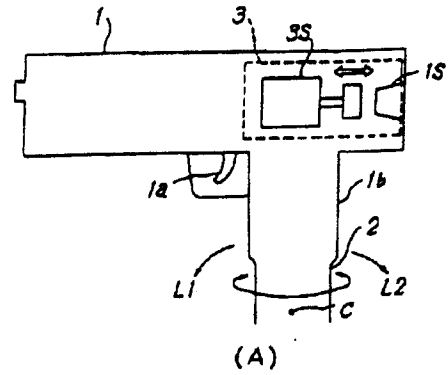
[Key]

- 4 gun body
- 5 support shaft
- 6 slider
- 7 vibrating mechanism

[Figure 1]



[Figure 2]



MSX 0047897

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		C	8403-2C

(43) Disclosure Date: July 19, 1990

Number of Claims: 2

Request for Examination: Not yet submitted

(Total of 6 pages [in original])

(54) Title of the Invention: Light Beam Gun Shooting Game Apparatus

(21) Application No.: H1-3664

(22) Filing Date: January 12, 1989

(72) Inventor: Itsuji Yamada

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Taito Building, 2-5-3 Hirakawa-cho, Chiyoda-ku, Tokyo

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Taito Building, 2-5-3 Hirakawa-cho, Chiyoda-ku, Tokyo

(74) Agent: Shoutaro Mogami, Patent Attorney

Specification

1. Title of Invention

Light Beam Gun Shooting Game Apparatus

2. Claims

(1) A light beam gun shooting game apparatus having a game controller comprising a central processing unit (hereinafter called CPU), a programmable ROM (hereinafter called PROM) and RAM for supporting the operation of said CPU, and a screen RAM wherewith image signals are written and read out in accordance with commands from said CPU, wherein prescribed video signals are formed according to a predetermined program, and a desired image containing a target is shown on a display device, while a target in said image is shot at using a light beam gun, wherein:

the configuring elements cited below in (a) to (f) are comprised, namely:

(a) a console,

(b) a video display device provided in said console,

(c) a light beam gun attached to said console, oriented relative to [said] video display device, such that the angle of elevation and azimuth angle can be freely changed,

(d) a potentiometer attached to said light beam gun, for detecting the angle of elevation and azimuth angle of [said] light beam gun,

(e) an analog/digital converter for converting the output of said potentiometer to a digital signal, and

(f) a judgment circuit for comparing the address of a target in one frame with the output of said analog/digital converter, every time the trigger of said light beam gun is pulled, and outputting an on-target signal when the target address and the shooting direction coincide.

(2) The light beam gun shooting game apparatus according to claim 1, wherein said light beam gun is provided in a plurality.

3. Detailed Description of Invention

(Industrial Field of Use)

This invention relates to improvements in a light beam gun shooting game apparatus.

(Prior Art)

Light beam gun shooting game apparatuses wherein prescribed video signals are formed according to a predetermined program, and a desired image containing a target is shown on a display device, while the target in the image is shot at using a light beam gun, are publicly known.

According to the configuration of a conventional publicly known light beam gun shooting game apparatus, a light beam gun is supported in a gun holding device so that the angle of elevation and the azimuth angle of the light beam gun can be freely changed,

and a lens and light receiving element are provided inside the gun barrel. When a player takes aim at a target in an image containing a target shown on a display device, and pulls the trigger of the light beam gun, the video signal for one frame only of the display device changes to a monochrome constant-level signal. When, during that time, the above-described light receiving element detects the image of a spot that scans the screen, the strike point is known by the address corresponding thereto, and, by comparing that with the address of a target existing on a normal game screen, either a hit or a miss is judged.

As a consequence, with a conventionally known light beam gun shooting game apparatus, the screen flickers because, every time the trigger of the light beam gun is pulled, the screen is made a monochrome screen for one frame only. That tendency is particularly conspicuous when the game is played by a plurality of players, and this has been a problem in terms of destroying player interest in the game.

(Problems Invention Would Resolve)

An object of the present invention, which was devised in order to resolve the problems described above, is to provide a new light beam gun shooting game apparatus configured such that hits and misses can be judged accurately, without making the screen a monochrome screen for one frame only when judging hits and misses, such that the flickering that appears on the display screen can be eliminated, and such that players can become completely absorbed in the game.

(Means for Resolving Problems)

The above-described object is attained by a light beam gun shooting game apparatus configured so that the direction of the gun barrel when shooting is measured by a potentiometer, the address of a screen RAM corresponding to the strike point on the screen is calculated, that is compared with the address of the target, and hits and misses are judged.

(Operation)

In the present invention, as described in the foregoing, when the trigger of the light beam gun is pulled, the position of a target in one frame of the screen and the position of the muzzle in the one frame of the screen calculated from the angle of elevation and azimuth angle of the light beam gun directed toward the above-described screen are compared, and thereby a hit or miss is judged. Therefore, it is possible to eliminate flickering on the display screen that appears every time the trigger of the light beam gun is pulled, as [occurs] with a conventional light beam gun shooting game apparatus, and to further increase player interest in the game.

(Embodiments)

The details of the present invention are now described concretely using the drawings.

Fig. 1 is an external view of one embodiment of a light beam gun shooting game apparatus related to the present invention, Fig. 2 is an external view showing the configuration of the light beam gun thereof, Fig. 3 is a partially cutaway explanatory diagram showing the internal mechanism of the light beam gun, Fig. 4 is a partially

cutaway view showing the internal mechanism of a gun holding apparatus, and Fig. 5 is a block diagram of the circuit configuration of the light beam gun shooting game apparatus related to the present invention.

In Fig. 1 to 4, item 1 is a light beam gun shooting game apparatus, 2 a console, 3 a video display screen, 4 a light beam gun, 4a the muzzle of the above-described light beam gun, 4b the trigger of the above-described light beam gun, 5 a money insertion slot, 6 a game start switch, 7 a money collection door, 8 an arm, 9 a gun master, 10 solenoid coil, 11 a microswitch, 12 a return spring, 13 a plunger, 14 a movable base, 15 a sub-base, 16 a first gear that turns together with the above-described movable base 14, 17 a second gear that turns in accordance with the arm 8, 18 a potentiometer for measuring azimuth angles, 19 a potentiometer for measuring angles of elevation, and 20 a turning-center shaft.

In Fig. 5, furthermore, where the numbers that are the same as those used in Fig. 1 to 4 indicate the same configuring elements, item 21 is an I/O port, 22 a PROM, 23 a CPU, 24 a RAM, 25 and 26 analog/digital converters, 27 an audio generator circuit, 28 a speaker, 29 a timing pulse generator, 30 a screen RAM, 31 a judgment circuit, and 32 a video signal generator circuit.

Descriptions pertaining to Fig. 1 to 4 are given first.

The light beam gun shooting game apparatus 1 relating to the present invention has provided, in the console 2, the video display screen 3 and two light beam guns 4 and 4 relatively oriented to the above-described video display screen 3.

The arm 8, which supports the light beam gun 4, is configured so as to be able to turn about a vertical center shaft on the movable base 14 together with the movable base 14, and so as to be able to tilt within a certain angle about the turning-center shaft 20 of the second gear 17.

Accordingly, the light beam gun 4 is configured so that the angle of elevation and azimuth angle can be changed to desired angles, but also so that, when the angle of elevation and azimuth angle reach certain angles, further movement is limited by the action of a moving range stopper case (not shown).

The configuration is further made so that, when the azimuth angle of the light beam gun 4 changes, the movable base 14 turns about the center shaft thereof, the potentiometer 18 for measuring the azimuth angle is turned by the first gear 16, and, when the angle of elevation of the light beam gun 4 is changed, the potentiometer 19 for measuring the angle of elevation is turned by the second gear 17 that turns together with the arm 8. Provision is [thus] made so that the direction of the light beam gun 4 can be known by the outputs from the above-described potentiometer 18 for measuring the azimuth angle and potentiometer 19 for measuring the angle of elevation.

Thereupon, when the aim is fixed on a target, and the trigger 4b of the above-described light beam gun 4 is pulled, a current is applied [sic] to the solenoid coil 10, the above-described solenoid coil 10 moves the plunger 13 forward and backward, in the direction of the gun barrel, against the elastic force of the return spring 12, thereby causing a vibration shaft (not shown) that is connected to the above-described plunger 13

to strike the chassis, whereby a [mechanical] shock is imparted to the light beam gun 4, giving the player the sensation of firing a gun.

A description pertaining to Fig. 5 is given next.

The I/O port 21 receives input signals from a publicly known money depositing apparatus and from the game start switch 6, etc., encodes those signals and sends them to the CPU 23, etc., and also receives signals from the above-described CPU 23 and controls the functions of the above-described input/output devices.

In the PROM 22 are stored the program and object patterns and the like necessary for the game. As necessary, these data are supplied to the CPU 23.

The CPU 23, responding to inputs from the I/O port 21, sends necessary command signals to the audio generator circuit 27, screen RAM 30, and judgment circuit 31. In the screen RAM 30 are stored a one-screen volume of image data for displaying background and targets and the like on the video screen.

The audio generator circuit 27, responding to signals from the CPU 23, generates prescribed audio signals according to the progress of the game, drives the speaker 28, and produces sound effects and the like.

When the trigger 4b of the light beam gun 4 is pulled, azimuth angle and angle of elevation detection signals for the above-described light beam gun 4 are output by the potentiometer 18 for measuring azimuth angles and the potentiometer 19 for measuring angles of elevation. Those detection signals, after being converted to digital signals by the analog/digital converters 25 and 26, are input to the judgment circuit 31. Those digital signals correspond to addresses in the screen RAM 30 which correspond with the direction of the light beam gun 4, that is, with the strike point.

The judgment circuit 31 compares the outputs of the above-described analog/digital converters 25 and 26 with the address of the target and, when those coincide, outputs an on-target signal to the CPU 23.

Thereupon, when an on-target signal is issued, image data representing a destroyed target are written to the screen RAM 30 by a signal from the CPU 23, and the image of the destroyed target is shown on the video display screen 3.

(Effectiveness of Invention)

Because the present invention is configured as described in the foregoing, when based on the present invention, when the trigger of a light beam gun is pulled, hits or misses are judged by comparing the address of the target in one frame of the screen, and the address of a strike point on the screen calculated on the basis of the angle of elevation and azimuth angle of the light beam gun oriented toward the above-described screen. Therefore, [the light beam gun shooting game apparatus relating to the present invention] is one wherewith flickering that appears on the display screen every time the trigger of the light beam gun is pulled, as occurs with a conventional apparatus, can be eliminated, and players can become completely absorbed in the game.

Furthermore, the present invention is not limited to or by the embodiment described in the foregoing. More specifically, for example, although in this embodiment an upright type shooting game is assumed, [the present invention] can be applied to other

types, such as similar games like aerial combat games, for example. The present invention comprehends all modified embodiments that could be arrived at easily, from the above-described embodiment, by one skilled in the art.

4. Brief Description of Drawings

Fig. 1 is an external view of one embodiment of a light beam gun shooting game apparatus related to the present invention, Fig. 2 is an external view showing the configuration of the light beam gun thereof, Fig. 3 is a partially cutaway explanatory diagram showing the internal mechanism of the light beam gun, Fig. 4 is a partially cutaway view showing the internal mechanism of a gun holding apparatus, and Fig. 5 is a block diagram of the circuit configuration of the light beam gun shooting game apparatus related to the present invention.

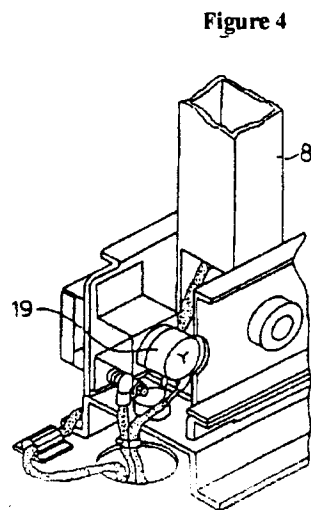
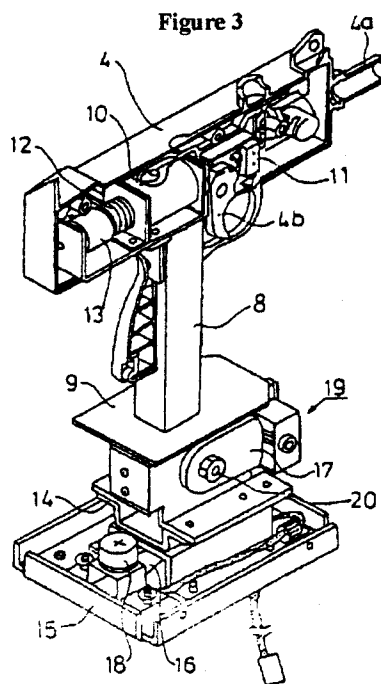
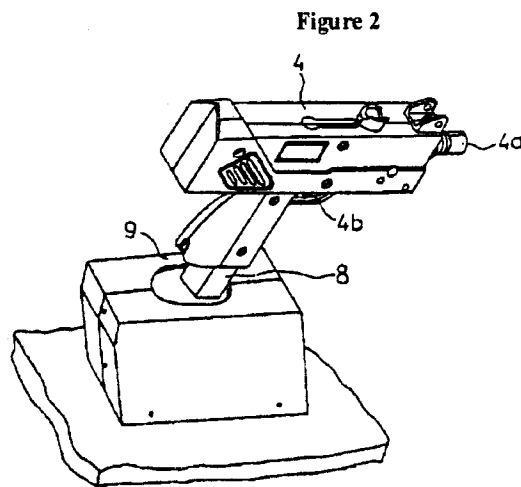
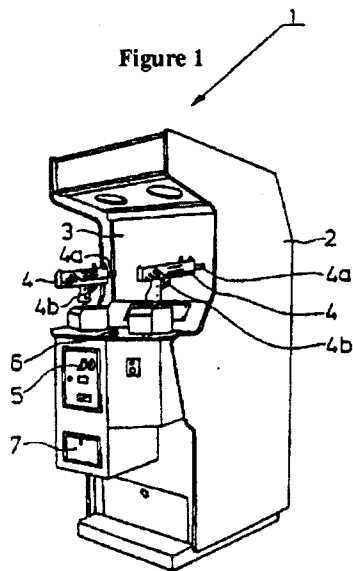
- 1 light beam gun shooting game apparatus
- 2 console
- 3 video display screen
- 4 light beam gun
 - 4a muzzle
 - 4b trigger
- 5 money insertion slot
- 6 game start switch
- 7 money collection door
- 8 arm
- 10 solenoid coil
- 12 return spring
- 13 plunger
- 14 movable base
- 15 sub-base
- 16 first gear
- 17 second gear
- 18 potentiometer for measuring azimuth angles
- 19 potentiometer for measuring angles of elevation
- 21 I/O port
- 22 PROM
- 23 CPU
- 24 RAM
- 25, 26 analog/digital converters

- 27 audio generator circuit
- 28 speaker
- 29 timing pulse generator
- 30 screen RAM
- 31 judgment circuit
- 32 video signal generator circuit

Patent Applicant: Taito Corporation

Agent: (7524) Shoutaro Mogami, Patent Attorney

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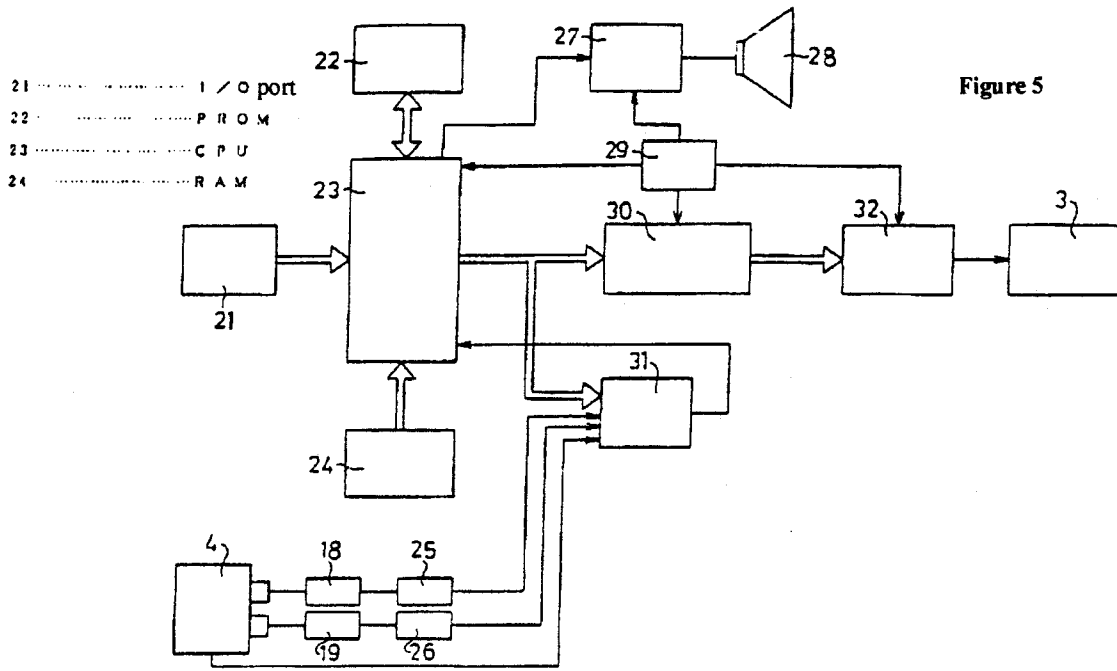


Figure 5

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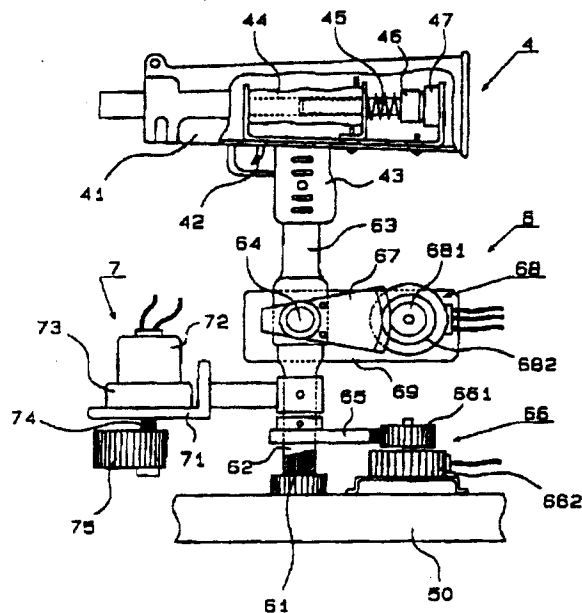
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(54) [Title of the Invention] Video Gun Shooting Game Machine, and Method for Controlling this Machine

(57) [Abstract]

[Object] It is an object of the present invention to inexpensively provide a novel video gun shooting game machine which has a simple structure and with which hits on a friend can be sensed directly through the body, and to provide a method for controlling this game machine.

[Constitution] A vibration generator is provided to a simulated gun or its support device, a vibration generating command signal is generated along with a player-hit signal by a game control circuit when it is determined that the player has been hit, and as a result the vibration generator is operated for a specific length of time so as to impart vibration to the simulated gun.



[Claims]

[Claim 1] A method for controlling a video gun shooting game machine, in which the player engages in a mock gun battle with an enemy appearing on the screen of a video display device (2), which displays the developing situation of the game according to a predetermined game program, by using a simulated gun (4) whose barrel (41) direction can be controlled and which is equipped with an apparatus capable of generating a hit location signal corresponding to the direction of the barrel (41) when the player aims at the screen of the video display device (2) and pulls a trigger (42), an enemy-hit signal is generated and sent to a game control circuit (3) when the enemy is present at a hit location on the screen corresponding to the signal generated by the hit location signal generator, or a player-hit signal is generated when the player is hit by a bullet fired by the enemy, the progress of the game is varied by these signals, and points are tallied according to the injury sustained by the player and enemy as a result of these hits,

wherein said method for controlling a video gun shooting game machine is characterized in that a vibration generator (7) is provided to a simulated gun (4) or its support device (6), a vibration generating command signal is generated along with a player-hit signal by a game control circuit (3) when it is determined that the player has been hit, and as a result the vibration generator (7) is operated for a specific length of time so as to impart vibration to the simulated gun (4).

[Claim 2] The method for controlling a video gun shooting game machine according to Claim 1, wherein the duration of the vibration imparted to the simulated gun (4) is controlled according to the injury sustained when the player is hit.

[Claim 3] A video gun shooting game machine, comprising:

a game control circuit (3) loaded with a predetermined game program;

a video display device (2) that is controlled by the game control circuit (3) and displays the developing situation of the game; and

a simulated gun (4) whose barrel (4) can be aimed at the screen of the video display device (2), and which is equipped with an apparatus capable of generating a hit location signal corresponding to the direction of the barrel when the player pulls a trigger (42),

in which the player engages in a mock gun battle with an enemy appearing on the screen of the video display device (2), an enemy-hit signal is generated and sent to the game control circuit (3) when the enemy is present at a hit location on the screen corresponding to the signal generated by the hit location signal generator, or a player-hit signal is generated when the player is hit by a bullet fired by the enemy, the progress of the game is varied by these signals, and points are tallied according to the injury sustained by the player and enemy as a result of these hits,

wherein said video gun shooting game machine is characterized in that a vibration generator (7) is provided to the simulated gun (4) or its support device (6), and a circuit is provided for operating the vibration generator (7) for a specific length of time when a player-hit signal is generated.

[Claim 4] The video gun shooting game machine according to Claim 3, wherein the vibration generator (7) comprises a motor (72) supported by a bracket (71) attached to a vertically rotating support shaft (62) that supports the simulated gun (4), and an eccentric weight (75) attached to an output shaft (74) of the motor (72) via a reduction gear (73).

[Detailed Description of the Invention]

[0001]

[Field of Industrial Utilization]

The present invention relates to a video gun shooting game machine and to a method for controlling this game machine.

[0002]

[Prior Art]

Video gun shooting game machines comprising a game control circuit loaded with a predetermined game program, a video display device that is controlled by the game control circuit and displays the developing situation of the game, and a simulated gun whose barrel can be aimed at the screen of the video display device and which is equipped with an apparatus capable of generating a hit location signal corresponding to the direction of the barrel when the player pulls a trigger, in which the player engages in a mock gun battle with an enemy appearing on the screen of the video display device, an enemy-hit signal is generated and sent to the game control circuit when the enemy is present at a hit location on the screen corresponding to the signal generated by the hit location signal generator, or a player-hit signal is generated when the player is hit by a bullet fired by the enemy, the progress of the game is varied by these signals, and points are tallied according to the injury sustained by the player and enemy as a result of these hits, are commonly known and have become very popular.

[0003] Various devices have been employed to make these games as realistic as possible by providing an apparatus for generating the feel of an impact or the sound of a bullet being fired when the trigger is pulled. Unfortunately, with conventional game machines of this type, when the player is shot, the image of an explosion or the like merely appears on the screen of the video display device, or a sound effect is generated, so the player cannot directly feel the hit, and consequently the game lacks realism or does not provide the feel of a simulated experience.

[0004] Realism and the feel of a simulated experience have recently become very important in video games, which is why game machines have become much bulkier, but a machine which allows the player to physically feel a hit on a friendly position by means of a simulator, for example, is extremely large and expensive, and is therefore not well suited to application to relatively inexpensive video gun shooting game machines. Accordingly, there have as yet been no proposals for video game machines that give the player a physical sensation of being shot.

[0005]

[Problems Which the Invention is Intended to Solve]

It is an object of the present invention to inexpensively provide a video gun shooting game machine with which hits on a friendly position can be sensed directly through the body, and to provide a method for controlling this game machine.

[0006]

[Means Used to Solve the Above-Mentioned Problems]

The stated object is achieved by providing a vibration generator to a simulated gun or its support device in the above-mentioned conventional video gun shooting game machine, and providing a circuit for operating this vibration generator for a specific length of time when a player-hit signal is generated.

[0007] The stated object is also achieved by providing a vibration generator to the support device of a simulated gun in a method for controlling the above-mentioned conventional video gun shooting game machine, generating a vibration generating command signal along with a player-hit signal from a game control circuit when it is determined that the player has been hit, which results in the vibration generator being operated for a specific length of time and vibration being imparted to the simulated gun.

[0008]

[Examples]

An example of the present invention will now be described through reference to the appended drawings. Fig. 1 is a diagram illustrating the overall structure of the video gun shooting game machine pertaining to the present invention, Fig. 2 is a diagram illustrating an example of the structure of the simulated gun used in this video gun shooting game machine, and Fig. 3 is a flow chart of the game.

[0009] In Fig. 1, 1 is the overall game machine, 10 is the cabinet thereof, 2 is a video display device attached to the cabinet 10, 3 is a game control circuit built into the cabinet 10, 4 is a simulated gun, 5 is a firing stand that houses a support device 6 for the simulated gun 4 and a vibration generator 7, 50 is a cabinet for this stand, and 8 is a signal transmission cable.

[0010] The program required for the game is loaded ahead of time into the game control circuit 3, and the developing situation of the game, including the image of the enemy that is the target in the gun battle, the background, obstacles, and so forth, is displayed on the video display device 2. The player uses the simulated gun 4 provided to the firing stand 5 to conduct a gun battle with the enemy appearing on the video display device.

[0011] Fig. 2 shows the details of the support device 6 and the vibration generator 7. 41 is the barrel¹ of the simulated gun 4, 42 is the trigger, and 43 is the grip. Inside the barrel 41 are housed a firing signal generator (not shown) and a firing sound and impact generator consisting of a solenoid 44, a compression spring 45, a weighted plunger 46, and a shock-absorbing rubber bushing 47.

¹ Translator's note: The Japanese word for barrel is used throughout the document, although from the drawings it does not appear to be a barrel per se, and might be more properly called the gun body.

drawings it does not appear to be a barrel per se, and might be more properly called the gun body.

[0012] When the trigger 42 is pulled, pulse current flows to the solenoid 44, while the firing signal generator sends out a pulse signal. When current flows to the solenoid 44, the weighted plunger 46 is pulled into the solenoid 44 against the elastic force of the compression spring 45, and then when the power is cut off, the weighted plunger 46 is repelled by the elastic force of the compression spring 45, and hits the shock-absorbing rubber bushing 47, which produces a firing sound and makes the barrel recoil. As the player continues to pull the trigger 42, the firing sounds and impacts are continuously generated.

[0013] The simulated gun support device 6 comprises a fixed support shaft 61 fixed to the bottom of the cabinet 50, a rotating support shaft 62, a fork 63 linked at its upper end to the grip 43, a pin 64 that bendably links the rotating support shaft 62 and the fork 63, a segment 65 that is attached to the rotating support shaft 62 and rotates together with the rotating support shaft 62, a potentiometer 66 that is controlled by the segment 65, a segment 67 that is attached to the fork 63 coaxially with the coupler pin 64 and that rotates together with the fork 63, a potentiometer 68 that is controlled by the segment 67, and a potentiometer supporting bracket 69 that is attached to the rotating support shaft 62.

[0014] The lower end of the rotating support shaft 62 is tubular in shape and rotatably fitted to the fixed support shaft 61, while the upper end is crimped flat. The forked portion at the lower end of the fork 63 flanks the flat part at the upper end of the rotating support shaft 62, and the two components are bendably coupled by the coupler pin 64. The potentiometer 66 comprises an input gear 661 and a converter 662, and is fixed to the cabinet 50 via a suitable bracket, and its input gear 661 meshes with the segment 65 that rotates together with the rotating support shaft 62.

[0015] The bracket 69 is welded to the rotating support shaft 62, and the potentiometer 68 is attached to this bracket 69. The potentiometer 68 comprises an input gear 681 and a converter 682, and is attached to the bracket 69, and its input gear 681 meshes with the segment 67 that rotates together with the fork 63.

[0016] Therefore, the orientation of the simulated gun 4 is controlled biaxially by the rotating support shaft 62 and the coupler pin 64, so the player can freely control the direction of the barrel 41 by turning the grip 43 to the right and left and pointing it up and down, allowing him to aim and fire at the image of the enemy appearing on the screen of the video display device 2. The azimuth and angle of elevation of the barrel 41 are converted into electrical signals by the potentiometer 66 and the potentiometer 68, respectively, and these signals are sent to the game control circuit 3.

[0017] As discussed above, when the player pulls the trigger 42, a fire signal is generated from the signal generator housed in the barrel 41, and this fire signal is also sent to the game control circuit 3. When a fire signal is generated, if the azimuth and elevation angle of the barrel 41 are within a predetermined range corresponding to the image of the enemy on the screen of the video display device 2, then the fired bullet is deemed to have hit the enemy, and the player earns points corresponding to the injury sustained by the enemy, but if the enemy accurately aims and fires at the player before the player knocks the enemy down, this is deemed a defeat of the player, and the player loses one friendly commando. The object of the game is to earn as many points as possible before all friendly commandos are wiped out.

[0018] With a conventional video gun shooting game machine, an apparatus was provided for imparting some kind of shock or recoil to the barrel 41 when the player pulled the trigger, and this did give the player a sense of realism or simulation, but the only thing that happened when a friend was shot was that a crash image was displayed on the screen or a suitable simulated sound was generated, so the game was not interesting enough to keep a single player engrossed for a long period of time.

[0019] The structure of this game is illustrated by the flow chart in Fig. 3. First, the player inserts the required coin or the like to start the game. The enemy and the background and obstacles required for the game are displayed on the video screen, and the enemy attacks the player while hiding behind trees, houses, or other such obstacles. The player continues firing at the hiding enemy with the simulated gun as long as he is not hit by a bullet from the enemy. The enemy falls down, explodes, and disappears when struck by a bullet from the simulated gun, and the player earns points.

[0020] Meanwhile, if a bullet fire by the enemy hits the player, the player is injured, and life memory decreases. At the same time, an explosion pattern is displayed on the screen, and the life memory panel flashes. The game up to this point is the same as in the past.

[0021] With the video gun shooting game machine pertaining to the present invention, however, right after the above process, the vibration generator 7 is activated and the player's gun vibrates violently to the left and right. The vibration at this time makes it difficult for the player to aim, so he has to firmly hold on to the grip 43 and use all his strength to steady the simulated gun 4 and keep firing, which makes it seem like intense hand-to-hand combat. After a predetermined time corresponding to the injury sustained by the player has elapsed, the vibration generator 7 is switched off and the vibration of the simulated gun 4 stops.

[0022] As discussed above, and shown in Fig. 2, with the video gun shooting game machine pertaining to the present invention, the vibration generator 7 is provided to the simulated gun support device 6, and when the player is shot, this vibration generator imparts powerful vibration to the simulated gun 4, and this vibration is transmitted to the body of the player, making him feel as if he is really a part of the game. This vibration also hampers the player's ability to fire and makes it harder for him to play the game, so the player must hold on tightly to the grip and keep returning fire. This raises the player's excitement level and keeps him interested in the game.

[0023] In this example, the vibration generator 7 comprises a bracket 71 attached to the rotating support shaft 62, a motor 72, a reduction gear 73, and an eccentric weight 75 attached to the output shaft 74 of this reduction gear. If the game controller 3 recognizes an injury on the player side, the game controller 3 operates the motor 72 for a specific length of time at a predetermined speed according to the extent of the injury to the player.

[0024] The rotation of the motor 72 is transmitted by the output shaft 74 through the reduction gear 73, and the eccentric weight 75 is rotated at high speed, which generates a powerful vibration. Accordingly, the rotating support shaft 62 is subjected to powerful rotational vibration, and consequently the barrel 41 is also vibrated to the left and right. This allows the player to physically feel a hit, and furthermore this vibration makes it more difficult to aim and hampers the player's ability to fire, so the player has to hold on tightly to the grip while returning fire, which inexorably draws the player into the game.

and makes the battle experience even more realistic, so the interest in the game is even higher.

[0025] The constitution of the present invention is not limited to the example given above. For instance, the simulated gun can be a laser gun or one with a built-in CCD, and the gun need not be in the form of a rifle, and can instead be a bazooka, missile launcher, machine gun, pistol, or the like. Furthermore, the structure of the support device is not limited to the biaxial system described above, and depending on how a hit with the simulated gun is determined, a coil spring support system or a freely jointed system can be employed. It is also possible to do away with the support device and make the simulated gun completely hand-held. Also, the vibration generator need not be attached to the support device, its base, or the like, and can instead be attached directly to the simulated gun or can be built into the simulated gun. Furthermore, many different kinds of vibration generator can be used, such as a solenoid type, magnetic vibrator type, air motor type, spring type, or hammer concussion type, and the machine can also be designed so that the player can select or adjust the energy level of the vibration as desired. All of these variations are encompassed by the present invention.

[0026]

[Effect of the Invention]

The present invention has the constitution and operation described above, and therefore provides an extremely interesting video gun shooting game machine.

[Brief Description of the Drawings]

Fig. 1 is a diagram illustrating the overall structure of the video gun shooting game machine pertaining to the present invention.

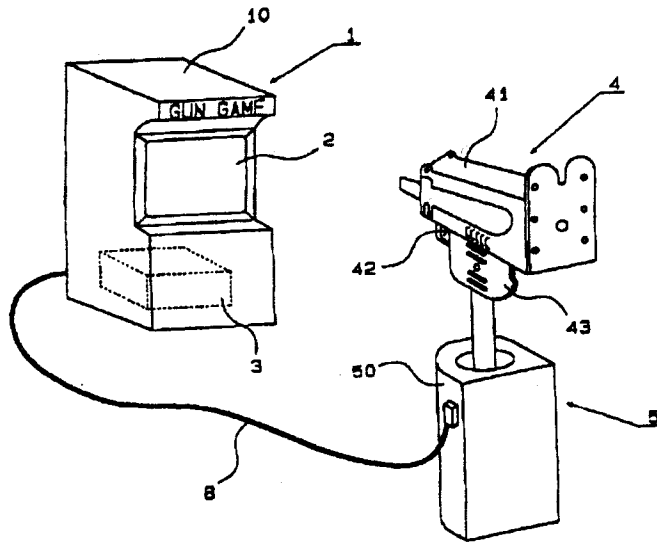
Fig. 2 is a diagram illustrating an example of the structure of the simulated gun.

Fig. 3 is a flow chart of the game.

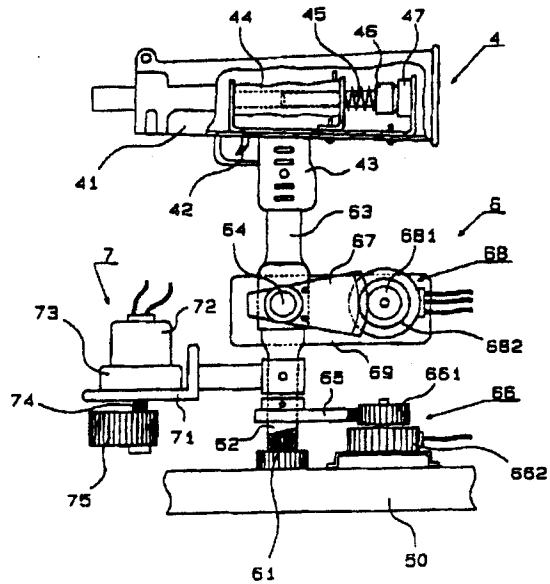
[Key]

- 1 overall game machine
- 2 video display device
- 3 game control circuit
- 4 simulated gun
- 5 firing stand
- 6 simulated gun support device
- 7 vibration generator

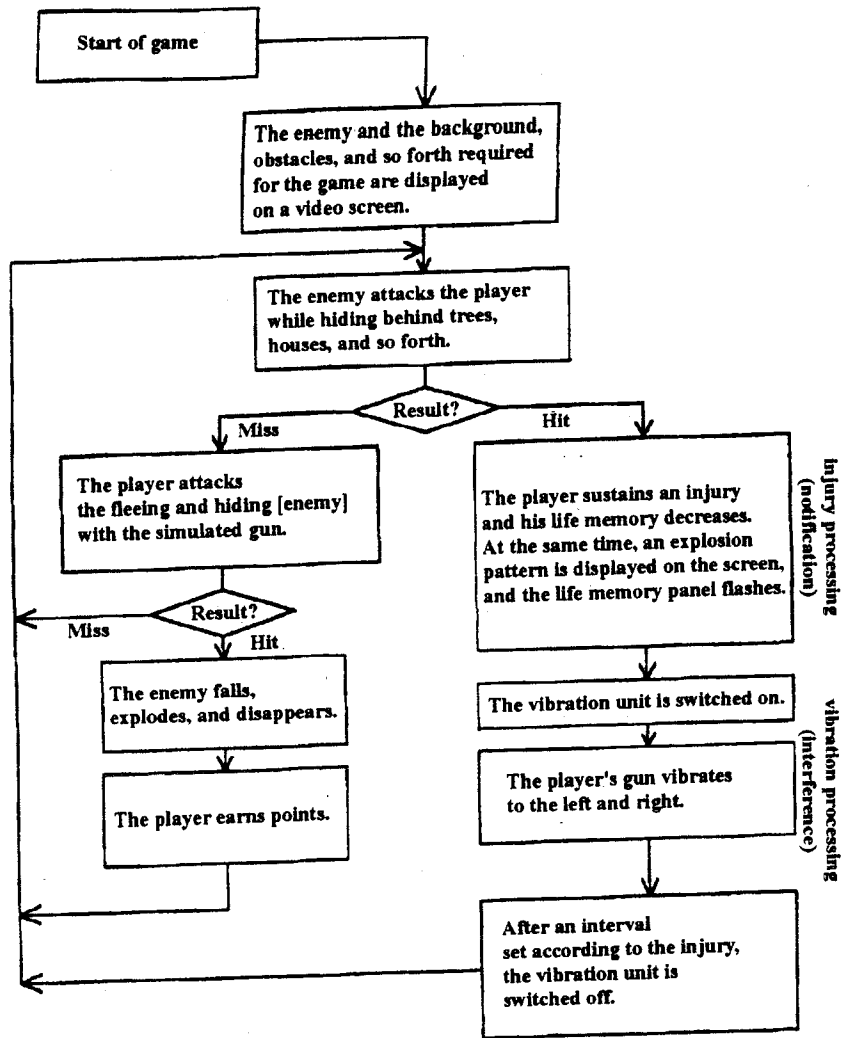
[Figure 1]



[Figure 2]



[Figure 3]



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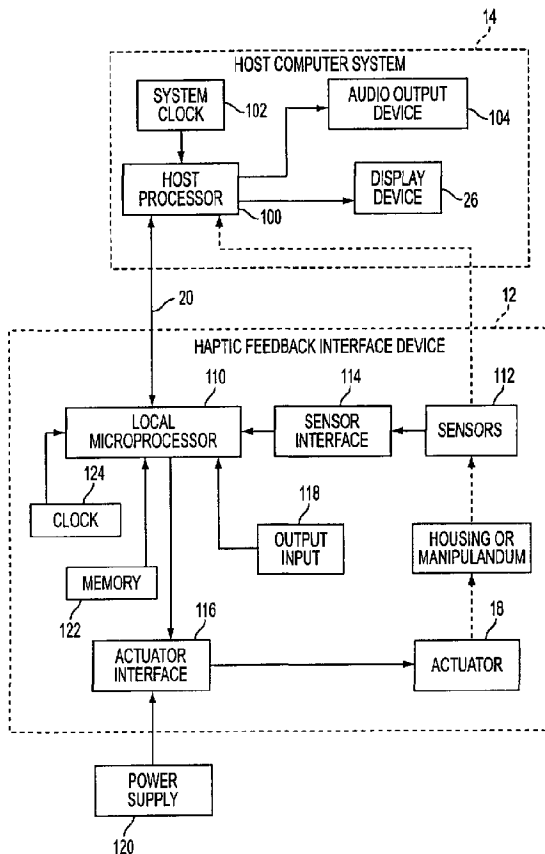
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[Continued on next page]

(54) Title: HAPTIC DEVICES USING ELECTROACTIVE POLYMERS



(57) Abstract: Haptic feedback interface devices using electroactive polymer (EAP) actuators to provide haptic sensations and/or sensing capabilities. A haptic feedback interface device (12) is in communication with a host computer (14) and includes a sensor (112) device that detects the manipulation of the interface device by the user and an electroactive polymer actuator (18) responsive to input signals and operative to output a force to the user cause by motion of the actuator. The output force provides a haptic sensation to the user. Various embodiments of interface devices employing EAP actuators are described, including embodiments providing direct forces, inertial forces, and braking forces.

WO 01/91100 A1



For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

HAPTIC DEVICES USING ELECTROACTIVE POLYMERS

5

BACKGROUND OF THE INVENTION

The present invention relates generally to interface devices for allowing humans to interface with computer systems, and more particularly to low-cost computer interface devices that allow the user to provide input to computer systems and allow computer systems to provide haptic feedback to the user.

10

A user can interact with an environment displayed by a computer to perform functions and tasks on the computer, such as playing a game, experiencing a simulation or virtual reality environment, using a computer aided design system, operating a graphical user interface (GUI), navigate web pages, etc. Common human-computer interface devices used for such interaction include a mouse, joystick, trackball, gamepad, steering wheel, stylus, tablet, pressure-sensitive sphere, or the like, that is connected to the computer system controlling the displayed environment. Typically, the computer updates the environment in response to the user's manipulation of a physical manipulandum such as a joystick handle or mouse. The computer senses the user's manipulation of the user object through sensors on the interface device that send locative signals to the computer. In other applications, interface devices such as remote controls allow a user to interface with the functions of an electronic device or appliance.

15

20

In some interface devices, force (kinesthetic) feedback and/or tactile feedback is also provided to the user, more generally known collectively herein as "haptic feedback." These types of interface devices can provide physical sensations which are felt by the user manipulating a user manipulandum of the interface device, such as a joystick handle, mouse, wheel, etc. One or more motors or other actuators are coupled to the manipulandum and are connected to the controlling computer system. The computer controls forces on the manipulandum and/or device housing in conjunction and coordinated with displayed events and interactions by sending control signals or commands to the actuators. The computer system can thus convey physical force sensations to the user in conjunction with other supplied feedback as the user is grasping or contacting the interface device or manipulatable object of the interface device.

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One problem with current haptic feedback controllers in the home consumer market is the high manufacturing cost of such devices, which makes the devices expensive for the consumer. A large part of this manufacturing expense is due to the inclusion of complex and multiple actuators and corresponding control electronics in the haptic feedback device. In addition, high quality mechanical and force transmission components such as linkages and

bearings further add to the cost of the device. Some low cost haptic devices exist, but are highly limited in their ability to output haptic sensations.

A need therefore exists for a haptic feedback device that is lower in cost to manufacture yet offers the user compelling haptic feedback to enhance the interaction with computer applications.

5

SUMMARY OF THE INVENTION

5 The present invention is directed toward providing haptic feedback in an interface device using electroactive polymer (EAP) actuators, which can provide haptic sensations more efficiently and at lower cost than many existing technologies for haptic devices.

10 More particularly, a haptic feedback interface device of the present invention is in communication with a host computer implementing a host application program and is manipulated by a user. The interface device includes a sensor device that detects the manipulation of the interface device by the user and outputs sensor signals representative of the manipulation, and an electroactive polymer actuator responsive to input signals and operative to output a force to the user caused by motion of the actuator. The output force provides a haptic sensation to the user. The interface device may also include a device housing that is physically contacted by the user. In some embodiments, the force and haptic sensation can be correlated with an event or interaction implemented by the host computer.

15 Various embodiments of interface devices employing EAP actuators are described. The force output by the electroactive polymer actuator can be an inertial force that is caused by moving an inertial mass. The force output by the electroactive polymer actuator can be a rotary force, a linear force, or a force caused by bending of the EAP element or area expansion of the EAP element. The electroactive polymer actuator can move a button on the interface device to output the force to the user, or the actuator can move one or more portions of the device housing. The EAP actuator can also move an element acting as a brake shoe against a moving part of the interface device to cause a resistance to the moving part, such as an axle for a wheel, a medical tool, a disc, or other part. The EAP actuator can provide haptic sensations for a rotating wheel on said interface device, a trackpoint controller, a rotating knob, a rotating sphere, a stylus, or other manipulandums. One or more (e.g. an array) electroactive polymer actuators can also be used to move members directly into contact or in shear with skin of the user to provide tactile sensations. A method similarly provides EAP actuators in haptic sensation output.

20
25
30 In other aspects of the present invention, a haptic feedback interface device in communication with a host computer includes a device housing that is physically contacted by said user and an electroactive polymer (EAP) element that is able to detect a manipulation of a manipulandum of the interface device by the user and output sensor signals representative of the manipulation, as well as output a force to the user in response to an input signal, the force caused on motion of the EAP element and providing a haptic sensation to the user. The EAP element can detect contact of the user with the manipulandum, or detect an amount of pressure on the EAP element caused by the user.

5 The present invention advantageously provides tactile feedback sensations for a tactile feedback device using electroactive polymer actuators. These actuators have several advantages, including high energy density, rapid response time, customizability in shape and performance characteristics, compactness, easy controllability, low power consumption, high force output and deflections/amount of motion, natural stiffness, sensing and actuation functions, relatively low raw materials cost, and relatively inexpensive manufacturing cost, making them desirable for haptic feedback and sensing devices.

10 These and other advantages of the present invention will become apparent to those skilled in the art upon a reading of the following specification of the invention and a study of the several figures of the drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a block diagram illustrating a haptic feedback system suitable for use with the present invention;

5 FIGURE 2a is a side elevational view of an electroactive polymer element in a bending motion;

FIGURE 2b is a top plan view of an electroactive polymer element in a bending motion;

FIGURE 2c is a side elevational view of an electroactive polymer sandwich structure providing linear and bending motion;

10 FIGURE 2d is a perspective view of an electroactive polymer element in a cylindrical configuration to provide motion in multiple degrees of freedom;

FIGURE 2e is a perspective view of an electroactive polymer structure that provides an area expansion of the element;

15 FIGURE 2f is a perspective view of an electroactive polymer structure in a cylindrical structure that provides axial motion of the element;

FIGURE 3 is a perspective view of an example mouse interface device suitable for use with EAP actuators of the present invention;

FIGURE 3a is a side elevational view of a mouse embodiment in which a button is moved in its degree of freedom by an electroactive polymer actuator;

20 FIGURE 3b is a top plan view of a mouse embodiment in which a button is moved laterally by an electroactive polymer actuator;

FIGURE 3c is a top plan view of a mouse embodiment in which a button includes an array of multiple electroactive polymer actuators;

25 FIGURE 4a is a schematic view of an embodiment in which an inertial mass is moved linearly by an electroactive polymer actuator to provide inertial sensations;

FIGURE 4b is a schematic view of an embodiment in which an inertial mass is moved rotationally by an electroactive polymer actuator to provide inertial sensations;

FIGURE 4c is a view of an embodiment in which multiple inertial masses are moved by an electroactive polymer actuators;

FIGURE 5a is a side view of a mouse embodiment in which a entire cover portion of the mouse is moved by an electroactive polymer actuator to provide tactile sensations;

FIGURE 5b is a top plan view of a mouse embodiment in which side portions of the mouse are moved by an electroactive polymer actuator to provide tactile sensations;

5 FIGURE 5c is a top plan view of a mouse embodiment in which top portions of the mouse are moved by an electroactive polymer actuator to provide tactile sensations;

FIGURE 5d is a side view of a mouse embodiment in which a rear top portion of the mouse is moved by an electroactive polymer actuator to provide tactile sensations;

10 FIGURE 6 is a top view of an embodiment in which a sphere is braked by an electroactive polymer actuator;

FIGURE 7a is a side view of a wheel embodiment in which a rotatable wheel includes an inertial mass that is rotationally moved by an electroactive polymer actuator;

FIGURES 7b and 7c illustrate a wheel embodiment including a number of electroactive polymer actuators which expand in area;

15 FIGURE 7d is a perspective view of a wheel embodiment in which a rotatable wheel is braked by an electroactive polymer actuator;

FIGURE 7e is a side elevational view of a wheel embodiment in which the entire rotatable wheel is moved laterally and vertically by electroactive polymer actuators;

20 FIGURE 8a is a perspective view of a trackpoint controller in which an electroactive polymer actuator provides haptic feedback in its degrees of freedom;

FIGURES 8b and 8c is perspective and side sectional views of a trackpoint controller in which an electroactive polymer actuator provides haptic feedback by linearly moving a poker against the user;

25 FIGURE 8d is a perspective view of a trackpoint controller in which electroactive polymer actuators provide haptic feedback in linear degrees of freedom;

FIGURE 9a is a perspective view of a vertical pin moved linearly by an electroactive polymer actuator against a user's finger;

FIGURES 9b and 9c are perspective views of arrays of the vertical pins of Fig. 9a;

30 FIGURES 9d and 9e are side views of a vertical pin moved laterally by an electroactive polymer actuator against a user's finger;

FIGURE 10 is a side elevational view of a device in which an electroactive polymer actuator provides braking forces on a medical tool;

FIGURE 11 is a side elevational view of a device in which an electroactive polymer actuator provides forces to a trigger on an interface device;

5 FIGURE 12a is a front view of a knob in which an electroactive polymer actuator provides direct rotary forces in the rotary degree of freedom of the knob;

FIGURE 12b is a perspective view of a knob in which an electroactive polymer actuator provides braking forces in the rotary degree of freedom of the knob;

10 FIGURE 13 is a side view of a rotating disc in which an electroactive polymer actuator provides braking forces in the rotary degree of freedom of the disc;

FIGURE 14a is a side elevational view of a stylus in which an electroactive polymer actuator provides linear forces to the tip of the stylus;

FIGURE 14b is a side elevational view of a stylus in which an electroactive polymer actuator provides linear forces to the front end of the stylus;

15 FIGURE 14c is a side elevational view of a stylus in which an electroactive polymer actuator provides forces to a button on the stylus;

FIGURES 14d and 14e are side elevational and perspective views of a stylus in which electroactive polymer actuators provide outward forces from the stylus body;

20 FIGURE 15a is a front view of a steering wheel in which an electroactive polymer actuator provides inertial forces;

FIGURE 15b is a side view of a joystick handle in which an electroactive polymer actuator provides inertial forces;

25 FIGURES 15c and 15d are perspective and side elevational views of a joystick handle in which electroactive polymer actuators provide braking forces in the degrees of freedom of the joystick handle;

FIGURE 16 is a perspective view of a rotating cylinder controller in which electroactive polymer actuators provide braking forces in the degrees of freedom of the cylinder;

FIGURE 17a is a side elevational view of a tactile element in which electroactive polymer actuators provide linear motion to the element; and

FIGURE 17b is a side elevational view of a tactile element in which electroactive polymer actuators provide lateral, shear motion to the element.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

FIGURE 1 is a block diagram illustrating a force feedback system suitable for use with
5 any of the described embodiments of the present invention. The force feedback system includes
a host computer system 14 and interface device 12.

Host computer system 14 preferably includes a host microprocessor 100, a clock 102, a
display screen 26, and an audio output device 104. The host computer also includes other well
known components, such as random access memory (RAM), read-only memory (ROM), and
10 input/output (I/O) electronics (not shown).

Host computer 14 can be a personal computer or workstation and may operate under any
well-known operating system. Alternatively, host computer system 14 can be one of a variety of
home video game console systems commonly connected to a television set or other display, such
as systems available from Nintendo, Sega, Sony, or Microsoft. In other embodiments, host
15 computer system 14 can be a "set top box" which can be used, for example, to provide
interactive television functions to users, or a "network-" or "internet-computer" which allows
users to interact with a local or global network using standard connections and protocols such as
used for the Internet and World Wide Web. In other implementations, the host computer can be
an appliance or electronic device, vehicle computer, etc.

Host computer 14 preferably implements a host application program with which a user is
interacting via interface device 12 which includes haptic feedback functionality. For example,
the host application program can be a video game, word processor or spreadsheet, Web page or
browser that implements HTML or VRML instructions, scientific analysis program, virtual
reality training program or application, or other application program that utilizes input of mouse
25 12 and outputs force feedback commands to the device 12. Herein, for simplicity, operating
systems such as Windows™, MS-DOS, MacOS, Linux, Be, etc. are also referred to as
"application programs." Herein, computer 14 may be referred as providing a "graphical
environment," which can be a graphical user interface, game, simulation, or other visual
environment. The computer displays "graphical objects" or "computer objects," which are not
30 physical objects, but are logical software unit collections of data and/or procedures that may be
displayed as images by computer 14 on display screen 26, as is well known to those skilled in the
art. Suitable software drivers which interface such software with computer input/output (I/O)
devices are available from Immersion Corporation of San Jose, California.

Display device 26 can be included in host computer 14 and can be a standard display
35 screen (LCD, CRT, flat panel, etc.), 3-D goggles, or any other visual output device. Typically,
the host application provides images to be displayed on display device 26 and/or other feedback,

such as auditory signals. Audio output device 104, such as speakers, is preferably coupled to host microprocessor 100 via amplifiers, filters, and other circuitry well known to those skilled in the art and provides sound output to user when an "audio event" occurs during the implementation of the host application program. Other types of peripherals can also be coupled to host processor 100, such as storage devices (hard disk drive, CD ROM drive, floppy disk drive, etc.), printers, and other input and output devices.

Interface device 12 is coupled to the computer 14 by a bus 20, which communicates signals between device 12 and computer 14 and may also, in some embodiments, provide power to the device 12. In other embodiments, signals can be sent between device 12 and computer 14 by wireless transmission/reception. In some embodiments, the power for the actuator can be supplemented or solely supplied by a power storage device provided on the device, such as a capacitor or one or more batteries. The bus 20 is preferably bi-directional to send signals in either direction between host 14 and device 12. Bus 20 can be a serial interface bus, such as an RS232 serial interface, RS-422, Universal Serial Bus (USB), MIDI, or other protocols well known to those skilled in the art; or a parallel bus or wireless link.

Device 12 can include a local microprocessor 110. Local microprocessor 110 can optionally be included within the housing of device 12 to allow efficient communication with other components of the device. Processor 110 is considered local to device 12, where "local" herein refers to processor 110 being a separate microprocessor from any processors in host computer system 14. "Local" also preferably refers to processor 110 being dedicated to haptic feedback and sensor I/O of device 12. Microprocessor 110 can be provided with software instructions (e.g., firmware) to wait for commands or requests from computer host 14, decode the command or request, and handle/control input and output signals according to the command or request. In addition, processor 110 can operate independently of host computer 14 by reading sensor signals and calculating appropriate forces from those sensor signals, time signals, and stored or relayed instructions selected in accordance with a host command. Suitable microprocessors for use as local microprocessor 110 include lower-end microprocessors as well as more sophisticated force feedback processors such as the Immersion Touchsense Processor. Microprocessor 110 can include one microprocessor chip, multiple processors and/or co-processor chips, and/or digital signal processor (DSP) capability.

Microprocessor 110 can receive signals from sensor 112 and provide signals to actuator 18 in accordance with instructions provided by host computer 14 over bus 20. For example, in a local control embodiment, host computer 14 provides high level supervisory commands to microprocessor 110 over bus 20, and microprocessor 110 decodes the commands and manages low level force control loops to sensors and the actuator in accordance with the high level commands and independently of the host computer 14. This operation is described in greater detail in US Patents 5,739,811 and 5,734,373. In the host control loop, force commands are

output from the host computer to microprocessor 110 and instruct the microprocessor to output a force or force sensation having specified characteristics. The local microprocessor 110 reports data to the host computer, such as locative data that describes the position of the device in one or more provided degrees of freedom. The data can also describe the states of buttons, switches, etc. The host computer uses the locative data to update executed programs. In the local control loop, actuator signals are provided from the microprocessor 110 to an actuator 18 and sensor signals are provided from the sensor 112 and other input devices 118 to the microprocessor 110. Herein, the term "tactile sensation" refers to either a single force or a sequence of forces output by the actuator 18 which provide a sensation to the user. For example, vibrations, a single jolt, or a texture sensation are all considered tactile sensations. The microprocessor 110 can process inputted sensor signals to determine appropriate output actuator signals by following stored instructions. The microprocessor may use sensor signals in the local determination of forces to be output on the user object, as well as reporting locative data derived from the sensor signals to the host computer.

In yet other embodiments, other hardware can be provided locally to device 12 to provide functionality similar to microprocessor 110. For example, a hardware state machine incorporating fixed logic can be used to provide signals to the actuator 18 and receive sensor signals from sensors 112, and to output tactile signals.

In a different, host-controlled embodiment, host computer 14 can provide low-level force commands over bus 20, which are directly transmitted to the actuator 18 via microprocessor 110 or other circuitry. Host computer 14 thus directly controls and processes all signals to and from the device 12, e.g. the host computer directly controls the forces output by actuator 18 and directly receives sensor signals from sensor 112 and input devices 118. Other embodiments may employ a "hybrid" organization where some types of forces (e.g. closed loop effects) are controlled purely by the local microprocessor, while other types of effects (e.g., open loop effects) may be controlled by the host.

Local memory 122, such as RAM and/or ROM, is preferably coupled to microprocessor 110 in device 12 to store instructions for microprocessor 110 and store temporary and other data. In addition, a local clock 124 can be coupled to the microprocessor 110 to provide timing data, similar to system clock 102 of host computer 14.

Sensors 112 sense the position or motion of the device (e.g. the housing or a manipulandum) in degrees of freedom and provides signals to microprocessor 110 (or host 14) including information representative of the position or motion. Sensors suitable for detecting motion include digital optical encoders, other optical sensor systems, linear optical encoders, potentiometers, optical sensors, velocity sensors, acceleration sensors, strain gauge, or other types of sensors can also be used, and either relative or absolute sensors can be used. Optional sensor interface 114 can be used to convert sensor signals to signals that can be interpreted by

the microprocessor 110 and/or host computer system 14, as is well known to those skilled in the art.

Actuator(s) 18 transmits forces to the housing, manipulandum, buttons, or other portion of the device in response to signals received from microprocessor 110 and/or host computer 14. Device 12 preferably includes one or more actuators which are operative to produce forces on the device 12 (or a component thereof) and haptic sensations to the user. The actuator(s) are electroactive polymer (EAP) actuators, which are described in greater detail below, and are “computer-controlled”, e.g., the force output from the actuators is ultimately controlled by signals originating from a controller such as a microprocessor, ASIC, etc. Many types of additional actuators can be used in conjunction with the electroactive polymer actuators described herein, including a rotary DC motors, voice coil actuators, moving magnet actuators, pneumatic/hydraulic actuators, solenoids, speaker voice coils, piezoelectric actuators, passive actuators (brakes), etc. Actuator interface 116 can be optionally connected between actuator 18 and microprocessor 110 to convert signals from microprocessor 110 into signals appropriate to drive actuator 18. Interface 116 can include power amplifiers, switches, digital to analog controllers (DACs), analog to digital controllers (ADCs), and other components, as is well known to those skilled in the art.

In some of the implementations herein, the actuator has the ability to apply short duration force sensation on the housing or manipulandum of the device, or via moving an inertial mass. This short duration force sensation can be described as a “pulse.” The “pulse” can be directed substantially along a particular direction in some embodiments. In some embodiments, the magnitude of the “pulse” can be controlled; the sense of the “pulse” can be controlled, either positive or negative biased; a “periodic force sensation” can be applied, where the periodic sensation can have a magnitude and a frequency, e.g. a sine wave; the periodic sensation can be selectable among a sine wave, square wave, saw-toothed-up wave, saw-toothed-down, and triangle wave; an envelope can be applied to the period signal, allowing for variation in magnitude over time. The wave forms can be “streamed” from the host to the device or can be conveyed through high level commands that include parameters such as magnitude, frequency, and duration.

Other input devices 118 can be included in device 12 and send input signals to microprocessor 110 or to host 14 when manipulated by the user. Such input devices include buttons, dials, switches, scroll wheels, knobs, or other controls or mechanisms. Power supply 120 can optionally be included in device 12 coupled to actuator interface 116 and/or actuator 18 to provide electrical power to the actuator. or be provided as a separate component. Alternatively, power can be drawn from a power supply separate from device 12, or power can be received across bus 20. Also, received power can be stored and regulated by device 12 and thus used when needed to drive actuator 18 or used in a supplementary fashion.

The interface device 12 can be any of a variety of types; some embodiments are described further below. For example, the device 12 can be a mouse device having planar degrees of freedom, in which the entire housing is moved. Alternatively, a manipulandum on the device, such as a joystick handle, a knob, a steering wheel, a trackball, etc., is moved by the user and tracked by sensors. Device 12 can also be a gamepad, joystick, steering wheel, stylus, touchpad, spherical controller, finger pad, knob, track ball, or other device, some embodiments of which are described below. Alternatively, a hand-held remote control device used to select functions of a television, video cassette recorder, sound stereo, internet or network computer (e.g., Web-TV™) can be used with the haptic feedback components described herein, or a cell phone, personal digital assistant, etc. The forces from the actuator(s) 18 can be applied to the housing of the device 12, and/or a movable manipulandum such as a joystick handle, steering wheel, knob, button, etc.

Electroactive Polymers in Haptic Feedback Devices

Electroactive polymers (EAP) are a class of polymers which can be formulated and/or processed to exhibit a wide range of physical, electrical, and electro-optical behaviors and properties.

When activated, such as by an applied voltage, EAP materials can undergo significant physical movement or deformations, typically referred to as electrostriction. These deformations can be along the length, width, thickness, radius, etc. of the material and in some cases can exceed 10% strain. Elastic strains of this magnitude are very unusual in common materials and even more unusual in that they can be fully controlled with the proper electronic systems. Materials in this class can be used to do useful work in a compact, easy to control, low power, fast, and potentially inexpensive package. They are often referred to as “electric muscles” because of these properties. These deformation properties can be used in the present invention to provide forces to a user in a haptic feedback device.

Many of the materials can also act as high quality sensors, particularly for time-varying (i.e. AC) signals. When mechanically deformed (e.g. by bending, pulling, etc.), most EAP materials develop differential voltages which can be electrically measured. This ability to essentially generate electric potential makes them promising as force, position, velocity, acceleration, pressure, etc. sensors in haptic feedback devices of the present invention. Many of these materials exhibit bi-directional behavior, and can act as either sensors or actuators, or act simultaneously as both sensors and actuators, depending on system design.

At present, there are four main classes of EAP, each with various advantages, disadvantages, and issues. The four classes are gels, ionic polymers (ionic polymer metal composites or IPMC), conducting polymers, and electrorestrictive polymers. Any of these types of EAP can be used in the present invention, although some types may be more appropriate for a particular application than other types. A variety of EAP structures are described in the papers, "High-field electrostriction of elastomeric polymer dielectrics for actuator," by Kornbluh et al., "Electro-mechanics of iono-elastic beams as electrically-controllable artificial muscles," by M. Shahinpoor, "Polymer Electrolyte Actuator with Gold Electrodes," by K. Oguro et al., and "Microgripper design using electro-active polymers," by R. Lumia et al., all SPIE Conf. on Electroactive Polymer Actuators and Devices, SPIE Vol. 3669, 1999.

In a majority of EAP materials, the actuation mechanism is based on the movement of ionic species either in or out of a polymer network. Currently, the most commercially viable of these is the electrorestrictive polymer class.

Electrorestrictive polymers presently can be classified in two classes: dielectric and phase transition. Dielectric polymers are typically a sandwich construction of two electrically conductive (and compliant) electrodes with a dielectric polymer in between. At high electric fields (e.g., 100's to 1000's of volts), the attractive force of the electrodes squeezes the intervening dielectric such that significant motion (strain) is induced. In some cases, this strain can be greater than 50%.

Phase transition electrorestrictive materials also exhibit high strain (deformation) in the presence of electric fields, but the mechanism is a ferroelectric-to-paraelectric transformation at the molecular chain level. One example of these materials has been developed by Q.M. Zhang et al. and is electron-irradiated polyvinylidene fluoride-trifluoroethylene (P(VDF-TrFE)) copolymer, described in the paper, "Electromechanical Behavior of Electroactive P(VDF-TrFE) Copolymers", SPIE Conf. on Electroactive Polymer Actuators and Devices, SPIE Vol. 3669, 1999. When processed, P(VDF-TrFE) exhibits exceptional strain (>10% in some cases), extreme energy density (Joules/cm³), and high physical stiffness (elastic modulus). It is proposed that this class of materials exhibits energy densities exceeding that of traditional piezoceramics (PZT) and magnetostrictive materials. Therefore, as described for the present invention, P(VDF-TrFE) may be nearly ideal actuator material, including intrinsic sensing capabilities, for haptic devices.

EAP materials are often derivatives of existing polymers and therefore share common processing steps with these existing products. This commonality makes EAP materials potentially economical to produce in large volume and provides repeatable quality standards. For haptic device applications, EAP materials (particularly P(VDF-TrFE)) have many potential advantages over conventional sensing and actuation methods. For example, the EAP materials have high energy density, rapid response time, customizability (shape and performance

characteristics), compactness, easy controllability, low power consumption, high force output and deflections/amount of motion, natural stiffness, both sensing and actuation functions, relatively low raw materials cost, and relatively inexpensive manufacturing cost.

5 Configurations

EAP actuators and sensors can be configured in several different ways. Some of these configurations are described below.

10 Bending: A sandwich/layered “bimorph” structure can be provided which can generate single-axis displacements or forces in two directions. For example, FIGURE 2a shows a side view of an EAP structure 200. A bending out of the flat plane of the structure 200 can be performed, as shown in Fig. 2a. This can be accomplished with IPMC structures, or, a polymer surrounded in a sandwich structure by a gold electrode and a carbon electrode, for example. Alternatively, as shown in the top plan view of FIGURE 2b, a bending within the plane of the structure 202 can be performed, e.g. using water dragging by cation. A bending beam can also
15 be used as a sensor, such as an IEM-Pt composite sensor placed between two electrodes.

Linear motion: FIGURE 2c shows a side view of a multiple layer bending beam 204 which is capable of both bending as well as longitudinal (lengthwise) displacements and forces. The beam 204 can include a top electrode 206a, a bottom electrode 206b, a middle electrode 206c, which can be made of a standard conductive material. Two elastomer layers 208 are
20 positioned between the electrodes. A linear motion of the beam 204, as shown by arrow 209, is created by actuating both the top electrode and the bottom electrode. A bending motion can be created by actuating either the top electrode or the bottom electrode (the middle electrode is coupled to ground). Other embodiments may provide only linear, axial deflection and no bending by using a sandwich structure.

25 Multiple degrees of freedom: FIGURE 2d is a perspective view of a cylinder 210 that may deflect in two degrees of freedom (four directions) using combined signals applied to four electrodes. Four electrodes 211 are shown in this example, which are positioned on an elastomer cylindrical layer 207. In other embodiments, other three-dimensional structures of electrodes can be provided to deflect in two degrees of freedom (four directions) or additional degrees of
30 freedom. For example, a structure having a triangular or other polygonal cross-section can be provided.

Area expansion: FIGURE 2e shows a structure including a soft dielectric 212 squeezed between two compliant electrodes 213. The dielectric 212 expands in area, e.g., along one or more linear directions, as shown by arrows 214. In other embodiments, the dielectric can expand
35 radially (in a circular dielectric), e.g. a polymer film stretched on a rigid frame between two

electrodes. Other shaped dielectrics may also be used. The thickness of the dielectric compresses simultaneously, as shown by arrows 215.

5 Axial motion: FIGURE 2f illustrates a sandwich structure of two polymer layers that are rolled into a cylinder 216, where electrical and mechanical connections can be made at regions 218 and the active, expanding region 220 is positioned between and includes overlapping electrodes. The resulting axial motion is indicated by arrow 219. In other embodiments, a sandwich structure can be rolled into a coil to produce rotational movement (a torque).

Diaphragm: Thin diaphragms can use planar expansion to generate in-plane or out-of-plane deflections, closing of apertures, etc.

10 Haptic Device Embodiments

The major classes of use contemplated for EAP actuators and sensors in haptic devices are inertial vibration actuators, linear actuators, rotational actuators, brakes, and miscellaneous uses. Many of these classes are described below in the provided example embodiments of haptic devices of the present invention.

It should be noted that the EAP actuators described in the below embodiments can be controlled by a local microprocessor in accordance with firmware and/or host computer commands or signals, or a host computer can directly control the actuator(s).

20 FIGURE 3 is an illustration of one example of an interface device 12 that can be used with the present invention. Mouse device 250 is a device having a housing 252 that is moved by the user in two planar degrees of freedom (x- and y-axes) to provide control signals to a host computer, e.g. to control the position of a cursor in a displayed graphical environment. As is well known to those of skill in the art, mouse device 250 includes one or more sensors to detect its x- and y position, such as a ball and roller sensor assembly, an optical sensor, or other types of sensor. A scroll wheel 254 can be provided to allow the user to provide additional input by rotating the wheel. Mouse buttons 256 can be pressed by the user to provide input signals to the host computer.

30 Three general types of haptic feedback are described in relation to the mouse embodiment 250; other types are also possible, and all may be implemented with other types of haptic feedback devices (joysticks, trackballs, steering wheels, laptop sensor pads, etc.). The three general types are button haptic feedback, inertial haptic feedback, and housing motion haptic feedback.

FIGURES 3a-3c illustrate generally the output of haptic feedback on a button. Button haptic feedback can be provided in several different ways. In Fig. 3a, the EAP actuator is used to provide haptic feedback and actuate motion of a button 256 in the button degree of freedom as shown by the arrow, i.e., in the direction of clicking or moving the button, where the button can be moved to another position as indicated by the dashed lines. The EAP structure (not shown) can, for example, be directly coupled to the button or be coupled to the button via a transmission or intermediate member (spring, flexure, etc.) For example, a linearly-extending EAP actuator can push or pull the button in its degree of freedom.

In the top plan view of Fig. 3b, an EAP actuator provides haptic feedback to button 256a in the direction of lateral button motion, i.e., motion in a direction substantially perpendicular to button motion and, in the case of a mouse embodiment, substantially parallel to mouse motion in its degree of freedom. The EAP actuator can be coupled to the button directly or through an intermediate structure. For example, a linearly-moving EAP actuator can push or pull the button from the side of the button 256a. Furthermore, the button can be moved along the x-axis or the y-axis, or along both axes, e.g. using two EAP actuators. A haptic button can also be implemented as button 256b, which is a standard button that may be clicked or pressed to provide an input signal, and which also includes a patch 258 provided on the button. The patch can be a separate film or member that can be moved by an EAP actuator independently of the surrounding portions of the button 256b. For example, as shown, the patch 258 can be positioned near the center of the button 256b; alternatively, the patch can be positioned on one side or edge of the button 256b.

Fig. 3c is a top plan view of another button embodiment, where a tactile array 260 of haptic EAP elements 262 can be placed on or near a button 256. Each EAP element 262 of the array can be individually moved up or down on the z-axis, allowing a variety of sensations to be conveyed to the user who is contacting the array or part of the array while resting a finger on the button. In other embodiments, a 1D array (single line of elements) can be provided instead of the 2-D array shown. EAP tactile arrays are described in greater detail below.

Another general type of haptic feedback is inertial feedback, which involves moving a mass with respect to an inertial ground such that the oscillations are conveyed to the user as vibrations or pulses. Inertial haptic feedback can be provided using EAP actuators of the present invention. FIGURE 4a shows a linear shaker 270 using an EAP actuator, where a mass M is moved linearly by the EAP structure 272 that can move axially, as indicated by arrow 274. An oscillating control waveform 274 is input to the shaker to cause the EAP actuator to oscillate back and forth. This causes an inertial force on the housing of the device to which the EAP actuator is attached. Such feedback can be provided for a mouse, gamepad, joystick handle or base, trigger button on any device, a stylus, a tablet, a glove, a knob, a remote control, or other handheld device or structure on a device.

FIGURE 4b illustrates a rotary inertial EAP actuator 280, which includes an EAP element 282 that is configured like a coil to move a mass 284 in a rotational degree of freedom and thus provide rotary inertial forces to a housing or structure to which the actuator is coupled. The inner end 288 of the element 282 can be grounded to provide a reference for the other end of the element which oscillates. For example, the mass 284 can be oscillated approximately about the axis of rotation A, where examples of extreme positions are shown by the dashed lines. The positive and negative connections 286, as with all the embodiments shown with such connections herein, indicate that a signal or waveform can be applied to the EAP actuator to cause it to move.

FIGURE 4c shows a multi-axis shaker module 290 which includes three masses M1, M2, and M3, each coupled to an associated EAP actuator structure 292 that is similar to the structure of Fig. 4a. Preferably, each EAP structure is oriented along a different axis (x, y, and z) to allow a mass to be linearly moved along the associated axis. When all three masses are moved simultaneously, inertial forces are provided in all three degrees of freedom, allowing more complex and realistic inertial haptic feedback to be output to the user of the haptic device. In other embodiments, masses and actuators are provided in only two degrees of freedom, or can be oriented at different angles.

Housing motion haptic feedback is another general type of haptic feedback and can also be output according to the present invention using one or more EAP actuators. FIGURE 5a shows an up-down motion of the entire housing 302 of mouse 300 (or the entire top-sides portion of the housing, excluding the bottom plate), as indicated by arrow 304 and the dashed lines 306. An EAP actuator 308 can be coupled directly to the moveable housing, as shown, and moved linearly. Or the EAP element can be coupled to the housing via a hinge, flexure, or other structure. In other embodiments, the EAP actuator can be made to bend to cause the up-down motion.

FIGURE 5b illustrates a mouse 320 including one or more moveable sections 322 provided in or on the side housing 324 of the mouse, where an EAP actuator can be coupled to each moveable section to move it. For example, a flexible material or hinge, such as rubber or flexible plastic, can couple the moveable sections 322 to the rest of the housing 324 to allow the motion. EAP actuators that bend, move linearly, or expand in area can be used to move the sections 322.

In FIGURE 5c, a mouse 330 includes entire portions 332 of the housing 324 which are moveable in a split shell configuration, allowing a dedicated EAP actuator coupled to each portion 322 to drive its associated portion independently of the other portion 322. The user's palm which contacts the moving portions 322 will feel the tactile sensations as the portions are moved, such as vibrations and the like. Alternatively, the portions 322 can be driven simultaneously or with a single EAP actuator having linkages to both sections.

FIGURE 5d shows a mouse 340 including an upper portion 342 of the housing moveable with respect to the remaining housing portion 344 as shown by arrow 346 and driven by an EAP actuator, where the user's palm contacts the moveable portion to feel the haptic contact forces. A hinge or other flexure can couple the moveable portion 342 with the base portion 344. Differently-sized portions 342 can be provided in other embodiments.

Ball haptic feedback provides haptic forces acting on a ball, such as a trackball device, a ball used in a sensor mechanism in a mouse device, or other frictional movement device, to output haptic feedback in the degrees of freedom of motion of the interface device. For example, as shown in FIGURE 6, a ball actuation assembly 350 includes a sphere or ball 352, an X roller 354, a Y roller 356, an X sensor 358, a Y sensor 360, an X EAP brake 362, a Y EAP brake 364, and a support 366 supporting the brakes. The ball 352 rolls against the cylindrical rollers 354 and 365 (the ball can be biased against the rollers by using, for example, a third roller that is spring biased against the ball). The encoder sensors 358 and 360 sense the position of the rollers, and thus the ball, in the x and y axes by providing an encoder wheel attached to a roller and an emitter-detector to detect slots or marks in the wheel, as is well known. The EAP brakes 362 and 364 each include a brake shoe 368 on their ends facing the rollers 354 or 356. The EAP brakes are provided with a control electrical signal to induce linear motion in the EAP elements and thus on brake shoes 368 to cause the brake shoes to frictionally contact the rolling members 354 and/or 356. This frictional contact causes resistance to motion of the ball 352, which the user feels as resistance to motion and haptic feedback. The EAP brakes 362 and 364 can be moved different distances to cause different amounts of friction on the rollers, thus causing different amounts of friction on the ball. This resistance also causes resistance to the mouse in its degrees of freedom, in such embodiments.

Some embodiments of the interface device 12 can include a wheel, such as mouse wheel 254 shown in Fig. 3. The wheel can be rotated by the user's finger(s) to provide position signals to a computer indicating a position or motion of the wheel, and which can be used to scroll documents displayed by a host computer, move a cursor and select an item in a list, or perform other functions well known to those of skill in the art. Haptic feedback can be output in the rotational degree of freedom of the wheel, and/or on the wheel itself, using an EAP actuator. For example, FIGURE 7a illustrates a wheel 380 which includes an EAP rotary inertial shaker 382. The shaker includes a curved EAP element 384 and a mass 386 positioned at the end of the element 384. The mass 386 can be oscillating using a periodic waveform as an input signal, similar to the shaker shown in Fig. 4b. This causes inertial sensation on the wheel 380, which are transferred to the user's finger 388.

In FIGURE 7b, a wheel 400 includes number of radially expanding EAP actuators 402. Each actuator 402, as shown in FIGURE 7c, can be similar to the area expansion actuator shown in Fig. 2e above to provide an expanding outer surface to the wheel 400. Multiple EAP actuators

are provided around the circumference of the wheel, where the expansion of each actuator can be controlled individually to provide tactile sensations to the user's finger based on the collective movement of those actuators in contact with the user's finger. Other types of EAP actuators, such as linear moving elements, can alternatively be used.

5 In FIGURE 7d, an EAP brake device 410 is shown which includes an EAP brake 412 that includes an EAP linearly-moving structure 414 coupled to a brake shoe 416. The brake shoe 416 frictionally contacts a rotating axle 418 of the wheel 420, similar to the EAP brake of Fig. 6, to cause resistance in the rotational degree of freedom of the wheel.

10 FIGURE 7e illustrates a wheel device 430 that uses an EAP actuator to provide lateral motion or forces on the wheel, parallel to the axis of rotation of the wheel. A linearly-moving EAP actuator 432 can be coupled to the rotating axle 434 (or to a member rotatably coupled to the axle) to provide horizontal forces and motion, as indicated by arrow 436, to wheel 438. Also, in some embodiments, a linearly-moving EAP actuator 440 can be coupled to a member as shown to provide a vertical force or motion on the entire wheel device 430 as indicated by arrow
15 442. These embodiments can also be used with a rotary control knob used in a variety of devices.

Other interface devices 12 can be provided with haptic feedback using EAP actuators. For example, in FIGURE 8a, a "trackpoint" controller 450 is shown, which is often positioned between keys on a standard computer keyboard of a laptop or other computer and used to control
20 a cursor or other pointing function by being moved in normal displacement directions, as shown by arrows 452. For example, the trackpoint can be translated or rotationally moved in the two degrees of freedom. The trackpoint 450 can be provided with an EAP actuator 454, which can be controlled to move linearly vertically (z-axis) in both directions to provide z-axis tactile feedback to the user's finger operating the trackpoint. In some embodiments, the EAP actuator
25 454 can also or alternatively act as a sensor to detect when the user is contacting the trackpoint and/or the amount of z-axis pressure or displacement exerted by the user on the trackpoint. The amount z-axis pressure can be used to control a value or parameter in an application program, such as a rate control function (scrolling, panning, zooming, velocity of a virtual vehicle in a game, etc.) or the position of a cursor in a representation of a third dimension. The trackpoint
30 controller can be considered the interface device as well as a manipulandum of the interface device.

In FIGURE 8b, a trackpoint controller 460 can include a linearly-moving EAP actuator similar to that of Fig. 8a but positioned within a hollow interior of a vertical post 462. The cap
35 461 of the trackpoint can be textured to allow a stronger user grip and includes an aperture 465. As shown in FIGURE 8c, the EAP actuator 464 can be controlled to extend a poker 466 or other member that is coupled to the EAP actuator 464 through the aperture into the skin of the user's

finger contacting the top of the trackpoint controller 460. The poker can be withdrawn and extended to provide texture sensations to the user.

FIGURE 8d shows another embodiment of a trackpoint controller 470, where EAP actuators are used to provide haptic feedback in the normal x-y directions of control of the trackpoint controller. Four linearly-moving EAP actuators 472 are placed at 90 degree increments around a base 474 of the controller to provide linear force and/or motion to the central vertical post 476. The post can be moved linearly by the user in the x- and/or y-directions to control a cursor, value, etc. It should be noted that the embodiments shown in Figs. 8a-8d can be used with standard, larger-sized joysticks as well as trackpoint controllers, or other types of interface devices.

Tactile arrays are multiple vertical "pins" that form a plane of contact perpendicular to the orientation of the pins at the pin's contact surfaces. The contact surfaces of the pins are contacted by a user's fingers or palm. Each pin can be individually moved perpendicularly to the pin's lengthwise axis, such that collectively the pins can be moved to convey different tactile sensations to the user. FIGURE 9a shows a single "pin" 490, which is implemented as an EAP actuator 494 that can be linearly moved as indicated by arrow 496. A tactile cap 492 is positioned on the EAP pin 494 to be contacted by a user. In FIGURE 9b, a plurality of the pins 490 of Fig. 9a have been positioned in a matrix to form a tactile array 500, where each pin 490 can be individually controlled to move vertically in either direction. An adjacent surface 502 provides a reference surface for the user's fingers. In FIGURE 9c, a high density array 504 of EAP pins 490 is shown, where each EAP pin can represent a pixel-sized element. This array of pins can be used to indicate haptically to the user when certain features in a graphical environment are crossed or interacted with. For example, the array can be provided as a trackpad, where the position of the user's finger on the array determines the position of a cursor or entity in a graphical environment. The array of pins can be matrix scanned (or individually addressed) to sense where the user's finger current is on the array. When the user's finger moves over a border of a window, the EAP pins corresponding to the border location are moved upwards, giving the user's finger the sensation of crossing over a 3-D border. Other displayed features such as icons, folders, etc. can also be similarly haptically indicated. The high density array 504 can also be used to provide other tactile sensations based on interactions or events implemented in a computer environment.

FIGURE 9d shows another embodiment 510 using the EAP pins described above. A lateral motion tactile element/array can be provided, where tactile sensations are provided moving pins perpendicular to their lengthwise axes (laterally). Each pin is moved laterally to provide stretching of the user's skin or shear sensations instead of indenting the skin of the user as in the embodiments of Figs. 9a-9c. More space can be provided between the pins to allow for the lateral motion. When using EAP actuators, one way to provide such lateral motion is to

place two linearly-moving EAP actuators 512 on a grounded element, and place a flexible membrane 514 (or other member) over the actuators 512, where a lateral moving element 516 is placed on the flexible membrane 514 as shown in Fig. 9d. One or both of the EAP actuators 512 is moved vertically (if both are moved, it is in opposite directions), causing the flexible membrane to flex and the lateral element 516 to rock left or right as indicated by arrow 518. Alternatively, as shown in FIGURE 9e, an EAP structure 520 that can be directly moved laterally using a control signal, such as referred to above in Fig. 2b and/or an element having sandwiched layers, can be used to provide the desired lateral motion. The actuator 520 can be moved laterally in one degree of freedom, or in some embodiments can be moved in two.

EAP actuators can be used to provide specific forces in particular applications. For example, FIGURE 10 is a side elevation view of an EAP brake 530 used in a medical device, where a catheter wire 532 (or laparoscopic extension, needle, or other portion of medical or other instrument) is used in a haptic feedback medical simulation that provides forces on the medical instrument to simulate a medical procedure. An EAP brake includes an EAP element 534 that is coupled to a brake shoe 536 that can be moved laterally against the catheter wire 532, causing friction in the linear degree of freedom of the wire. The amount of friction can be adjusted by moving the EAP brake different distances. Another EAP brake can be used to provide resistance in the rotary degree of freedom of the wire 532.

Trigger devices can also make use of EAP actuators. FIGURE 11 is a side elevational view of a device 540 including a trigger 542 that is pressed by a user to provide a signal to a game, simulation, or other program or device. The trigger 542 can be included in an interface device such as a gamepad, joystick, mouse, etc. For example, the trigger 542 can rotate about an axis of rotation B, which can be a coupling to a housing of the interface device. An EAP actuator 544 can be positioned between the trigger and a grounded switch 546. The switch 546 sends a signal indicating activation when a portion 548 is pressed. A spring 550 normally biases a contact plate 552 away from the switch 546; when the plate 552 is moved by the EAP actuator 544, the spring is compressed and the plate hits the portion 548 of the switch 546, activating it. The spring 550, meanwhile, biases the trigger back to its origin or rest position as well as providing a spring resistance force to trigger motion. The EAP actuator can be used to move in opposition to, or in conjunction with, trigger motion to provide a haptic sensation to the user pushing the trigger (this EAP force can supplement or override the spring force from 550). The actuator can thus make it easier or more difficult for the trigger to cause the switch to change states. For example, different resistances, damping, pulses, or vibrations can be output, as in all the linear EAP actuator embodiments described herein.

FIGURE 12a shows a rotary knob 560 that can be used to control functions in a wide variety of devices. A spiral or coil EAP actuator 562 can be positioned inside the knob so that the EAP actuator exerts a torque on the knob when it is activated. Resistance or force can thus

be provided in the rotary degree of freedom of the knob, as indicated by arrow 564, although a knob of limited rotational range should be used.

FIGURE 12b illustrates a knob device 570 that includes an EAP actuator. Knob 572 is coupled to a rotating shaft 574, which is coupled to a cylindrical brake member 576 that can include a frictional surface. EAP actuator 578 includes a brake shoe 580 that is moved by the actuator 578 to contact the brake member 576. This engagement provides frictional forces on the shaft 574 and knob 572. This embodiment allows a knob having an unlimited (continuous) rotational range to be used. A linear EAP element can be used, as described in braking embodiments above.

FIGURE 13 is a side elevational view of a braking embodiment 590 for a rotating disk. Disk 592 rotated about axis C. A caliper 594 is positioned at one end of the disk, and an EAP actuator 596 is coupled to one end of the caliper. The EAP actuator can be moved linearly to move a brake shoe 598 against the spinning cross-sectional surface of the disk, thus causing frictional resistance to the disk. A brake shoe 600 can be positioned on the other end of the caliper 594, opposite the brake shoe 598. The disk can be coupled to a variety of objects, such as a joystick handle or mouse, or a rotating axle in a vehicle.

A stylus-shaped interface device can also be provided with an EAP actuator to produce haptic feedback to the user of the stylus. A stylus can be used to point to or select objects on a screen, or draw or write lines by contacting the stylus with a tablet or with a display screen surface, e.g. on Personal Digital Assistants (PDA's), touch screens, graphics tablets, laptop computers, etc. For example, FIGURE 14a shows a stylus 610 having a moveable tip 612, where the tip is moved by an EAP actuator 614 that is coupled to the tip and positioned inside the stylus housing. The EAP actuator moves linearly and causes the tip member 616 to move linearly through an aperture in the stylus housing. The EAP actuator can be controlled to produce vibrations, pulses, or other force sensations on the tip and thus to the user holding the stylus.

FIGURE 14b shows a different embodiment 620 that causes a front end portion 622 of the stylus to linearly move with respect to the back portion 624 of the stylus. A rubber bellows 626 can be positioned between the moving front portion and the back portion, and an EAP actuator (not shown) can be positioned inside the stylus housing. The EAP actuator can be a linearly-moving element that is coupled to the front end portion 622 to move that portion similarly to moving the tip member as shown in Fig. 14a. Haptic sensations can be output to the user similarly as described with respect to Fig. 14a.

Other features of a stylus can also be actuated using EAP actuators. In FIGURE 14c, a stylus 640 is shown having a button 642 which can be controlled (by a host computer or other controller) to linearly move back and forth by coupling a linearly moving EAP actuator 644 to

the button as shown. The button can be actuated to correspond to interactions between a controlled cursor and other displayed objects, for example.

5 In FIGURE 14d, a stylus 650 includes an expanding grip 652 which can be implemented using EAP actuators. The cylindrical grip provides an expanding circumference that is haptically discernible to the user gripping the cylindrical grip. The grip can be expanded and contracted to provide various haptic sensations, such as pulses, vibrations, 3-D surface simulations, etc. The grip can be implemented using a plurality of EAP actuators 654 (four are shown) that are disc-shaped and which expand in circumference with the activation signal is applied, as indicated in FIGURE 14e which shows a single EAP actuator 654. These actuators can be similar to the EAP
10 structure described above with respect to Fig. 2e.

Other devices can also be used with EAP actuators. For example, as shown in FIGURE 15a, a steering wheel 660 of a steering wheel controller device can be provided with an EAP inertial shaker 662 coupled in or on the wheel to provide inertial forces to the user contacting the steering wheel and which are coordinated with displayed events or interactions. The inertial
15 shaker can be similar to the shaker described above with reference to Fig. 4a. Brakes can also be provided to exert frictional forces in the degree of freedom of the steering wheel, similar to the knob of Fig. 12b. FIGURE 15b shows a joystick handle 666 of a joystick controller, where the handle is similarly outfitted with an inertial EAP actuator 668 provided within the joystick handle to output inertial forces on the joystick handle.

20 FIGURE 15c is a perspective view of a joystick embodiment 680 that provides passive force feedback to the joystick. Joystick handle 682 is placed in apertures of two rotating members 684a and 684b. When the handle 682 is rotated in a direction, the corresponding member 684 rotates as well. Frictional brake disks 686a and 686b are coupled to their associated rotating members 684a and 684b. EAP brakes 688a and 688b provide frictional forces on the
25 disks 686 which causes resistance in the two degrees of freedom of the joystick handle (sensors, not shown, sense the rotational motion of the joystick handle). For example, the EAP brakes can include linearly-moving elements, similar to other brake embodiments described herein. FIGURE 15d illustrates one example of an EAP brake caliper that can be used as an EAP brake 688, where a linearly-moving EAP actuator 690 coupled to a caliper support 691 can be coupled
30 to a brake shoe 692 that frictionally contacts the disk 686.

EAP brakes as disclosed herein can also be used on other controllers. For example, FIGURE 16 is a perspective view of a cylindrical pointer controller 700, which includes a cylinder 702 that can be rotated about its lengthwise axis as indicated by arrow 704 to provide
35 input in one degree of freedom (e.g. move a cursor along one axis) and can be translated parallel to its axis of rotation as indicated by arrow 706 on a carriage 708 to provide input in another degree of freedom (e.g. move a cursor along the other axis). Sensors (not shown) detect the rotation and translation. Such a controller is described in greater detail in U.S. Patent No.

4,896,554. In one embodiment, an EAP brake 710 can move a brake shoe against an axle 712 coupled to the cylinder to provide frictional braking forces in the rotational degree of freedom. That EAP brake and the cylinder can be translated linearly on carriage 708, and another EAP brake 714 can apply braking frictional forces on the carriage in the translatory degree of freedom.

5 FIGURE 17a illustrates an embodiment 720 providing skin tactors using an EAP actuator. Skin tactors are similar to the pin grid arrays described above, in which one or more moving elements contacts a user's skin to provide a tactile sensation. One or more skin tactors can be provided in a haptic glove to engage the user's fingers and palm, in arrays on a vest to engage the user's chest or other body parts, or in other areas that can contact a user's skin. In
10 Fig. 17a, an EAP linearly-moving actuator 722 is coupled to a tactor element 724, where the tactor element is moved linearly into the user's skin through an opening in a support 726. The tactor element is preferably moved and/or oscillated with a waveform similarly to the pin grid arrays described above.

 FIGURE 17b illustrates another embodiment 730 having tactor elements. A linearly-
15 moving EAP actuator 732 is coupled to a support 734. A tactor element 736 is coupled to a member 738 that is coupled to the end of the actuator 732. When the actuator 732 is moved linearly, the tactor element is moved laterally as indicated by arrow 740. This motion stretches the user's skin instead of moving an element into the skin. The grounded surface surrounding the tactor element, as well as the tactor element itself, can include ridges 742 or bumps to engage
20 the user's skin. The stationary ridges on the grounded surface hold an engaged portion of the user's skin in place, while the moving ridges on the tactor element 736 stretch the middle area of the engaged portion of user's skin, creating a highly effective tactile sensation.

 While this invention has been described in terms of several preferred embodiments, it is contemplated that alterations, permutations and equivalents thereof will become apparent to
25 those skilled in the art upon a reading of the specification and study of the drawings. For example, many different types of haptic sensations can be provided with the actuators of the present invention. Furthermore, certain terminology has been used for the purposes of descriptive clarity, and not to limit the present invention.

CLAIMS

5 1. A haptic feedback interface device in communication with a host computer implementing a host application program, said interface device manipulated by a user, the interface device comprising:

a device housing that is physically contacted by said user;

a sensor device operative to detect said manipulation of said interface device by said user, said sensor device outputting sensor signals representative of said manipulation; and

10 a computer-controlled electroactive polymer actuator operative to output a force to said user caused by motion of said actuator, wherein said force provides a haptic sensation to said user.

15 2. A haptic feedback interface device as recited in claim 1, wherein said force is correlated with an event or interaction implemented by said host computer.

3. A haptic feedback interface device as recited in claim 1, wherein said force output by said electroactive polymer actuator is an inertial force that is caused by moving an inertial mass.

20 4. A haptic feedback interface device as recited in claim 1 further comprising a button, and wherein said electroactive polymer actuator moves said button to output said force to said user.

5. A haptic feedback interface device as recited in claim 4 wherein said button is moved in a degree of freedom of motion of said button.

6. A haptic feedback interface device as recited in claim 4 wherein said button is moved laterally, approximately perpendicular to a degree of freedom of motion of said button.

25 7. A haptic feedback interface device as recited in claim 1 wherein said force output by said electroactive polymer actuator is a rotary force.

8. A haptic feedback interface device as recited in claim 1 wherein said force output by said electroactive polymer is a linear force.

9. A haptic feedback interface device as recited in claim 1 wherein said electroactive polymer moves portions of said device housing of said haptic feedback interface device.

10. A haptic feedback interface device as recited in claim 1 wherein said electroactive polymer moves a brake shoe against a moving part of said interface device to cause a resistance to said moving part.

11. A haptic feedback interface device as recited in claim 1 wherein said electroactive polymer provides tactile sensations when the user contacts a rotating wheel on said interface device.

12. A haptic feedback interface device as recited in claim 8 wherein said electroactive polymer actuator moves a member directly into contact or in shear with skin of said user to provide a tactile sensation to said user.

13. A haptic feedback interface device as recited in claim 12 wherein said electroactive polymer actuator is one of a plurality of electroactive polymer actuators of said interface device arranged in a tactile array.

14. A haptic feedback interface device as recited in claim 1 wherein said interface device includes a stylus.

15. A haptic feedback interface device as recited in claim 1 wherein said interface device includes a trackpoint joystick controller.

16. A haptic feedback interface device in communication with a host computer implementing a host application program, said interface device manipulated by a user, the interface device comprising:

a sensor device operative to detect said manipulation of said interface device by said user, said sensor device outputting sensor signals representative of said manipulation; and

an electroactive polymer actuator operative to output a force to said user caused by motion of said actuator, said actuator controlled by an input electrical signal, wherein said force provides a haptic sensation to said user.

17. A haptic feedback interface device as recited in claim 16 wherein said force output by said electroactive polymer actuator is an inertial force that is caused by moving an inertial mass.

18. A haptic feedback interface device as recited in claim 16 further comprising a button, and wherein said electroactive polymer actuator moves said button to output said force to said user.

5 19. A haptic feedback interface device as recited in claim 16 wherein said force output by said electroactive polymer actuator is a rotary force.

20. A haptic feedback interface device as recited in claim 16 wherein said force output by said electroactive polymer is a linear force.

10 21. A haptic feedback interface device as recited in claim 16 wherein said electroactive polymer actuator bends based on at least two layers of electroactive polymer material included in said actuator.

22. A haptic feedback interface device as recited in claim 16 wherein said electroactive polymer actuator includes a dielectric surrounded by two electrodes, wherein said dielectric expands in area when controlled with electrical signals.

15 23. A haptic feedback interface device as recited in claim 16 wherein said electroactive polymer moves portions of said device housing of said haptic feedback interface device.

24. A haptic feedback interface device as recited in claim 16 wherein said electroactive polymer moves a braking member against a moving part of said interface device to cause a resistance force to said moving part.

20 25. A haptic feedback interface device as recited in claim 16 wherein said electroactive polymer actuator moves a member directly into contact or in shear with skin of said user to provide a tactile sensation to said user.

25 26. A haptic feedback interface device in communication with a host computer implementing a host application program, said interface device manipulated by a user, the interface device comprising:

a device housing that is physically contacted by said user; and

30 an electroactive polymer (EAP) element, said EAP element operative to detect a manipulation of a manipulandum of said interface device and to output sensor signals representative of said manipulation, said EAP element also operative to output a force to said user in response to an input signal, said force caused by motion of said EAP element and providing a haptic sensation to said user.

27. A haptic feedback interface device as recited in claim 26 wherein said EAP element is operative to detect contact of said user with said manipulandum.

28. A haptic feedback interface device as recited in claim 26 wherein said EAP element is operative to detect an amount of pressure on said EAP element caused by said user.

29. A haptic feedback interface device as recited in claim 26 wherein said force output by said electroactive polymer is a linear force.

30. A haptic feedback interface device as recited in claim 26 wherein said interface device includes a joystick or trackpoint controller.

31. An method for outputting haptic sensations to a user of an interface device, the interface device manipulated by a user and coupled to a host microprocessor implementing a host application program, the method comprising:

detecting said manipulation of said interface device by said user and outputting sensor signals representative of said manipulation; and

outputting a force to said user using an electroactive polymer actuator by sending signals to said electroactive polymer actuator, where said force is caused by motion of said actuator, said force providing a haptic sensation to said user.

32. A method as recited in claim 31 wherein said electroactive polymer actuator outputs a rotary force.

33. A method as recited in claim 31 wherein said electroactive polymer actuator outputs a linear force.

34. A method as recited in claim 31 wherein said electroactive polymer actuator moves a braking member against a moving part of said interface device to cause a resistance force to said moving part.

35. A method as recited in claim 31 wherein said electroactive polymer moves portions of a device housing of said haptic feedback interface device to provide said force to said user.

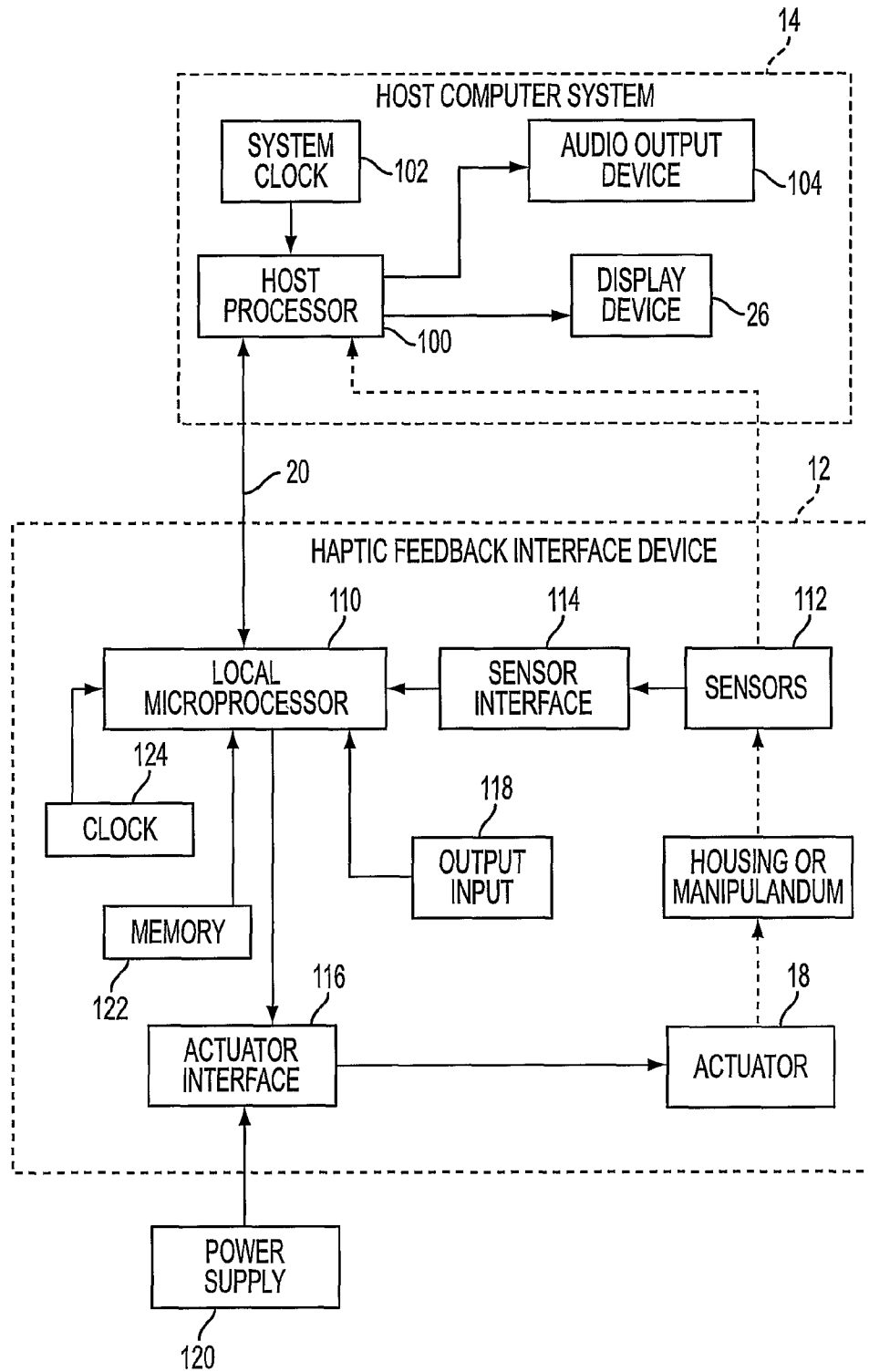


FIG. 1

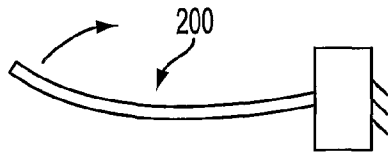


FIG. 2A

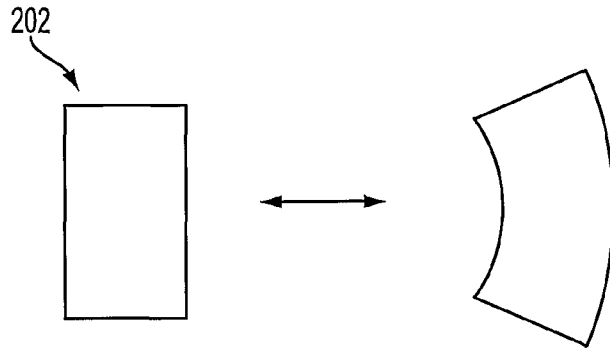


FIG. 2B

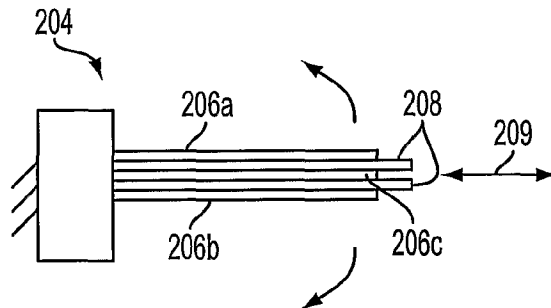


FIG. 2C

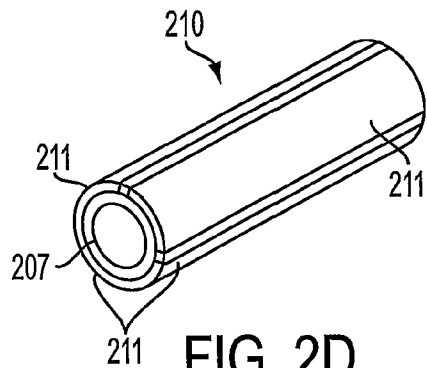


FIG. 2D

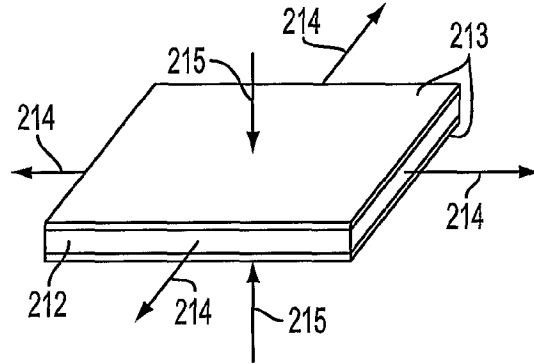


FIG. 2E

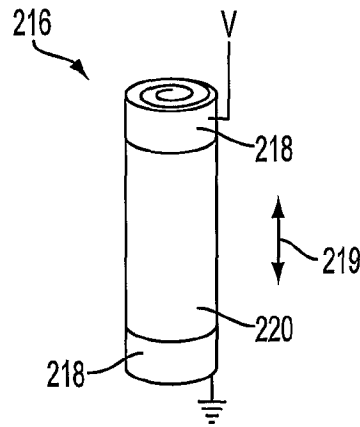


FIG. 2F

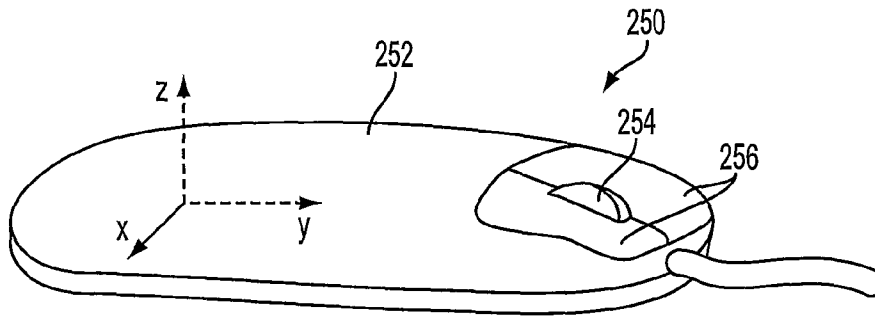


FIG. 3

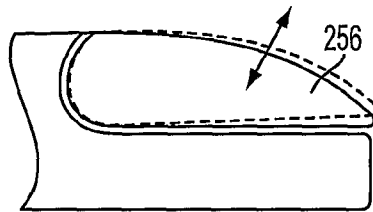


FIG. 3A

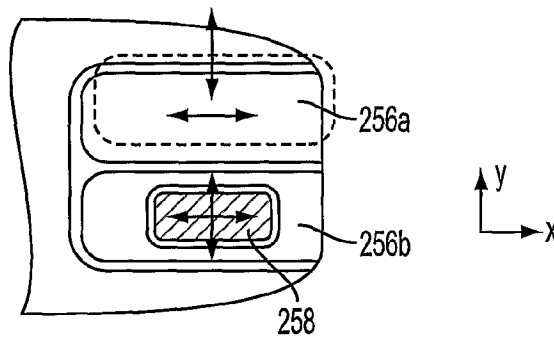


FIG. 3B

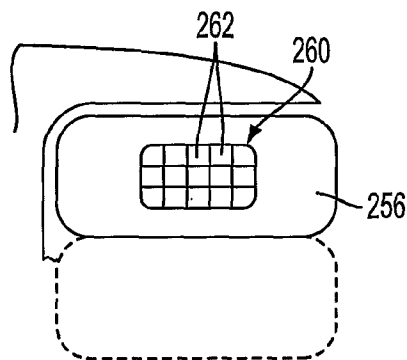


FIG. 3C

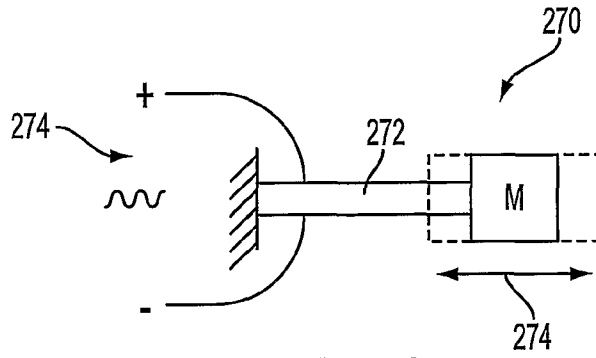


FIG. 4A

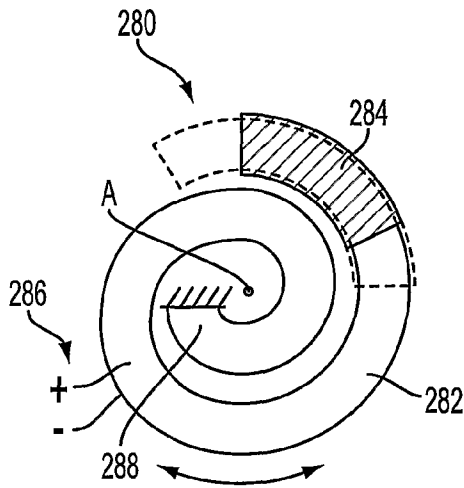


FIG. 4B

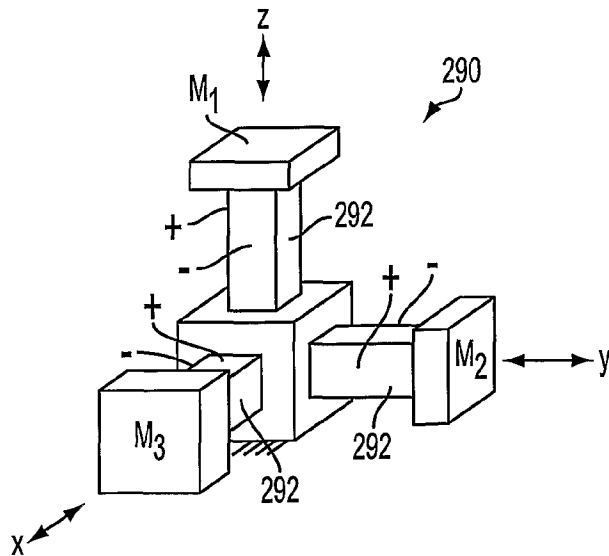


FIG. 4C

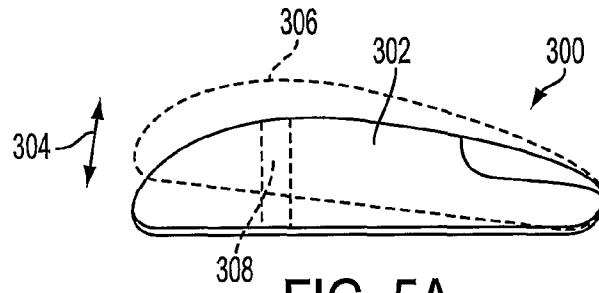


FIG. 5A

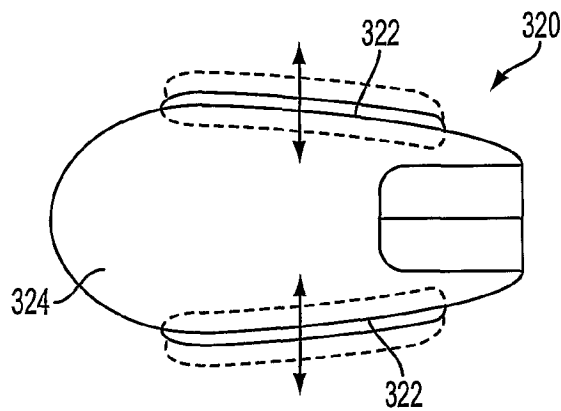


FIG. 5B

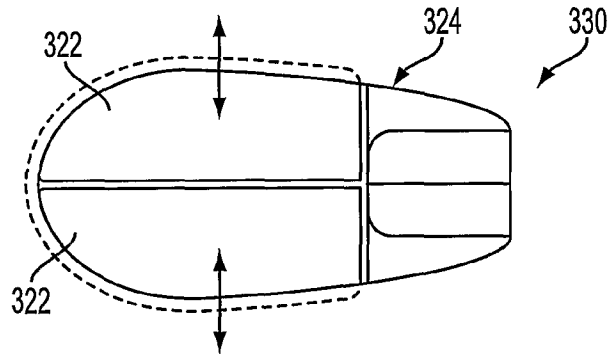


FIG. 5C

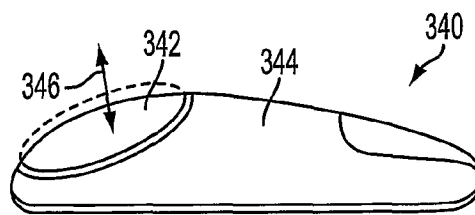


FIG. 5D

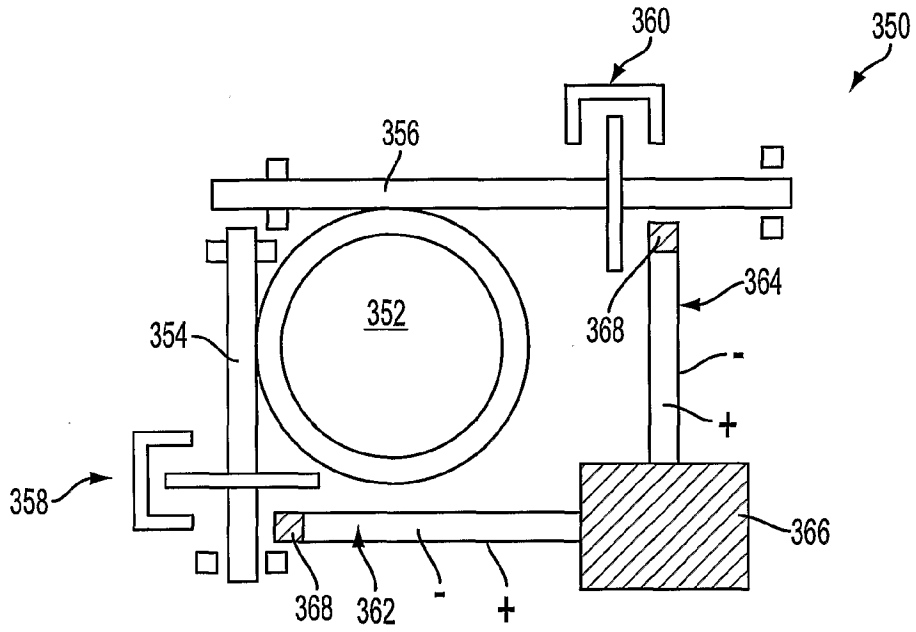


FIG. 6

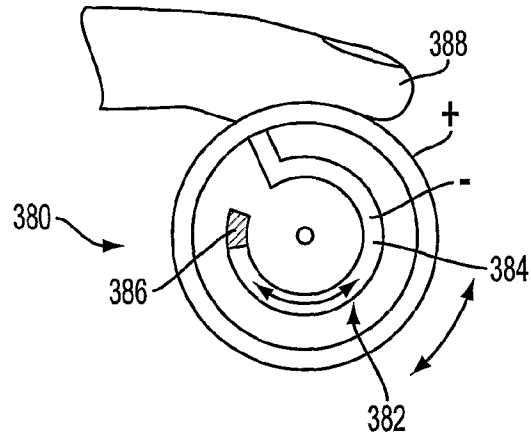


FIG. 7A

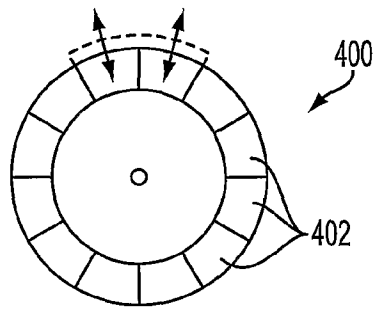


FIG. 7B

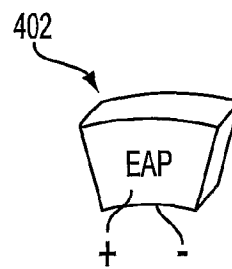


FIG. 7C

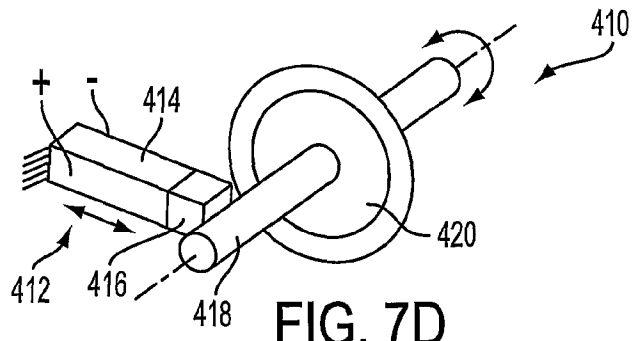


FIG. 7D

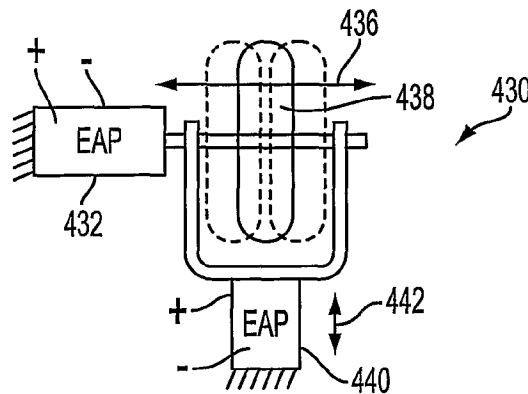


FIG. 7E

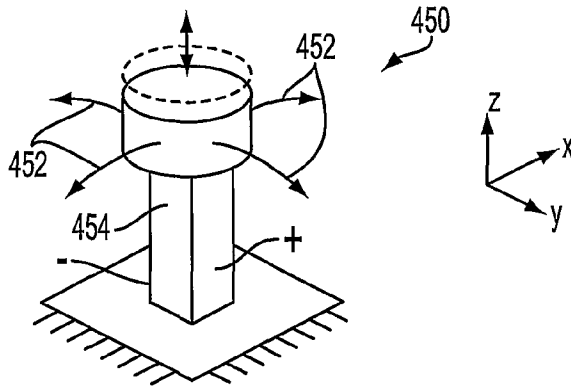


FIG. 8A

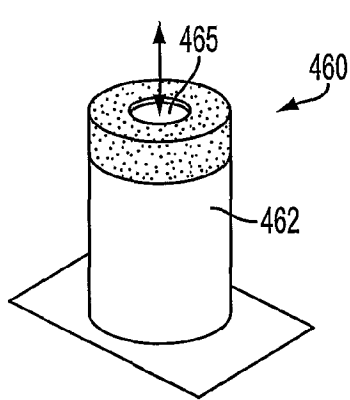


FIG. 8B

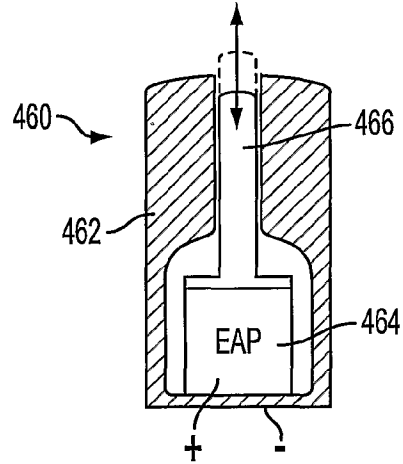


FIG. 8C

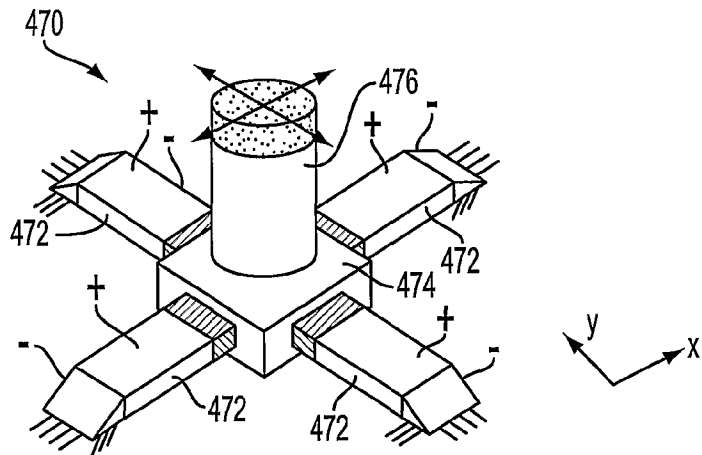


FIG. 8D

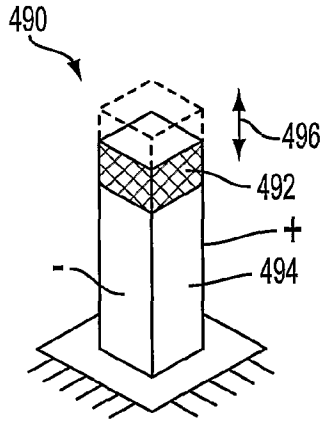


FIG. 9A

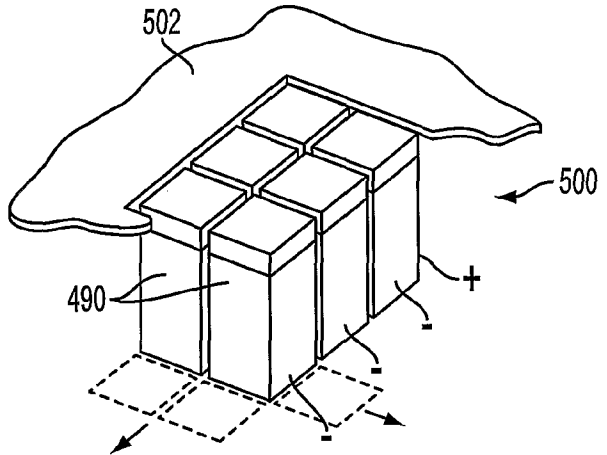


FIG. 9B

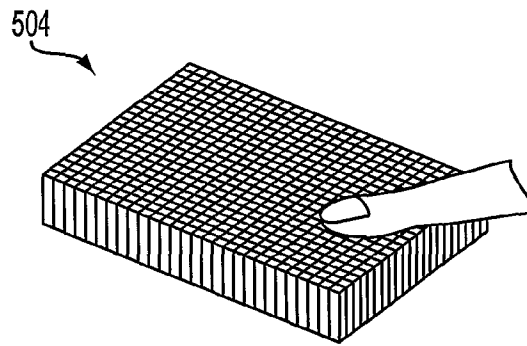


FIG. 9C

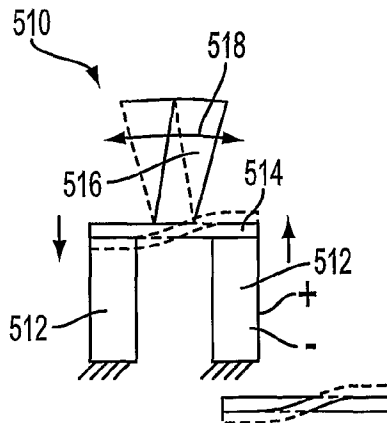


FIG. 9D

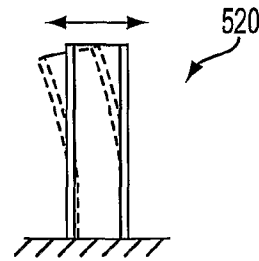


FIG. 9E

11/14

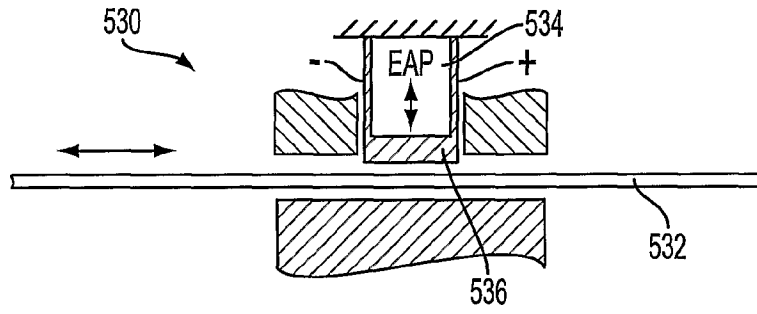


FIG. 10

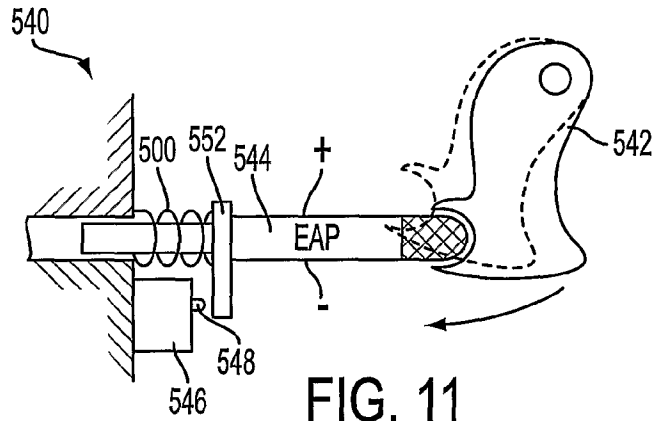


FIG. 11

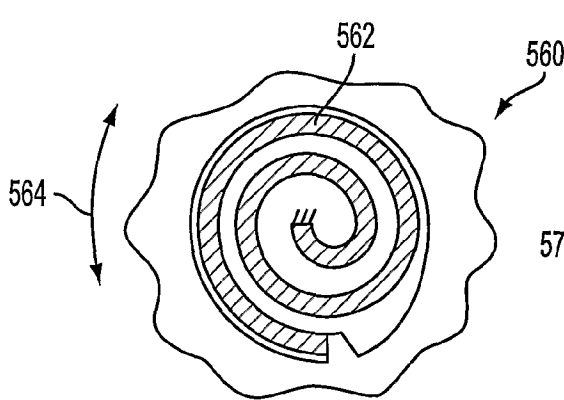


FIG. 12A

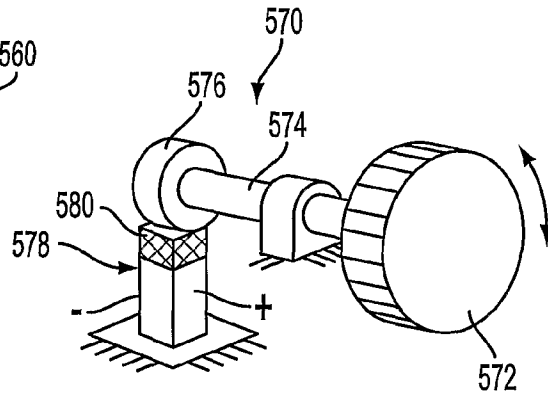


FIG. 12B

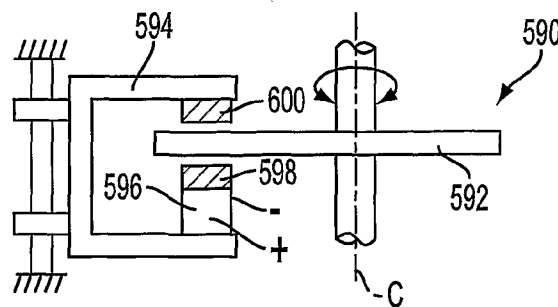


FIG. 13

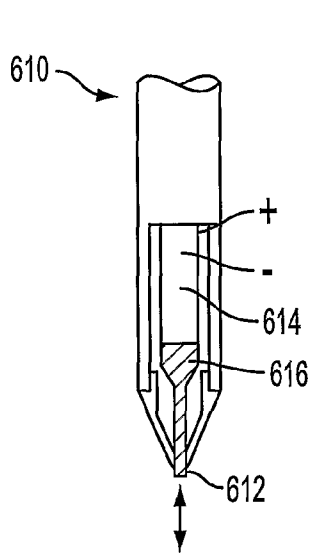


FIG. 14A

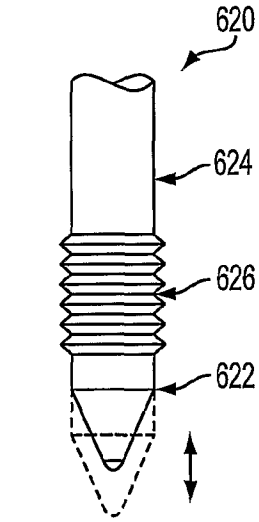


FIG. 14B

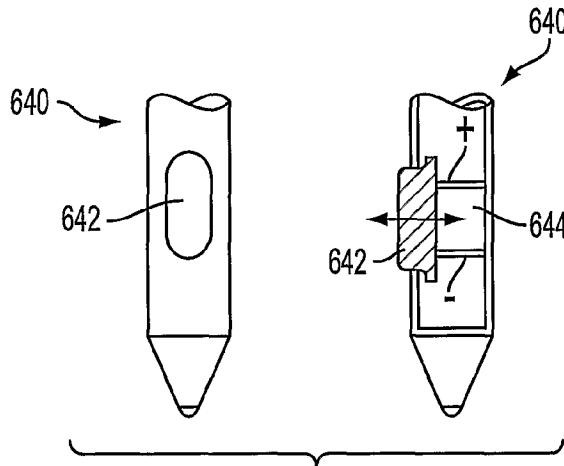


FIG. 14C

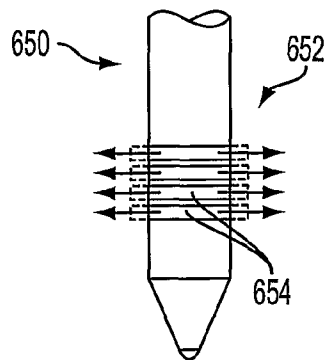


FIG. 14D

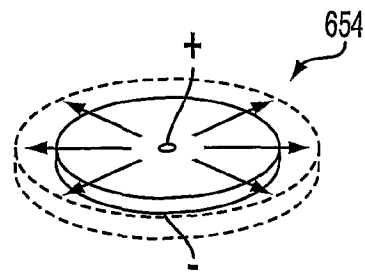


FIG. 14E

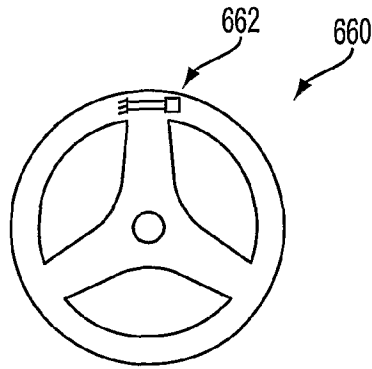


FIG. 15A

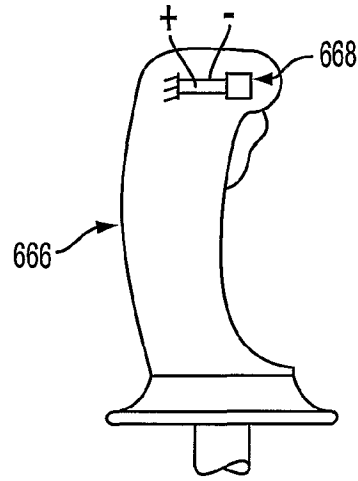


FIG. 15B

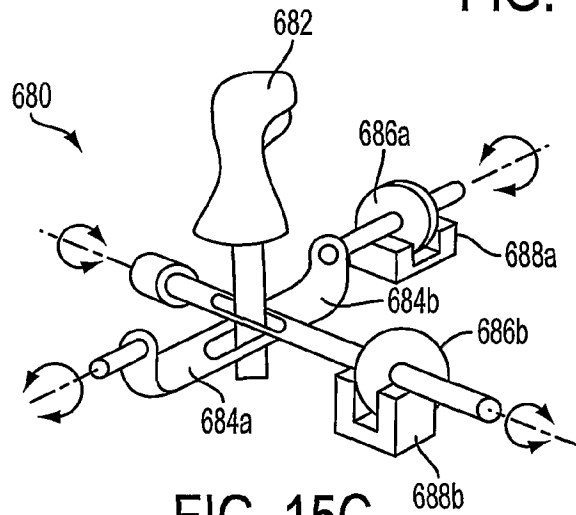


FIG. 15C

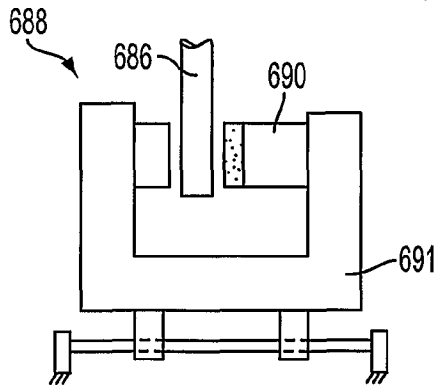


FIG. 15D

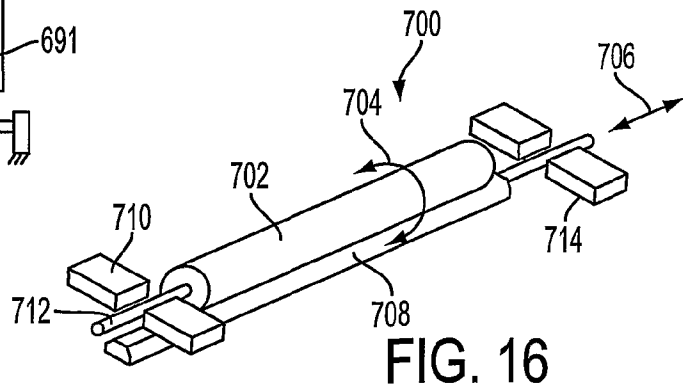


FIG. 16

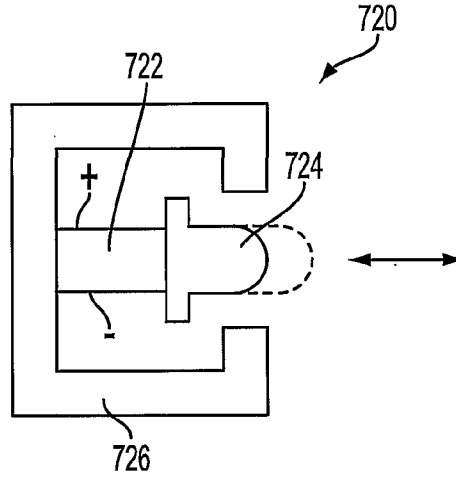


FIG. 17A

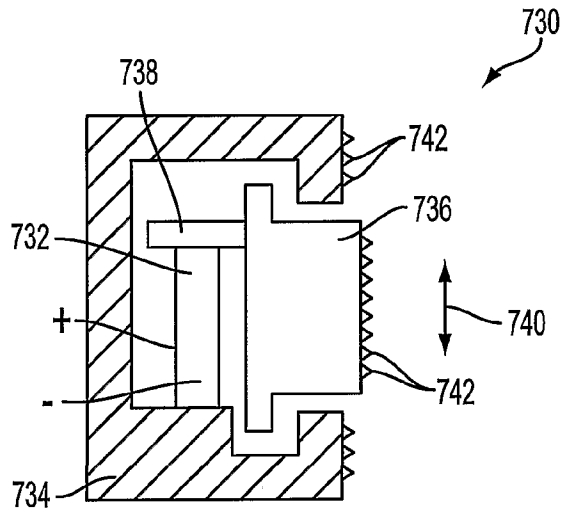


FIG. 17B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/16974

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : G09G 5/00

US CL : 345/156, 168

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 345/156, 168

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST 1.01

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y, P	US 6,147,674 A (ROSENBERG et al.) 14 November 2000, abstract, col. 1, line 55-col. 2, line 10, col. 9, line 37-col. 10, line 18, and col. 11, lines 1-14.	1-35
Y	US 6,002,184 A (DELSON et al.) 14 December 1999, col. 3, lines 5-37.	1-35
A	US 5,736,978 A (HASSER et al.) 07 April 1998, ALL	1-35

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"B" earlier document published on or after the international filing date	"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

09 JULY 2001

Date of mailing of the international search report

02 AUG 2001

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Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

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(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

(19) Weltorganisation für geistiges Eigentum
Internationales Büro



(43) Internationales Veröffentlichungsdatum
4. April 2002 (04.04.2002)

PCT

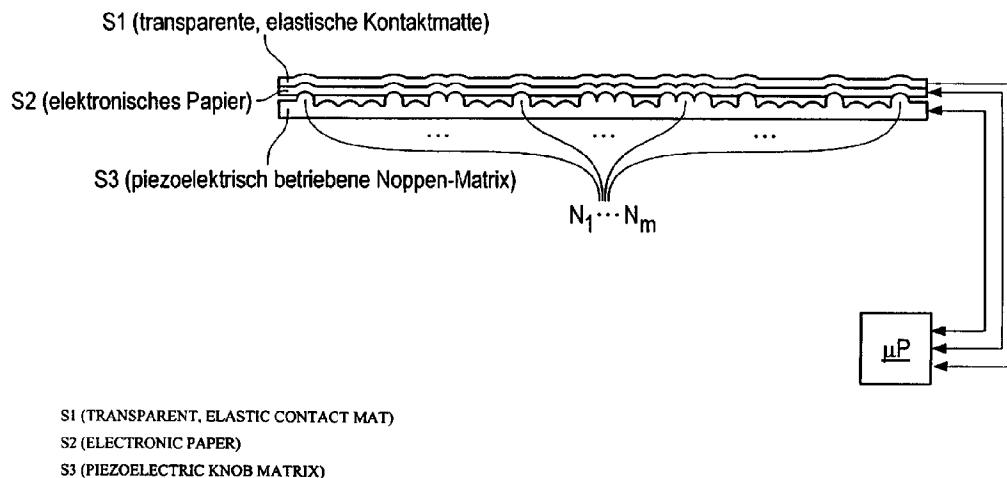
(10) Internationale Veröffentlichungsnummer
WO 02/27645 A1

- (51) Internationale Patentklassifikation⁷: G06K 11/06, 11/08, 11/16
- (21) Internationales Aktenzeichen: PCT/DE01/03402
- (22) Internationales Anmeldedatum: 5. September 2001 (05.09.2001)
- (25) Einreichungssprache: Deutsch
- (26) Veröffentlichungssprache: Deutsch
- (30) Angaben zur Priorität: 100 46 099.2 18. September 2000 (18.09.2000) DE
- (71) Anmelder (für alle Bestimmungsstaaten mit Ausnahme von US): SIEMENS AKTIENGESELLSCHAFT [DE/DE]; Wittelsbacherplatz 2, 80333 München (DE).
- (72) Erfinder; und
- (75) Erfinder/Anmelder (nur für US): FRANZEN, Michael [DE/DE]; Elbestr. 33, 46395 Bocholt (DE).
- (74) Gemeinsamer Vertreter: SIEMENS AKTIENGESELLSCHAFT; Postfach 22 16 34, 80506 München (DE).
- (81) Bestimmungsstaaten (national): CN, JP, US.
- (84) Bestimmungsstaaten (regional): europäisches Patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).

[Fortsetzung auf der nächsten Seite]

(54) Title: TOUCH-SENSITIVE DISPLAY WITH TACTILE FEEDBACK

(54) Bezeichnung: BERÜHRUNGSENSITIVE ANZEIGE MIT TAKTILER RÜCKKOPPLUNG



(57) **Abstract:** The invention relates to a touch-sensitive display with tactile feedback, comprising a first layer S_1 , a mechanically flexible display medium, a second layer S_2 with at least one receptor, and a third layer S_3 with at least one controllable actuator. The second layer S_2 is disposed in such a way that the receptor detects a contact in at least one section of the first layer S_1 and generates at least one first signal. The third layer S_3 is disposed in such a way that the controllable actuator mechanically manipulates the first layer S_1 at least in some points of the section. The display is further provided with a control device μP that is designed and contacted with the second layer S_2 and the third layer S_3 to generate in an initial state at least one second signal for controlling the actuator, at least one modified second signal being generated on the basis of the first signal.

(57) **Zusammenfassung:** Berührungssensitive Anzeige mit taktiler Rückkopplung mit einer ersten Schicht S_1 , mit einem mechanisch flexiblen Anzeigemedium, einer zweiten Schicht S_2 mit mindestens einem Rezeptor, einer dritten Schicht S_3 mit mindestens einem steuerbaren Aktor, wobei die zweite Schicht S_2 derart angeordnet ist, dass der Rezeptor eine Berührung in zumindest einem Teilbereich der ersten Schicht S_1 unter Erzeugung mindestens eines ersten Signals erfasst und

[Fortsetzung auf der nächsten Seite]

WO 02/27645 A1

**Erklärungen gemäß Regel 4.17:**

- *hinsichtlich der Berechtigung des Anmelders, ein Patent zu beantragen und zu erhalten (Regel 4.17 Ziffer ii) für die folgenden Bestimmungsstaaten CN, JP, europäisches Patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR)*
- *Erfindererklärung (Regel 4.17 Ziffer iv) nur für US*

Veröffentlicht:

- *mit internationalem Recherchenbericht*

Zur Erklärung der Zweibuchstaben-Codes und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

wobei die dritte Schicht S3 derart angeordnet ist, dass der steuerbare Aktor die erste Schicht S1 zumindest in dem Teilbereich punktuell mechanisch manipuliert, sowie eine Steuereinrichtung mP, die mit der zweiten Schicht S2 und dritten Schicht S3 derart ausgestaltet und verbunden ist, dass in einem Ausgangszustand mindestens ein zweites Signal zur Ansteuerung des Aktors erzeugt wird, wobei auf Grundlage des ersten Signals mindestens ein geändertes zweites Signal erzeugt wird.

Beschreibung

Berührungssensitive Anzeige mit taktiler Rückkopplung

5 Die Erfindung betrifft eine berührungssensitive Anzeige mit taktiler Rückkopplung.

Berührungssensitive Anzeigen "Touchscreens" kommen überwiegend in sogenannten Touchscreen-Terminals zu Einsatz, die
10 mittels Fingerberührung des Bildschirms durch einen Benutzer bedient werden, wobei die vom PC bekannte Tastatur und Maus meist entfallen.

Eine Bestätigung, dass eine von einem Benutzer getätigten
15 Eingaben erfolgt ist, wird im Allgemeinen durch audiovisuelle Rückkopplung erreicht, beispielsweise durch einen Piepton oder Farbwechsel des Anzeigebereichs beim Berühren der Anzeige.

20 Touchscreen-Terminals werden auf Messen, Präsentationen oder im Empfangsbereich eines Unternehmens zum Dialog mit Kunden aufgestellt. Ebenso finden Touchscreen-Terminals auch Anwendung auf Flughäfen, in Stadtzentren als Informations-Terminals für Touristen und in Produktionsstätten zur Erfas-
25 sung und Steuerung von Produktionsabläufen.

Ein Nachteil bei den zuletzt genannten Anwendungen sind laute und unregelmäßig auftretende Umgebungsgeräusche, die an Flughäfen, Straßen bzw. Produktionsstätten gegeben, so das die
30 Gefahr besteht, dass eine auditive Rückkopplung durch die Umgebungsgeräusche überlagert werden und vom Benutzer unbemerkt bleiben.

Eine visuelle Rückkopplung ist ebenfalls von Umgebungseinflüssen abhängig. Beispielsweise können direkte oder reflektierte Sonnenstrahlen zu Irritationen führen, so dass eine
35 visuelle Rückkopplung nicht ihre Wirkung erzielt. Zudem kommt

es auch vor, dass der Benutzer für die visuelle Rückkopplung vorgesehenen Bereiche der Anzeige durch die Hand verdeckt.

Aus der US 4,885,565 ist dazu ein berührungssensitiver Monitor bekannt, bei dem bei einer durch Berührung erfolgten Eingabe eines Benutzers eine taktile Rückkopplung ausgelöst wird, wobei dazu eine Schwingspule durch einen Mikroprozessor derart angesteuert wird, dass sie einen mechanischen Impuls auslöst, der das Gehäuse des Monitors in Schwingung versetzt, so dass zusätzlich zur audiovisuellen Rückkopplung der Benutzer auch spürt, dass seine Eingabe detektiert wurde.

Nachteilig bei dieser Lösung ist, dass egal welche Eingabe durch Berührung erfolgt ist, stets die gleiche taktile Rückkopplung erfolgt und erst durch die Verbindung mit der nach wie vor vorhandenen audiovisuellen Rückkopplung eine Differenzierung möglich ist.

Die der Erfindung zugrundeliegende Aufgabe ist es eine berührungsempfindliche Anzeige mit taktiler Rückkopplung anzugeben, die die Nachteile des Standes der Technik löst.

Diese Aufgabe wird durch die Merkmale des Patentanspruches 1 gelöst.

Erfindungsgemäß weist eine berührungssensitive Anzeige mit taktiler Rückkopplung eine erste mechanisch flexible Schicht, derart ausgestaltet, dass sie als Anzeige funktioniert beispielsweise eine als elektronisches Papier bekannte Folie, eine zweite Schicht aufweisend mindestens einen Rezeptor, eine dritte Schicht aufweisend mindestens einen steuerbaren Aktor, wobei die zweite Schicht derart angeordnet ist, dass der Rezeptor eine Berührung in zumindest einem Teilbereich der ersten Schicht unter Erzeugung mindestens eines ersten Signals erfasst und wobei die dritte Schicht derart angeordnet ist, dass der steuerbare Aktor die erste Schicht zumindest in dem Teilbereich punktuell mechanisch manipuliert sowie eine

Steuereinrichtung, die mit der zweiten und dritten Schicht derart ausgestaltet und verbunden ist, dass in einem Ausgangszustand mindestens ein zweites Signal zur Ansteuerung des Aktors erzeugt wird, wobei auf Grundlage des ersten Signals mindestens ein geändertes zweites Signal erzeugt wird.

Die erfindungsgemäße Anzeige ermöglicht ein Erfassen einer Berührung der Anzeige durch den Rezeptor, wobei unmittelbar am Ort der Berührung ein taktiler Feedback gegeben wird, in dem beispielsweise bei einem auf der Anzeige dargestellten virtuellen Tastenblock, der durch Druck auf die entsprechende Stelle der Anzeige bedient werden kann, für jede der dargestellten Tasten des Tastenblocks durch den Aktor eine fühlbare Begrenzung und/oder eine Tastaturbeschriftung, die insbesondere auch für die Realisierung eines Terminals für Sehbehinderte bzw. Blinde hilfreich ist - realisiert wird. Beispielsweise ist es denkbar, dass Tastatur und Beschriftung für Sehende dargestellt werden, während gleichzeitig durch den Aktor eine Ausgabe in Blindenschrift "Brailleschrift" unterhalb der dargestellten Taste erzeugt wird.

Durch geeignete Steuerung (Software) kann, um den Eindruck einer wirklichen Tastatur näher zu kommen, ein Nachgeben bzw. Einrasten der virtuellen Taste erzeugt werden und es ist sogar möglich, einen Schieberegler zu simulieren, in dem eine einen Regler darstellende virtuelle Taste der Berührung bzw. dem Ziehen der Taste folgt, wobei dazu evtl. die Oberfläche eines solchen Reglers insbesondere rau und griffig erzeugt wird. Durch die erfindungsgemäße Anzeige erhält der Benutzer eine intuitive Rückkopplung, die dem Benutzer eine höhere Sicherheit im Umgang mit einer berührungssensitiven Anzeige gewährt und den Einfluss störender Geräusche und Lichtegebenheiten minimiert bzw. neutralisiert.

Als erste Schicht besonders geeignet sind Anzeigemedien, die gemäß der Technologie des "elektronischen Papiers", "mikroge-

kapselten elektrophoretischen Anzeige" oder "organischen Elektro-Lumineszenz" ausgestaltet sind, da diese sehr dünn und ausgestaltet als flexible Folie mechanischen Kräften, die insbesondere punktuell auf die Folienfläche wirken, wie sie
5 der Aktor erzeugt, nachgibt. Dabei ist die Folie derart elastisch ausgestaltet, dass sie in den Ausgangszustand vor der mechanischen Krafteinwirkung zurückkehrt, sobald die Krafteinwirkung beendet ist.

10 Eine Ausgestaltung des Rezeptors als Lichtgitter, erlaubt das indirekte Detektieren von Berührungen, da ein solches knapp über der ersten Schicht angebrachte Lichtgitter lediglich den Ort erfasst an dem ein Benutzer beispielsweise mit dem Finger das Licht des Gitters unterbricht, um eine virtuelle Taste zu
15 berühren. Des Weiteren hat diese Ausgestaltung den Vorteil, dass die zweite Schicht aus dem Luft gebildet wird, welches nur durch die das Lichtgitter realisierende Einrichtungen begrenzt ist, so dass der Aktor keinen zusätzlichen Widerstand zur punktuellen mechanischen Manipulation erfährt und wenig
20 Antriebsenergie benötigt.

Die Ausgestaltung des Aktors als Matrixanordnung von elektrisch und/oder magnetisch angetriebenen Stiften erlaubt die Erzeugung einer Rauheit bzw. Griffigkeit der virtuellen Tasten und ist insbesondere für die Realisierung der Ausgabe einer
25 Blindenschrift besonders geeignet.

Eine Matrix von senkrecht zur Anzeige gelagerten beweglichen Stiften als Rezeptor ist geeignet, um das Einrasten bzw.
30 Nachgeben auf einen Tastendruck zu simulieren. Auch das Erfassen eines virtuellen Schiebereglers ist mit dieser Ausgestaltung einfach zu realisieren, da für die Ermittlung der Schieberichtung lediglich der Zustand benachbarter Stifte geprüft werden muss.

35

Stifte von Aktor-Matrix und der Rezeptor-Matrix nebeneinander abwechselnd in der gleichen Ebene (Schicht) anzuordnen spart Raum.

5 Noch vorteilhafter ist es die Stifte derart auszugestalten, dass sie sowohl die Aktor als auch Rezeptor-Funktion erfüllen. Dadurch lässt sich auch effektive und platzsparende Art die Begrenzung bzw. Beschriftung einer virtuellen Taste erzeugen (herausfahren der Stifte), wobei ein (hinein-)drücken
10 der Stifte zum einen das Detektieren der Berührung ermöglicht und zum anderen das Nachgeben bzw. Einrasten. Zudem ist die durch die Ortsübereinstimmung von Rezeptor und Aktorfunktion eine präzisere Zuordnung von ermitteltem Druckpunkt und dargestellter virtueller Information möglich.

15

Piezoelektrische Elemente eignen sich besonders für den Antrieb bzw. das Detektieren von Berührungen da sie, beispielsweise durch Mikroprozessoren erzeugte, Spannungen (Signale) in Druck bzw. Bewegung direkt umsetzen können und umgekehrt
20 Druck in sofort, durch Mikroprozessoren, weiterverarbeitbare Spannungen (Signale) erzeugen.

Elektromagnetische Elemente werden, ebenso wie die piezoelektrischen Elemente, für die Realisierung von Blindenschrift
25 Terminalen, Braillezeile, bekannt und daher leicht zu erwerben.

Eine Sensormatte als Rezeptor vorzusehen, hat unter anderem den Vorteil, dass die Sensormatte als Massenprodukt günstig
30 in der Anschaffung ist.

Ist die zweite Schicht als transparente Sensormatte ausgestaltet, die zudem unmittelbar oberhalb der ersten Schicht zu liegen kommt, wird das mechanisch flexible Anzeigemedium geschützt da es nicht mehr direkt der Berührung durch einen
35 Nutzer ausgesetzt ist. Die Lebensdauer des, sicherlich im

Vergleich zur Sensormatte mit höheren (Anschaffungs-)Kosten verbundenen Anzeigemediums wird erhöht.

Ein Ausführungsbeispiel der Erfindung wird anhand der einzigen Figur dargestellt. Diese zeigt:

Seitenansicht des Schichtaufbaus einer berührungssensitiven Anzeige mit taktilem Feedback.

- 10 In der Figur ist eine in drei Schicht S_1 , S_2 und S_3 gegliederte Anzeige in Seitenansicht dargestellt, wobei in der ersten Schicht S_1 eine transparente, flexible Sensormatte zu liegen kommt.
- 15 Diese Sensormatte ist derart ausgestaltet, dass sie Berührungen detektiert und mindestens ein erstes Signal erzeugt, das zumindest den Ort (kartesische Koordinaten) der Berührung bestimmt.
- 20 Unmittelbar oberhalb dieser ersten Schicht S_1 ist die zweite Schicht S_2 angeordnet, die durch eine flexible elastische Folie gebildet wird, welche nach der Technologie des sogenannten elektronischen Papiers ausgestaltet ist.
- 25 Unter einem elektronischem Papier wird in der Fachwelt ein eine Technologie verstanden, bei der die Vorteile von Flachbildschirmen und Druckerfarbe auf Papier vereint werden, indem kleinste Farbkapseln mit mindestens zwei Farben - etwa Schwarz und Weiß - auf einer Papierfläche je nach elektrischer Ladung an einer einzelnen Stelle mit der einen oder der
- 30 anderen Seite nach oben zeigen. Für die Ansteuerung des dafür notwendigen elektrischen Feldes sind sogenannte Plastik Transistoren gedacht.
- 35 Alternative der Fachwelt bekannte Technologien sind "organische Elektro-Lumineszenz Folien" oder "mikrogekapselte e-

lektrophoretische Anzeigen", die ebenfalls eine Ausgestaltung als flexible sehr dünne Anzeigemedien erlauben.

5 Für die erfindungsgemäße Anordnung ist die Anwendung dieser Technologie auf eine Folie gedacht, die mechanisch flexibel und elastisch ausgestaltet ist, so dass sie punktuell mechanisch manipuliert werden kann, um Auswuchtungen auf der Oberfläche der Folie zu erzeugen, die sich nach Beenden der mechanischen Manipulation selbständig zurückbilden.

10 Unterhalb der zweiten Schicht S_2 kommt die dritte Schicht S_3 zu liegen, die durch eine flächendeckende Matrix aus senkrecht zur Folienfläche beweglich gelagerten piezoelektrisch betriebenen als Nylon- oder Metallstift ausgestaltete "Noppen" $N_1..N_m$ gebildet wird.

Die drei Schichten S_1, S_2 und S_3 sind dabei derart angeordnet, dass die piezoelektrisch betriebenen Noppen $N_1..N_m$ die ersten beiden Schichten S_1 und S_2 punktuell mechanisch manipulieren
20 können, so dass durch nebeneinander angeordnete Noppen $N_1..N_m$ in einem Ausgangszustand Tastaturbegrenzungen und/oder -beschriftungen eines virtuellen Tastenblock auf der Oberfläche der zweiten Schicht erzeugt und dort zu ertasten sind. Hierbei kann die Beschriftung in der Brailleschrift verfasst
25 sein, so dass sehende Nutzer die Möglichkeit haben eine vom Anzeigenmedium dargestellte virtuelle Tastatur und ihre Funktion zu sehen, wobei sie die Tastaturbegrenzung fühlen können, und gleichzeitig sehbehinderte Nutzer die Möglichkeit haben die Tastaturfunktion durch die von den Noppen $N_1..N_m$
30 erzeugte Brailleschrift zu ertasten.

Zumindest die zweite Schicht S_2 und die dritte Schicht S_3 sind mit einer Steuereinheit μP verbunden, die derart ausgestaltet ist, dass sie in einem Ausgangszustand, d.h. ein Zustand in dem (noch) keine Eingabe durch Berührung erfolgt
35 ist, beispielsweise einen virtuellen Tastaturblock und/oder eine virtuelle Menüleiste durch Erzeugung mindestens eines

zweiten Signals, zur Ansteuerung der Noppen-Matrix $N_1..N_m$,
realisiert wird. Des Weiteren ist die Steuereinheit μP derart
ausgestaltet, dass sie das aufgrund einer Berührung von der
Sensormatte erzeugtes erstes Signal ein mindestens ein neues
5 zweites Signal erzeugt, wobei die Berührung in einem zulässigen
Bereich, das heißt ein Bereich in dem ein virtuelles Be-
dientelement dargestellt ist, erfolgt sein muss.

Die Steuereinheit μP ist dazu außerdem noch mit einer die An-
10 zeige steuernden Einheit verbunden oder bildet mit ihr eine
Einheit, so dass auch Steuersignale zur Erzeugung bedienungs-
bedingter Veränderungen der virtuellen Bedienelemente erzeugt
werden.

15 Als Alternative zu der Sensormatte kann in der zweiten
Schicht S_2 auch ein Lichtgitter zu liegen kommen.

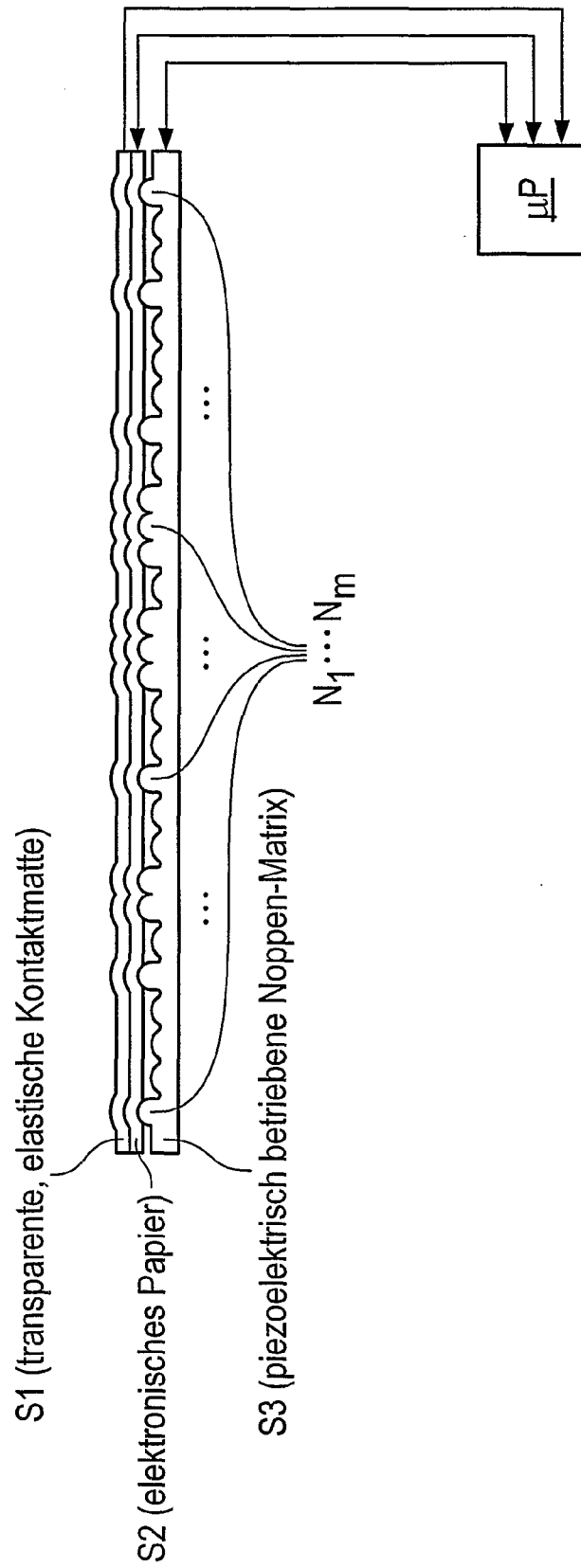
Lichtgitter bestehen im Allgemeinen aus zwei senkrecht zuein-
ander angeordneten Senderleisten, die jeweils mehrere Licht-
20 strahlen emittieren sowie gegenüber jeder Senderleiste ange-
ordnete Empfängerleisten, die die Lichtstrahlen detektiert.
Die Lichtstrahlen der senkrecht angeordneten Senderleisten
kreuzen sich dabei und erzeugen ein Lichtgitter. Bei einem
Durchdringen des Lichtgitters werden auf den senkrecht zuein-
25 ander angeordneten Empfängerleisten, das Ausbleiben jeweils
mindestens eines Lichtstrahls detektiert, so dass sich Koor-
dinatenpaare bilden lassen, mit denen eine genau Bestimmung
des Durchdringungsortes erfolgt. Die ermittelten Koordinaten
können dann als erstes Signal an die Steuereinheit μP gelei-
30 tet werden.

Das Lichtgitter ist dabei derart oberhalb der ersten Schicht
 S_1 angeordnet, dass die durch die Noppen-Matrix $N_1..N_2$ punktu-
ellen Ausbuchtungen der Anzeigenoberfläche keine Lichtstrah-
35 len unterbrechen.

Patentansprüche

1. Berührungssensitive Anzeige mit taktiler Rückkopplung gekennzeichnet durch
 - 5 a) eine erste Schicht S_1 , mit einem mechanisch flexiblen Anzeigemedium,
 - b) eine zweite Schicht S_2 mit mindestens einem Rezeptor,
 - c) eine dritte Schicht S_3 mit mindestens einem steuerbaren Aktor,
 - 10 d) die zweite Schicht S_2 derart angeordnet ist, dass der Rezeptor eine Berührung in zumindest einem Teilbereich der ersten Schicht S_1 unter Erzeugung mindestens eines ersten Signals erfasst,
 - e) die dritte Schicht S_3 derart angeordnet ist, dass der steuerbare Aktor die erste Schicht S_1 zumindest in dem
15 Teilbereich punktuell mechanisch manipuliert,
 - f) eine Steuereinrichtung μP , die mit der zweiten Schicht S_2 und dritten Schicht S_3 derart ausgestaltet und verbunden ist, dass in einem Ausgangszustand mindestens
20 ein zweites Signal zur Ansteuerung des Aktors erzeugt wird, wobei auf Grundlage des ersten Signals mindestens ein geändertes zweites Signal erzeugt wird.
2. Anzeige nach Anspruch 1, dadurch gekennzeichnet, dass das
25 Anzeigemedium eine gemäß der Technologie des "elektronischen Papiers", "mikrogekapselten elektrophoretischen Anzeige" oder "organischen Elektro-Lumineszenz", ausgestaltete Folie ist.
- 30 3. Anzeige nach Anspruch 1 oder 2, dadurch gekennzeichnet, dass der Rezeptor als "Lichtgitter" ausgestaltet ist.
4. Anzeige nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, dass
35 a) der Aktor eine erste Matrixanordnung beweglich gelagerter elektrisch und/oder magnetisch angetriebener Stifte $N_1..N_m$ ist,

- b) die Stifte $N_1..N_m$ senkrecht zur Fläche der ersten Schicht S_1 bewegbar sind.
5. Anzeige nach einem der Ansprüche 2 bis 4, dadurch gekennzeichnet, dass
- 5 a) der Rezeptor eine zweite Matrixanordnung beweglich gelagerter Stifte $N_1..N_m$ ist,
- b) die Stifte $N_1..N_m$ senkrecht zur Fläche der ersten Schicht S_1 bewegbar sind.
- 10
6. Anzeige nach Anspruch 5, dadurch gekennzeichnet, dass die zweite Schicht S_2 und dritte Schicht S_3 eine gemeinsame Schicht bilden, wobei die Stifte $N_1..N_m$ der ersten Matrixanordnung und die Stifte $N_1..N_m$ der zweiten Matrixanordnung nebeneinander angeordnet sind.
- 15
7. Anzeige nach Anspruch 6, dadurch gekennzeichnet, dass die Stifte $N_1..N_m$ als Aktor und zugleich Rezeptor ausgestaltet sind.
- 20
8. Anzeige nach einem der Ansprüche 4 bis 6, dadurch gekennzeichnet, dass die Stifte $N_1..N_m$ piezoelektrische Elemente sind.
- 25
9. Anzeige nach einem der Ansprüche 4 bis 6, dadurch gekennzeichnet, dass die Stifte $N_1..N_m$ elektromagnetische Elemente sind.
- 30
10. Anzeige nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass die zweite Schicht S_2 eine Sensormatte ist.
11. Anzeige nach Anspruch 10, dadurch gekennzeichnet, dass
- 35 a) die erste Schicht S_1 unterhalb der zweiten Schicht S_2 zu liegen kommt,
- b) die zweite Schicht S_2 transparent und flexibel ist.



INTERNATIONAL SEARCH REPORT

International Application No

PCT/DE 01/03402

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 G06K11/06 G06K11/08 G06K11/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 118 435 A (KAWAKAMI MASAHIKO ET AL) 12 September 2000 (2000-09-12) column 3, line 63 -column 9, line 5; figures 1,2	1
A	US 5 977 867 A (BLOUIN FRANCOIS) 2 November 1999 (1999-11-02) the whole document	1
A	US 5 412 189 A (CRAGUN BRIAN J) 2 May 1995 (1995-05-02) abstract	1

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US 6118435	A	12-09-2000	JP 10289061 A JP 10293644 A	27-10-1998 04-11-1998
US 5977867	A	02-11-1999	NONE	
US 5412189	A	02-05-1995	NONE	

INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen

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A. KLASSIFIZIERUNG DES ANMELDUNGSGEGENSTANDES
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Nach der Internationalen Patentklassifikation (IPK) oder nach der nationalen Klassifikation und der IPK

B. RECHERCHIERTE GEBIETE

Recherchiertes Mindestprüfstoff (Klassifikationssystem und Klassifikationssymbole)
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Recherchierte aber nicht zum Mindestprüfstoff gehörende Veröffentlichungen, soweit diese unter die recherchierten Gebiete fallen

Während der internationalen Recherche konsultierte elektronische Datenbank (Name der Datenbank und evtl. verwendete Suchbegriffe)

EPO-Internal, WPI Data, PAJ

C. ALS WESENTLICH ANGESEHENE UNTERLAGEN

Kategorie ^a	Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile	Betr. Anspruch Nr.
A	US 6 118 435 A (KAWAKAMI MASAHIKO ET AL) 12. September 2000 (2000-09-12) Spalte 3, Zeile 63 -Spalte 9, Zeile 5; Abbildungen 1,2	1
A	US 5 977 867 A (BLOUIN FRANCOIS) 2. November 1999 (1999-11-02) das ganze Dokument	1
A	US 5 412 189 A (CRAGUN BRIAN J) 2. Mai 1995 (1995-05-02) Zusammenfassung	1



Weitere Veröffentlichungen sind der Fortsetzung von Feld C zu entnehmen



Siehe Anhang Patentfamilie

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INTERNATIONALER RECHERCHENBERICHT

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Im Recherchenbericht angeführtes Patentdokument		Datum der Veröffentlichung	Mitglied(er) der Patentfamilie	Datum der Veröffentlichung
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US 5977867	A	02-11-1999	KEINE	
US 5412189	A	02-05-1995	KEINE	

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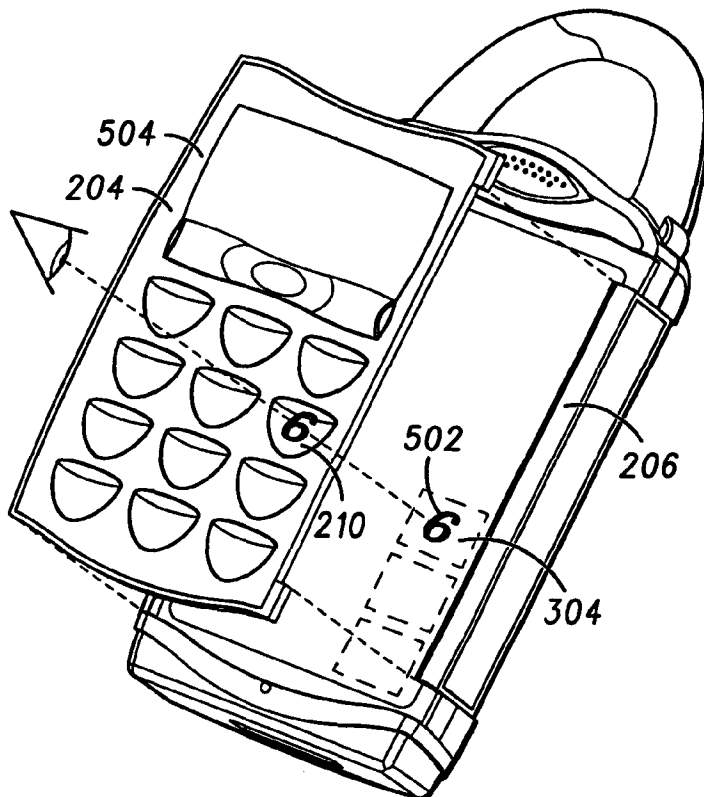
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- (74) Agents: **VAAS, Randall S.**, et al.; MOTOROLA, INC., 600 North U.S. Highway 45, Libertyville, IL 60048 (US).
- (81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.
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[Continued on next page]

(54) Title: DATA ENTRY DEVICE



(57) Abstract: A data entry device (Fig. 7) having a touch screen display (214) with software definable images, or soft keys, and a movable keypad (208) that covers the touch screen display in a closed position (200). The keypad has at least one transparent key (210) which further comprises an actuator (408) on a second side (404) and a substantially smooth surface, or lens on a second side (402). When the keypad is in the closed position the software definable images are projected through the transparent keys to the user. The user may then depress the transparent key associated with a corresponding image, causing the actuator to contact the touch screen display and thereby select the desired function. Each transparent key provides tactile feedback to the user indicating the transparent key has been sufficiently depressed. The device therefore retains tactile feedback of traditional keypads, while allowing each key to be dynamically labeled to in accordance with the mode of operation.



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Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Data Entry Device

BACKGROUND OF THE INVENTION

The invention relates generally to a configurable data entry device and more particularly an apparatus providing tactile feedback to the configurable data entry device while maintaining configurability of the data entry device.

Portable electronic devices are becoming more and more popular as size, weight and functionality improve. Some of these portable devices function as wireless communication devices and traditionally include such devices as cellular telephones, two-way radio services, or cordless phone services just to name a few. Other portable devices do not incorporate wireless connectivity but are carried extensively by the user. For example, Personal Digital Assistants (PDAs) can be used for many functions including personal information management or games. These devices are currently available to the consumer, largely as separate products. However, devices have begun to emerge enclosing two or more devices within one housing. For example, the combination of a cellular radiotelephone and a personal digital assistant (PDA), or a radio transceiver and a PDA, allowing wireless communication. Convergence of these devices into one unit or multifunctional device, is the result of the desire to have internet access at all times as well as the increase in popularity of personal information devices, such as PDAs and the like. These types of devices are limited in number and have just begun to surface in the market place.

Short messaging devices having short messaging service (SMS) or similar capability are also popular allowing users to communicate with text messages as an alternative to voice communication. Devices with this capability are commonly used in meetings as they allow meeting participants to communicate with others not in the meeting on a real time basis. The user can type and send a message with the device without disrupting the meeting, whereas this is not the case with voice communication. More and more devices are becoming multifunction in nature and there for have user interfaces to accommodate the

multiple modes. However, most of these devices use software definable touch screen displays or similar devices, which do not provide the user with tactile feedback. As a result of the transition to portable multifunctional devices, the need to improve the user interface has become apparent.

5 Current single function devices such as a cellular radiotelephones generally have one or two functions assigned to each individual button on the user interface. For example very simple low cost radiotelephones include an alphanumeric keypad having only a numeral and the typical three or four letters assigned to an individual key. If the user is dialing a number, the keys associated with the desired numbers are depressed. If the user is entering a name, when
10 storing a phone number for example, the user must cycle through the key having the desired letter until the letter appears on the output device or display because each key represents more than one letter. In more advanced cellular radiotelephones, the device may have other functions or options the user must
15 access. This requires either more keys, further requiring more space and a larger device which is less conducive to portability, or adding more functions to the existing keys, increasing the complexity. In some cases the device size is not important and additional keys may not be an issue. However, in the growing portable wireless device market, small size and light weight is important as it
20 allows the device to be easily transported. The device is more apt to be used, providing more billable usage to the service provider, if it is carried on the user at all times; small size and light weight promote this behavior. Adding another function to a key increases the complexity of operation as well as clutters the key with a plurality of indicia identifying the keys functions making the device more
25 difficult to operate. As a result, this reduces the user inclination to use the device as all three deficiencies: complexity, size and weight discourage use and therefore billable time is reduced.

 One method of providing more functions without increasing the complexity of device operation and yet maintain a portably favorable size and weight is to use a touch screen display. The touch screen is a combination
30 input/output (I/O) device comprised of an input layer place on top of an output

layer. The output layer displays images which correspond with a designated input portion of the input layer. Software that controls the display defines or displays icons, which may for example resemble buttons or keys, on the display. Touching the icon of the output layer activates the designated input portion of the input layer, activating the desired function. This is commonly known as software defined keys or soft keys.

Use of a touch screen display, however, has several downfalls. First, it is not always viable for the user to look directly at the data entry portion of the device when entering or selecting functions. The tactile feedback of traditional keys, which allows the user to blindly select the keys while still entering the desired information, is not present.

Second it is desirable for the user in general to have tactile feedback when depressing a key. This acknowledges to the user that the key has been sufficiently depressed and the desired function has been activated. This is not available on current touch screen devices. Some devices may provide buttons over the touch screen device to provide a tactile feel however the buttons cover the touch screen, such as described in U.S. Patent 5,742, 894 assigned to Motorola Inc., the assignee of the present invention, and only act as an actuator, actuating the touch screen, therefore limiting the user to the functions indicated on the buttons.

Some devices incorporate an audible feedback tone alerting the user that the desired function has been activated and even further, other devices combine the audible feedback with the tactile feedback. Audible feedback alone however, may not be appropriate in all environments or user modes. For instance, audible keypad tones are not desired when the user is in a meeting yet desires to receive feedback when a key has been depressed. For example, a cellular radiotelephone having only audible feedback will not provide any feedback to the user if the audible feedback is turned off.

The use of additional keys also poses a problem as this requires more space within the device and cost reduction is almost always desired. Touch screen displays may add flexibility to the input output device however this

renders the device without tactile feedback to the user. The current methods are deficient in these areas by creating larger more complex devices that are less user friendly than predecessors. Touch screen displays without any feedback or audible feedback only limit the user's options and functionality to the user.

5 Therefore, there is a need to improve the means and method of providing data input and output capability for portable electronic devices.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of the wireless communication device in accordance with the preferred embodiment of the present invention;

10 FIG. 2 is a front view of the wireless communication device with the second housing portion in the closed position in accordance with the preferred embodiment of the present invention;

FIG. 3 is a front view of the wireless communication device with the second housing portion in the open position in accordance with the preferred
15 embodiment of the present invention;

FIG. 4 is a cross section view of one transparent key in a relaxed state in accordance with the preferred embodiment of the present invention;

FIG. 5 is a cross section view of one transparent key in a depressed state in accordance with the preferred embodiment of the present invention;

20 FIG. 6 is a cross section view of one transparent key in a relaxed state in accordance with an alternative embodiment of the present invention;

FIG. 7 is an exploded view of the wireless communication device in accordance with the preferred embodiment of the present invention;

25 FIG. 8 is a top view of the wireless communication device in accordance with the preferred embodiment of the present invention; and

FIG. 9 is FIG. 2 rotated 90° degrees showing the touch screen display in accordance with the preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

5 The present invention relates to a user interface and more particularly to the data entry portion of the user interface. The preferred embodiment of the present invention is a portable wireless communication device that combines a radiotelephone with personal information management capability. The user interface of the preferred embodiment of the present invention combines a touch screen display having a movable keypad incorporating transparent keys so that
10 the touch screen display is visible through the transparent keys. The keypad is movable from a closed position, which allows the user to use the device as a phone and more voice-centric activity, using the keypad to enter telephone numbers, to an open position where the keypad moves away from the touch screen display, thereby fully uncovering the touch screen display for data-centric oriented operation. In the open position, using the keys of the keypad in
15 conjunction with the soft keys of the touch screen display gives the user tactile feed back when entering data, yet allows the image of the soft key, which is displayed on the touch screen display, to be projected through the transparent keypad maintaining configurable soft key capability.

20 The block diagram in FIG. 1 shows a wireless communication device 100 in accordance with the preferred embodiment of the present invention. This device is a multifunctional wireless communication device incorporating the present invention. One function of the device is to operate as a radiotelephone in a cellular telephone system or the like. In the preferred embodiment a frame
25 generator ASIC 102, such as a CMOS ASIC available from Motorola, Inc. and a microprocessor 104, such as a 68HC11 microprocessor also available from Motorola, Inc., combine to generate the necessary communication protocol for operating in a cellular radiotelephone system. Microprocessor 104 uses memory 106 comprising RAM 108, EEPROM 110, and ROM 112, preferably consolidated
30 in one package 114, to execute the steps necessary to generate the protocol and to perform other functions for the wireless communication device, such as

accepting information from writing to a touch screen display 116, or controlling a frequency synthesizer 130, and receiving in a signal from a keypad sensor 136. ASIC 102 processes audio transformed by audio circuitry 124 from a microphone 122 and to a speaker 126.

5 A transceiver processes the radio frequency signals. In particular, a transmitter 128 transmits through an antenna 134 using carrier frequencies produced by a frequency synthesizer 130. Information received by the communication device's antenna 134 enters the receiver 132 that demodulates the symbols using the carrier frequencies from frequency synthesizer 130. The
10 communication device may optionally include a message receiver and storage device 131 including digital signal processing means. The message receiver and storage device could be, for example, a digital answering machine or a paging receiver.

 FIG. 2 shows the preferred embodiment of the present invention
15 comprised of a first housing portion 202 coupled to a second housing portion 204 by a double hinge 206. The second housing portion 204 has a fixed transparent member or a lens 212 adjacent to a keypad 208. The keypad 208 is comprised of a plurality of transparent keys 210 either connected together as one piece or as individual keys. The keypad 208 is disposed in the second housing portion such
20 that each transparent key 210 is accessible from both a front side 218 and a backside 302 of the second housing portion 204 as shown later. The plurality of transparent keys 210 of the preferred embodiment of the present invention, are arranged in a radiotelephone keypad array having keys operative to typical radiotelephone functions. These functions include dialing, entering personal
25 information data, web browsing and other similar functions. When the second housing portion 204 is in the second housing portion first position or closed position 200, the transparent keys 210 of the keypad 208 partially cover the touch screen display 214 which is mounted in the first housing portion 202. The exposed portion of the touch screen display 216 visible through the lens 212 of
30 the second housing portion displays information to the user and works in conjunction with the keypad 208 while the second housing portion is in the

closed position 200. While in the closed position, the sensor 136, either a magnetic reed switch as in the preferred embodiment, or by other detecting means is activated, signaling the microprocessor 104 that the second housing portion is in the closed position 200.

5 Turning to FIG. 3, the device is shown in the second housing portion second position or open position 300. In the open position 300, the touch screen display 214 is fully accessible to the user. The user can input data and view the touch screen display 214 directly and not through the transparent keys 210 or lens 212 of the second housing portion 202. This allows for the unlimited display and entry options as the touch screen display is configurable by software and can be programmed in accordance with the desired mode of operation. For example, the device may advantageously be used as a personal organizer having the capability to display a calendar, a to do list, personal contact information and other personal management data and the like. Even further, the device is intended to be used with internet browsing software that conform to such standards as the wireless application protocol (WAP) or iMode and the like to gain access to the internet in a wireless fashion. The device may also be used as a writing or drawing tablet wherein the touch screen display 214 is adapted for handwriting recognition or to receive drawing input respectively. The adaptability of a software definable touch screen display is only limited by microprocessor 104 capability and the amount of memory 106 necessary to store the given information, therefore allowing unlimited modes of operation.

15 FIG. 4 shows a cross section view of the first and second housing portions (202, 204), respectively, with the transparent key 210 in its relaxed, non-depressed state. The transparent keys 210 shown in combination with the touch screen display 214, advantageously give the user tactile feedback. Physically, the transparent keys 210 have a front side 402 and a back side 404. The front side 402 is accessible from the front side 218 of the second housing portion 204 and acts as a lens showing the image 310. This front side 402 may be a magnifying lens, magnifying the image 310 displayed on the touch screen display 214. The back side 404 of the transparent key 210 is accessible from the back side 302 of the

second housing portion 204. The back side 404 of the transparent key 210 has an actuator 408 protruding therefrom which makes contact with the touch screen display 214 when the transparent key 210 is depressed. Tactile feedback is provided in two ways. First the presence of a physical key as opposed to a soft key on a touch screen display 214, allows the user to advantageously locate and recognize the desired key through feel. The user does not need to look at the device to determine where the desired key is. In addition, when the transparent key 210 of the keypad 208 is depressed, tactile feedback is advantageously provided by the movement of the transparent key 210 as it is depressed toward the touch screen display 214.

FIG. 5 shows the same cross section as in FIG. 4 however the transparent key 210 is now in a depressed state. The transparent key 210 is integrally coupled to a webbed material 410 usually made of plastic, and elastomer, or PVC as in the preferred embodiment. The webbed material 410 generally forms the keypad 208, having a plurality of transparent keys 210 protruding therefrom. The webbed material 410 of the keypad 208 is located between the front side 402 and the back side 404 of the second housing portion 204. The front side 402 and the back side 404 of the transparent key 210, hold the keypad 208 in place by sandwiching the webbed material 410 therebetween. The transparent key 210 is accessible through the second housing portion 204 through an aperture in the front side 218 and the back side 302. The aperture in the backside 302 of the second housing portion 204 has a geometry larger than the transparent key 210 and the aperture in the front side 218, allowing the transparent button 210 to move downward towards the back side 318 when depressed. In the depressed state, the actuator 408 contacts a corresponding selectively active portion 304 of the touch screen display 214 closing the circuit and activating the desired function.

In an alternative embodiment of the present invention, shown in FIG. 6, the tactile feedback is provided by a poppel dome 612 of the poppel dome layer 610, mounted to the back side 404 of the second housing portion 204, placed in between the transparent keys 210 and the touch screen display 214. The actuator

408 contacts the poppel dome 612 when the transparent key 210 is depressed, and the poppel dome 612 in turn contacts the corresponding selectively active portion 304 of the touch screen display 214 thereby sending the desired input signal.

5 The tactile feedback is beneficial for three reasons. First, the tactile feel associated with the depression of the transparent key 210 beneficially compliments other feedback, such as an audible tone, the combination of which provide comprehensive feedback. Secondly, the tactile feedback advantageously allows the user to blindly enter data or dial the device as it allows the user to
10 locate the transparent keys 210 without looking at the device. Lastly, the tactile feedback is further advantageous as hearing impaired users will not here the audible feedback tone and must rely on the tactile feedback provided by the transparent key 210. Yet in other device modes where a writing or drawing tablet is necessary, the keypad 208 can be moved out of the way of the touch
15 screen allowing the user full access to the touch screen display to enter data accordingly. The key indicia or image of the preferred embodiment of the present invention, indicating the function of the transparent key 210, are provided by the touch screen display 214. Dynamic labeling, or software programability of the indicia, in conjunction with the tactile feel of the
20 transparent key 210, maintains both the soft key configurability and tactile feedback of the data entry device.

 The touch screen display 214, displays the appropriate indicia, visible through the transparent key 210 when the second housing portion 204 is in the closed position 200. Turning to FIG. 7, a first image 702 displayed by the touch
25 screen display 214 is projected through the corresponding transparent key 210 to the user 506, shown by path 504, indicating to the user 506 which function will be carried out when the transparent key 210 is depressed. In the preferred embodiment of the present invention when the device is operating in a cellular radiotelephone mode, the touch screen display 214 would display an array of
30 numbers corresponding in location to the array of transparent keys 210 of keypad 208 in a first touch screen display mode. In a second touch screen

display mode letters are displayed in the same manner as number, for the entry of words. In a third touch screen mode, a full text keyboard is displayed and the user may move the keypad 208 aside and enter the text directly via the full text keyboard. Each number or letter is displayed through its corresponding transparent key 210. This advantageously allows for a larger font to be used as the transparent key 210 is not displaying as much information at one time as an alphanumeric key would. This is beneficial as the transparent key 210 is easier to ready as a result of the larger font size. This is further beneficial as the transparent key is less cluttered with numerous indicia or images therefore reducing the complexity of the data entry device and the operation of the device in general.

The double hinge 206 has two joints, a first joint 306 coupling the second housing portion 204 to the hinge 206 and a second joint 308 coupling the hinge 206 to the first housing portion 202. This allows the second housing portion 204 to move freely about the first housing portion 202 as shown in FIG. 8, rotating from the closed position 200 wherein the keypad 208 mounted therein is planarly adjacent and effectively coupled thereto for interaction with the touch screen display 214 to an open position 300 wherein the keypad 208 is planarly adjacent to the back side of the first housing portion 202. In the second housing portion second position the second housing portion 204, and therefore the keypad 208, is out of the way of the user such that the touch screen display 214 can be used in any device orientation without the hindrance of the second housing portion 204. The free rotation capability of the second housing portion 204 allows the second housing portion to act as a stand, propping the device up into either a portrait configuration for speaker phone mode for one example or in a landscape orientation for viewing video or graphics of similar nature.

Depending on the operation mode of the device, the device will display the appropriate indicia on the touch screen display 214. The indicia that is displayed is projected through the transparent key 210 and the indicia is changed based on the mode of the device. In a first operation mode, a first icon is displayed, and the user can depress the transparent key 210, activating the touch

screen display 214 in the location corresponding to the first indicia which selects the first desired function. In a second operation mode the device software would display a second indicia representing a different function and the user would select the second desired function. For example, in cellular telephone operation mode, the software would display a numeric telephone keypad for dialing phone numbers. A second mode may be entering an individual's name when storing a phone number in the device's memory. In this case, as shown in FIG. 9, the software would display a full text alphabetic keyboard 902 or a QWERTY keyboard for easy entry of the name by the user.

The previous description of the preferred embodiments are provided to enable any person skilled in the art to use the method of or making data entry devices. It is understood that this description is by way of example only and that numerous changes and modifications can be made by those skilled in the art without departing from the true spirit and scope of the invention. For example, although the present method and apparatus is for a cellular radiotelephone, it may also apply to other types of portable electronic devices such as personal digital assistants, digital cameras and the like. Further, other means of employing a tactile feedback may also be incorporated. The display, displaying the image that is projected through the transparent key does not have to be a touch screen display. Other displays such as a LED display or an organo-emissive display or the like may be incorporated into the invention.

We claim:

CLAIMS

1. A data entry device comprising:

a first housing portion having electronic circuitry disposed therein;

a user interface mounted in said first housing portion and having at least one input portion, said input portion sending a signal to said electronic circuitry in response to user input;

an image displayed on said user interface wherein a location of said image on said user interface corresponds to said at least one input portion of said user interface; and

a tactile keypad coupled to said first housing portion and having at least one transparent tactile key, said at least one transparent tactile key transmitting said image displayed on said user interface to a user when said at least one transparent tactile key is aligned therewith, wherein said at least one transparent tactile key has a lens portion and an actuator portion,

wherein said actuator portion is adjacent to said user interface and makes contact with said at least one input portion of said user interface when said transparent tactile key is depressed, and

wherein said transparent tactile key provides a tactile feedback to said user when said at least one transparent tactile key is depressed.

2. The data entry device of claim 1 wherein said tactile keypad is coupled to said first housing portion by a hinge.

3. The data entry device of claim 1 wherein said user interface is a touch screen display.

4. The data entry device of claim 1 wherein said user interface is a plurality of switches.

5. The data entry device of claim 1 wherein said at least one image of said user interface is software definable.

6. The data entry device of claim 1 wherein said at least one image has a geometry substantially the same geometry as said at least one transparent tactile key of said tactile keypad.

10

7. A wireless communication device comprising:

a first housing portion having a front outer surface, and a back outer surface;
a touch screen display mounted in said first housing and accessible from said front outer surface thereof, said touch screen display having an output portion and an input portion to display user information and receive user input, respectfully,
wherein said output portion of said touch screen display is planarly adjacent to said input portion of said touch screen display, said input portion being transparent such that said display portion is clearly visible through said input portion, and wherein said input portion has at least one selectively active portion for receiving user input, and wherein said output display portion displays at least one image aligned with said selectively active portion;

15

a hinge coupled to said first housing portion, said hinge having a first axis;
a second housing portion having a first surface and a second surface, said second housing portion coupled to said first housing portion by said hinge wherein said second housing portion rotates about said first axis such that in a second housing portion first position, said second housing portion is planarly adjacent to said front outer surface and covers a portion of said touch screen display; and

20

25

a tactile keypad mounted in said second housing portion having at least one transparent key, said at least one transparent key having a front side and a back side,

5 wherein said at least one transparent key transmits said at least one image of said touch screen display to the user looking at said front side of said transparent key when said second housing portion is in said second housing portion first position,

10 wherein said at least one transparent key has an actuator portion protruding from said back side such that when said second housing portion is in said second housing portion first position said actuator is accessible from said second surface and is adjacent to said touch screen display such that when said at least one transparent key is depressed, said actuator activates said at least one selectively active portion of said touch screen display, activating a first desired function, and

15 wherein said at least one transparent key provides tactile feedback to the user when said at least one transparent key is depressed.

8. The wireless communication device of claim 7 wherein said at least one transparent key aligns with both said at least one selectively active portion of said input portion of said touch screen display and said at least one image of said output portion of said touch screen display in said second housing portion first position, such that said at least one image is visible to the user through said at least one transparent key.

9. The wireless communication device of claim 7 wherein said at least one image of said output portion is a software definable image.

10. The wireless communication device of claim 9 wherein said at least one software definable image has a geometry which is substantially the same geometry as a

corresponding said at least one transparent key such that said at least one software definable image is completely visible through said at least one transparent key when said second housing portion is in said second housing portion first position.

5 11. The wireless communication device of claim 7 wherein said hinge further comprises a second axis, wherein said second axis is substantially parallel to said first axis and wherein said first axis and said second axis are separated by a distance equal to half the distance separating said first surface of said first housing portion to said second surface of said housing portion and wherein said second housing
10 portion rotates about said first axis and said first housing portion rotates about said second axis allowing said second housing portion to rotate from said second housing portion first position to a second housing portion second position wherein said second housing portion is planarly adjacent to said back outer surface of said first housing portion.

15

12. The wireless communication device of claim 7 wherein said touch screen display in a first operation mode displays a plurality of soft keys arranged in a radiotelephone configuration.

20 13. The wireless communication device of claim 12 wherein said tactile keypad having a plurality of transparent keys aligns with said plurality of soft keys arranged in a radiotelephone configuration.

25 14. The wireless communication device of claim 7 wherein said touch screen display in a second operation mode displays a plurality of soft keys arranged as a full text keyboard, and wherein said touch screen display in a third operation mode operates as a handwriting recognition device.

15. The wireless communication device of claim 7 wherein said touch screen display displays a plurality of software definable images including icons, buttons, or text.
16. The wireless communication device of claim 7 wherein said touch screen display
5 in a fourth operation mode operates as a drawing tablet.
17. The wireless communication device of claim 7 wherein said touch screen display has an illumination means for backlighting said touch screen display.
- 10 18. The wireless communication device of claim 7 wherein said second housing portion in a second housing portion third position forms an angle between said first housing portion and said second housing portion between 90° degrees and 360° degrees.
- 15 19. The wireless communication device of claim 7 wherein said front side of said transparent key is a magnifying lens, magnifying said image of said touch screen display.
- 20 20. The wireless communication device of claim 7 wherein a transceiver is disposed in said first housing portion.

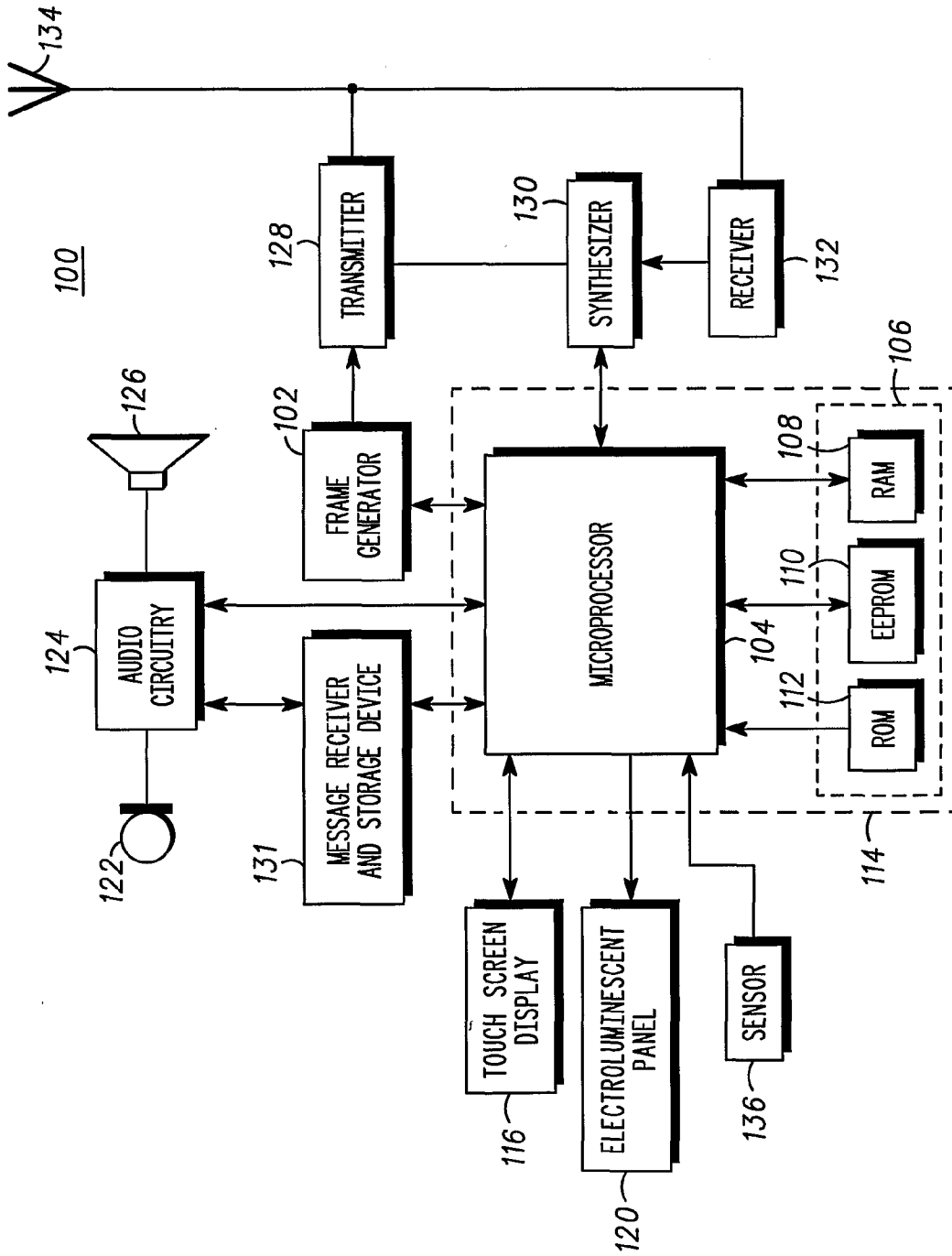


FIG. 1

200

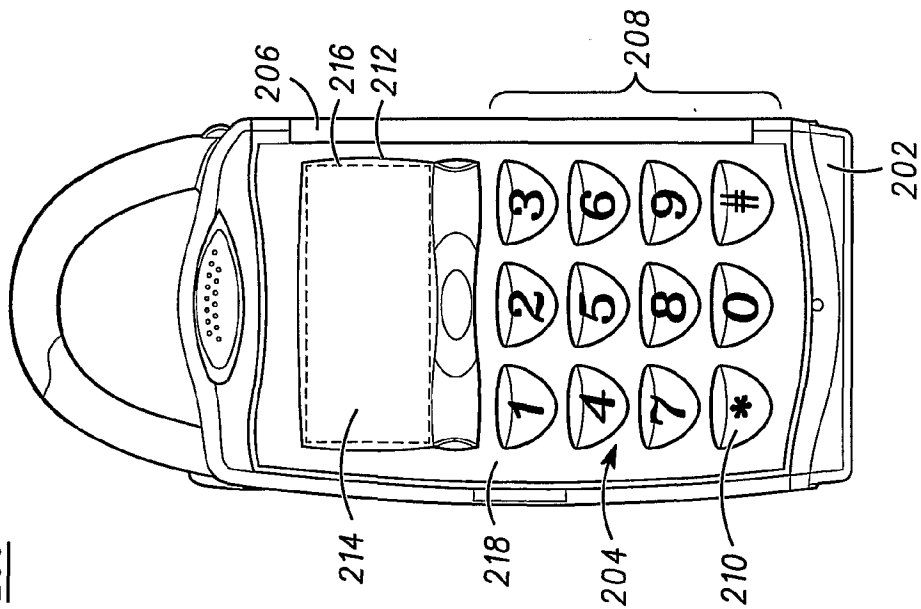


FIG. 2

300

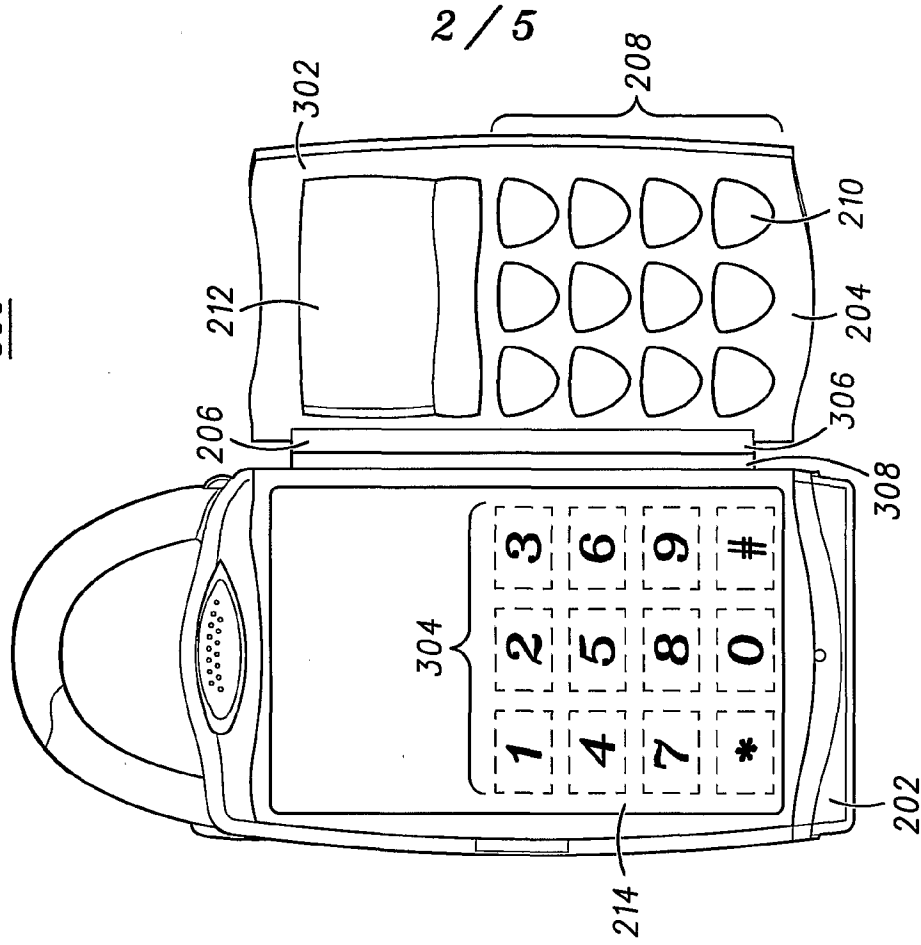


FIG. 3

3 / 5

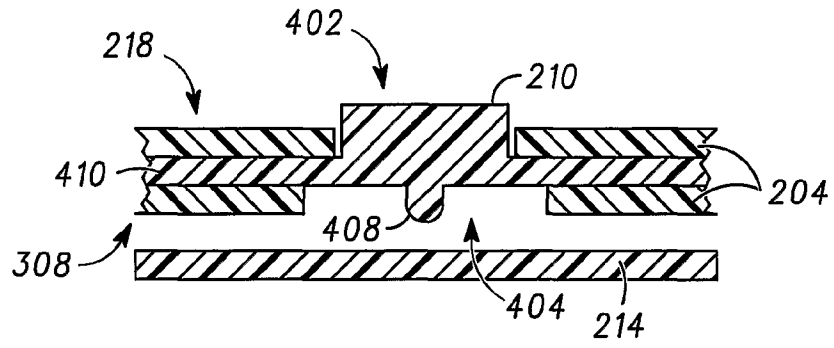


FIG. 4

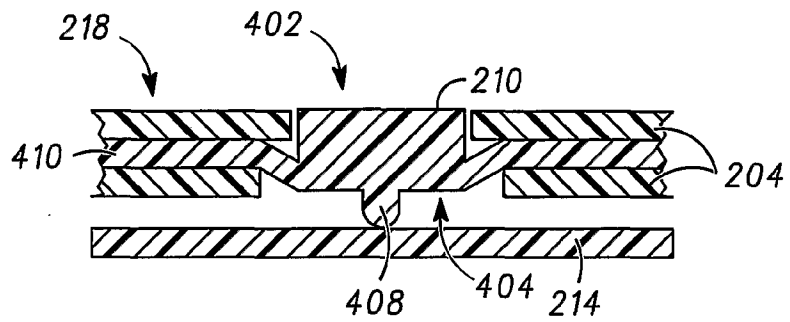


FIG. 5

FIG. 7

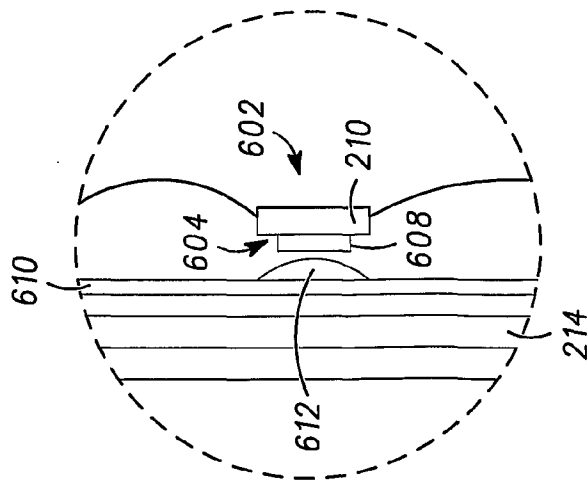
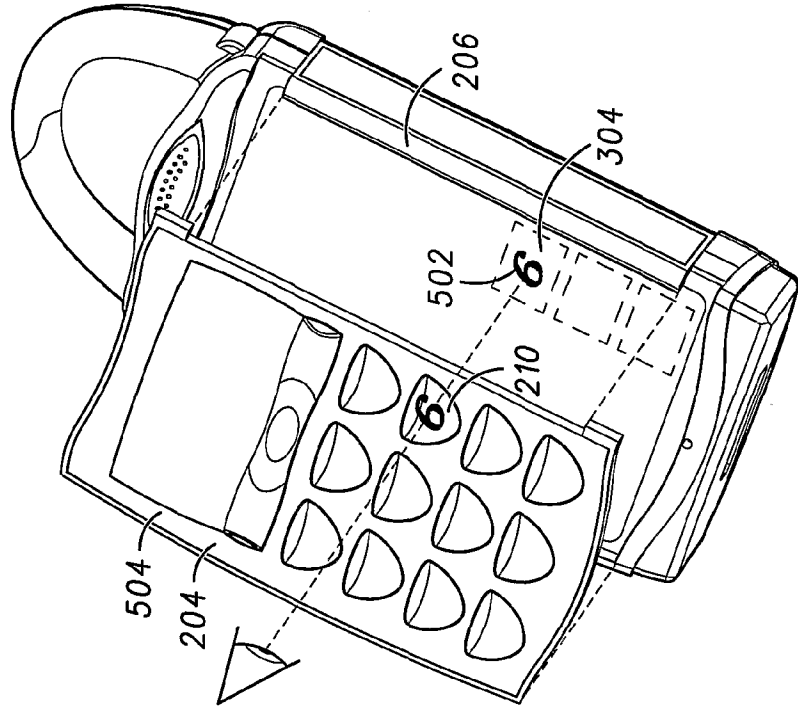


FIG. 6

5 / 5

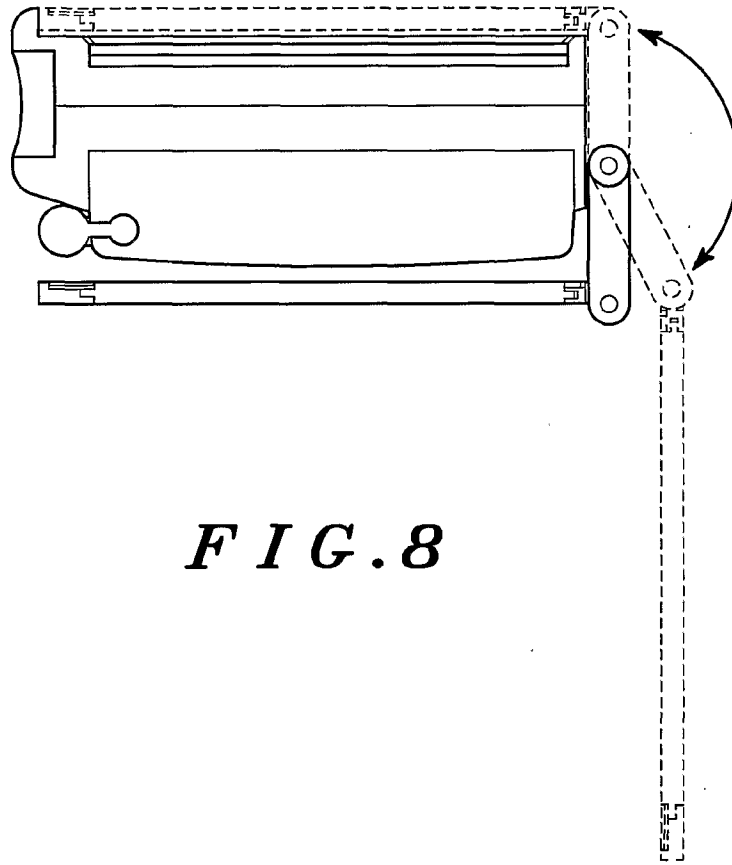


FIG. 8

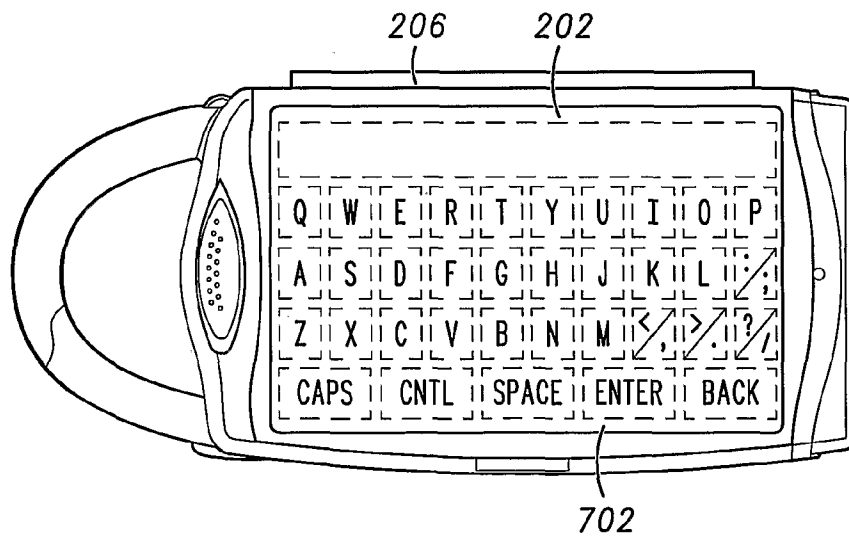


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/31077

A. CLASSIFICATION OF SUBJECT MATTER		
IPC(7) :G09G 5/08 US CL :345/173; 455/90,556,566 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) U.S. : 345/173; 455/90,556,566		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EAST		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,584,054 A (TYNESKY et al) 10 December 1996, col. 1, line 38-col. 2, line 65.	1-20
Y	US 6,130,665 A (ERICSSON) 10 October 2000, col. 4, lines 38-50.	1-20
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* Special categories of cited documents:	"I"	Later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"B" earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Q"	document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means		
"P" document published prior to the international filing date but later than the priority date claimed		
Date of the actual completion of the international search 24 JANUARY 2002	Date of mailing of the international search report 13 FEB 2002	
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer RICARDO OSORIO <i>Ricardo Osorio</i> Telephone No. (703) 305-2248	



Substitute for form 1449A/PTO <h2 style="margin: 0;">Information Disclosure Statement by Applicant</h2> <p style="margin: 0;"><i>(use as many sheets as necessary)</i></p>				Complete if Known		
				Application Number	11/693,117	
Sheet		1	of	9	Examiner Name	Unknown
					Attorney Docket Number	IMM147C1 (51851-342043)

U.S. PATENT DOCUMENTS						
Examiner	Cite No. ¹	Document Number		Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number	Kind Code ² (if known)			
	1	2,972,140		2/14/1961	Hirsch	
	2	3,157,853		11/17/1964	Hirsch	
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	31	4,821,030		4/11/1989	Tektronix, Inc.	
	32	4,823,106		4/16/1989	Tapeswitch Corporation of America	
	33	4,840,634		6/20/1989	Clayton Foundation for Research	
	34	4,885,565		12/8/1989	General Motors Corporation	

Examiner Signature	Date Considered
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¹ EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ Applicant's unique citation designation number (optional). ² Kinds of U.S. Patent Documents at www.uspto.gov or MPEP 901.04. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached.

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Substitute for form 1449A/PTO				Complete if Known	
Information Disclosure Statement by Applicant <i>(use as many sheets as necessary)</i>				Application Number	11/693,117
				Filing Date	March 29, 2007
				First Named Inventor	Martin et al.
				Group Art Unit	2817
				Examiner Name	Unknown
Sheet	2	of	9	Attorney Docket Number	IMM147C1 (51851-342043)

U.S. PATENT DOCUMENTS					
Examiner	Cite No. ¹	Document Number	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number Kind Code ² (if known)			
	35	4,891,764	1/2/1990	McIntosh	
	36	4,930,770	6/5/1990	Baker	
	37	4,934,694	6/19/1990	McIntosh	
	38	4,982,918	1/8/1991	British Aerospace Public Limited Company	
	39	4,983,786	1/8/1991	The University of British Columbia	
	40	5,019,761	5/28/1991	Kraft	
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	42	5,022,407	6/11/1991	Horch et al.	
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	66	5,390,128	2/14/1995	Cargill Detroit Corporation	
	67	5,390,296	2/14/1995	Comshare Incorporated	

Examiner Signature	Date Considered
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Substitute for form 1449A/PTO Information Disclosure Statement by Applicant (use as many sheets as necessary)				Complete if Known		
				Application Number	11/693,117	
Sheet		3	of	9	Attorney Docket Number	IMM147C1 (51851-342043)
		Filing Date	March 29, 2007			
		First Named Inventor	Martin et al.			
		Group Art Unit	2817			
		Examiner Name	Unknown			

U.S. PATENT DOCUMENTS						
Examiner	Cite No. ¹	Document Number		Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number	Kind Code ² (if known)			
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Information Disclosure Statement by Applicant (use as many sheets as necessary)				Filing Date	March 29, 2007
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				Group Art Unit	2817
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				Attorney Docket Number	IMM147C1 (51851-342043)
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		Country Code ²	Number ⁴	Kind Code ⁵ (if known)			
	135.	EP	0349086		1/3/1990	Stork Kwant B.V.	
	136.	JP	01-003664		7/19/1990	Taito Corporation	
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	Examiner Name	Unknown			
Sheet	6	of	9	Attorney Docket Number	IMM147C1 (51851-342043)

OTHER PRIOR ART -- NON PATENT LITERATURE DOCUMENTS			
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	Filing Date	March 29, 2007	
	First Named Inventor	Martin et al.	
	Group Art Unit	2817	
	Examiner Name	Unknown	
Sheet	7	of	9
	Attorney Docket Number	IMM147C1 (51851-342043)	

OTHER PRIOR ART -- NON PATENT LITERATURE DOCUMENTS			
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		Group Art Unit	2817
		Examiner Name	Unknown
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Examiner Signature	Date Considered
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¹ EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ Applicant's unique citation designation number (optional). ² Kinds of U.S. Patent Documents at www.uspto.gov or MPEP 901.04. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached.

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EFS ID:	2332401
Application Number:	11693117
International Application Number:	
Confirmation Number:	8743
Title of Invention:	Method and Apparatus for Providing Tactile Sensations
First Named Inventor/Applicant Name:	Kenneth M. Martin
Customer Number:	34300
Filer:	Christopher W. Bosken/Amber Johnson
Filer Authorized By:	Christopher W. Bosken
Attorney Docket Number:	IMM147.C1
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Application Type:	Utility under 35 USC 111(a)

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National Stage of an International Application under 35 U.S.C. 371
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of : Martin et al.
Application No. : 11/693,117
Filed : March 29, 2007
For : **Method and Apparatus for Providing Tactile Sensations**
Examiner : Unknown
Art Unit : 2817

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

TRANSMITTAL

Sir:

Transmitted herewith are copies of the following documents for filing in the above-identified application:

Information Disclosure Statement Letter
Form PTO/SB/08a
Non-Patent Literature Documents

The Commissioner is hereby authorized to charge any deficiency to Deposit Account Number 16-1435.

Respectfully submitted,

Date: 10/17/07
KILPATRICK STOCKTON LLP
1001 West Fourth Street
Winston-Salem, NC 27101-2400
(336) 607-7300

By: Christopher W. Bosken
Christopher W. Bosken (Reg. No. 58,887)

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I hereby certify that this correspondence is being electronically filed with The United States Patent Office via EFS-Web, on 10/17/07.

Amber C Johnson
Amber C. Johnson

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of : Kenneth M. Martin
Application No. : 11/693,117
For : **Methods and Apparatus for Providing Tactile Sensations**
Filed : March 29, 2007
Examiner : To Be Assigned
Art Unit : 2817

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

SUGGESTED RESTRICTION REQUIREMENT

UNDER 37 C.F.R. §§ 1.75(b) AND 1.142(c)

Sir:

Pursuant to 35 U.S.C. §§101 and 121, and 37 CFR 1.75(b) and 1.142(c) Applicants respectfully suggest that the above-identified application be subjected to the following restriction. This Suggested Restriction Requirement is being submitted before:

- 1) issuance of a First Office Action on the merits,
- 2) an Office Action that contains a Restriction Requirement under 35 U.S.C. §121, or
- 3) an Office Action that contains a requirement to comply with the requirement of unity of invention under PCT Rule 13.

I. Suggested Restriction Requirement

Applicants suggest a restriction requirement according to the following groups/species of claims:

Group I: Claims 1-25 directed to a method, system, and apparatus

Group II: Claims 26-43 directed to two apparatuses

Applicants believe the suggested restriction requirement is proper as the two groups of claims are directed to patently distinct inventive concepts, and the Examiner would be unduly burdened if required to examine both groups of claims on the merits.

II. Election

Should the Examiner agree to the groupings above, Applicants elect without traverse Group I directed to a method, system, and apparatus for prosecution on the merits.

Accordingly, Applicants kindly request that a restriction requirement be issued by the Examiner in accordance with the Suggested Restriction Requirement. Should the Examiner not agree with the above suggested restriction requirement, the Examiner is invited to contact the undersigned at the below phone number to suggest and/or issue an alternate restriction requirement.

Applicants believe that no fee is necessary; however, should a fee be deemed to be necessary, the Commissioner is hereby authorized to charge any fees required, or to credit any overpayment of fees, by this action or any future action, to Deposit Account No. 16-1435.

Date: _____

10/30/2007

Respectfully submitted,



Carl Sanders
Reg. No. 57,203

KILPATRICK STOCKTON LLP
1001 West Fourth Street
Winston-Salem, NC 27101
(336) 607-7474 (voice)
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of : Kenneth M. Martin
Application No. : 11/693,117
For : **Methods and Apparatus for Providing Tactile Sensations**
Filed : March 29, 2007
Examiner : To Be Assigned
Art Unit : 2817

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

PRELIMINARY AMENDMENT

Sir:

Please amend the above-identified application as follows.

Amendments to the Claims begin on page 2 of this paper.

Remarks begin on page 12 of this paper.

AMENDMENTS TO THE CLAIMS

1. (Currently Amended) A method, comprising:
outputting a display signal configured to display a graphical object on a touch-sensitive input device;
receiving a sensor signal from the touch-sensitive input device, the sensor signal indicating an object contacting the touch-sensitive input device;
determining an interaction between the object contacting the touch-sensitive input device and the graphical object; ~~and~~
generating an actuator signal based at least in part on the interaction; and
outputting the actuator signal.
2. (Original) The method of claim 1 wherein, the actuator signal is configured to cause a haptic effect to be output.
3. (Original) The method of claim 1, wherein the actuator signal is generated when the object contacts the touch-sensitive device at a location corresponding to the graphical object.
4. (Original) The method of claim 1, wherein the actuator signal is generated when the object contacts the touch-sensitive device at a location not corresponding to the graphical object.

5. (Original) The method of claim 1, wherein the display signal is configured to display a keypad comprising a plurality of softkeys.
6. (Original) The method of claim 5, wherein the haptic effect is caused to be output when a user contacts the touch-sensitive device at a location corresponding to a softkey in a home position.
7. (Original) The method of claim 5, wherein the plurality of softkeys comprises one softkey for each digit from 0 to 9.
8. (Original) The method of claim 5, wherein the plurality of softkeys comprises the key configuration of a standard 101-key keyboard.
9. (Original) The method of claim 1, wherein the graphical object comprises a first graphical object and a second graphical object, the haptic effect comprises a first haptic effect and a second haptic effect, and wherein the first haptic effect is configured to be output when the object contacts the first graphical object, and the second haptic effect is configured to be output when the object contacts the second graphical object.
10. (Original) A system, comprising:
 - a touch sensitive input device configured to output a sensor signal indicating an object contacting the touch-sensitive input device;

an actuator coupled to the touch-sensitive input device, the actuator configured to receive an actuator signal and output a haptic effect to the touch-sensitive surface based at least in part on the actuator signal; and

a processor in communication with the sensor and the actuator, the processor configured to:

output a display signal configured to display a graphical object on the touch-sensitive input device;

receive the sensor signal from the touch-sensitive input device;

determine an interaction between the object contacting the touch-sensitive surface and the graphical object,

generate the actuator signal based at least in part on the interaction; and

transmit the actuator signal to the actuator.

11. (Original) The system of claim 10, wherein the processor is configured to generate the actuator signal when the object contacts the touch-sensitive input device at a location corresponding to the graphical object.

12. (Original) The system of claim 10, wherein the processor is configured to output the actuator signal when the object contacts the touch-sensitive device at a location not corresponding to the graphical object.

13. (Original) The system of claim 10, wherein the display signal is configured to display a keypad comprising a plurality of softkeys.

14. (Original) The system of claim 13, wherein the haptic effect is caused to be output when a user contacts the touch-sensitive device at a location corresponding to a softkey in a home position.
15. (Original) The method of claim 13, wherein the plurality of softkeys comprises one softkey for each digit from 0 to 9.
16. (Original) The method of claim 13, wherein the plurality of softkeys comprises the key configuration of a standard 101-key keyboard.
17. (Original) The method of claim 10, wherein the graphical object comprises a first graphical object and a second graphical object, the haptic effect comprises a first haptic effect and a second haptic effect, and wherein the first haptic effect is configured to be output when the object contacts the first graphical object, and the second haptic effect is configured to be output when the object contacts the second graphical object.
18. (Currently Amended) A computer-readable medium comprising program code, comprising:
- program code for outputting a display signal configured to display a graphical object on a touch-sensitive input device;
 - program code for receiving a sensor signal from the touch-sensitive input device, the sensor signal indicating an object contacting the touch-sensitive input device;
 - program code for determining an interaction between the object contacting the touch-sensitive input device and the graphical object; and

program code for generating an actuator signal based at least in part on the interaction, the actuator signal configured to cause a haptic effect to be output; and
program code for outputting the actuator signal.

19. (Original) The computer-readable medium of claim 18, wherein the actuator signal is generated when the object contacts the touch-sensitive device at a location corresponding to the graphical object.

20. (Original) The computer-readable medium of claim 18, wherein the actuator signal is generated when the object contacts the touch-sensitive device at a location not corresponding to the graphical object.

21. (Original) The computer-readable medium of claim 18, wherein the display signal is configured to display a keypad comprising a plurality of softkeys.

22. (Original) The computer-readable medium of claim 21, wherein the haptic effect is caused to be output when a user contacts the touch-sensitive device at a location corresponding to a softkey in a home position.

23. (Original) The computer-readable medium of claim 21, wherein the plurality of softkeys comprises one softkey for each digit from 0 to 9.

24. (Original) The computer-readable medium of claim 21, wherein the plurality of softkeys comprises the key configuration of a standard 101-key keyboard.

25. (Original) The computer-readable medium of claim 1, wherein the graphical object comprises a first graphical object and a second graphical object, the haptic effect comprises a first haptic effect and a second haptic effect, and wherein the first haptic effect is configured to be output when the object contacts the first graphical object, and the second haptic effect is configured to be output when the object contacts the second graphical object.

26. (New) An apparatus comprising:

at least one input device comprising a first position and a second position, the input device moveable to the first position upon application of a first pressure to the input device, and moveable to the second position upon application of a second pressure to the input device, the second pressure greater than the first pressure;

at least one actuator in communication with the input device, the actuator configured to output tactile sensations to the apparatus; and

at least one processor in communication with the input device, the processor configured to:

receive a first input signal from the input device, the first input signal associated with the first position,

receive a second input signal from the input device, the second input signal associated with the second position,

transmit a first actuator signal to the actuator, the first actuator signal configured to cause the actuator to output a first tactile sensation associated with the first position, and

transmit a second actuator signal to the actuator, the second actuator signal configured to cause the actuator to output a second tactile sensation associated with the second position.

27. (New) The apparatus of claim 26, wherein the input device comprises at least one of an analog switch, a force sensing resistor, a strain gauge based sensor, a capacitive touch switch, or a touchpad.

28. (New) The apparatus of claim 26, wherein the at least one input device comprises a plurality of input devices, and the at least one actuator comprising a plurality of actuators, each actuator coupled to a distinct input device.

29. (New) The apparatus of claim 26, wherein the actuator comprises at least one of a piezo-electric actuator, a voice coil, a moving magnet actuator, or a flexure coupled to a motor.

30. (New) The apparatus of claim 26, wherein the input device comprises a pressure-sensitive touchpad, and the apparatus further comprises:

a display panel in communication with the pressure-sensitive touchpad, the display panel configured to receive the tactile sensations from the pressure-sensitive touchpad; and

at least one software-generated button configured to be displayed on the display panel.

31. (New) The apparatus of claim 30, wherein the touchpad comprises a pressure calculator to measure the distinct amount of pressure.
32. (New) The apparatus of claim 30, further comprising:
an interface object configured to be used to contact a location on the display panel corresponding to the at least one software-generated button; and
a pressure calculator to calculate an amount of pressure based upon an amount of area of the interface object in contact with the display panel.
33. (New) The apparatus of claim 32, wherein the interface object comprises a stylus.
34. (New) The apparatus of claim 26, the apparatus comprising at least one of a mobile telephone, a personal computer, or a hand-held computing device.
35. (New) An apparatus comprising:
an input device configured to communicate an input signal indicating a position of the input device to an electronic device, the input device configured to move between multiple positions;
at least one actuator in communication with the input device, the actuator configured to output a plurality of tactile sensations to the input device; and
at least one processor in communication with the input device and the actuator, the processor configured to:
receive the input signal,
detect the position of the input device,

to generate an actuator signal configured to cause the actuator to output one of the plurality of tactile sensations based at least on the position of the input device.

36. (New) The apparatus of claim 35, wherein the actuator is configured to vary the magnitude of the produced tactile sensation in accordance with the detected position of the input device.

37. (New) The apparatus of claim 35, the input device associated with the selection of at least one function of the apparatus, and the actuator further produces a function failure notification tactile sensation upon receipt of the input signal associated with the function and notification of failure of that function.

38. (New) The apparatus of claim 35, further comprising a plurality of input devices, each input device capable of communicating a unique input signal to the electronic device and moving between multiple positions.

39. (New) A mobile phone comprising the apparatus of claim 38.

40. (New) The mobile phone of claim 39, comprising a keypad comprising the plurality of input devices.

41. (New) The mobile phone of claim 39, wherein the at least one actuator comprising a plurality of actuators, each actuator coupled to a separate input device.

42. (New) The mobile phone of claim 39, comprising a plurality of keys associated, each of the plurality of keys configured to activate a predetermined mobile phone function, and wherein the actuator is configured to produce the tactile sensation associated with each mobile phone function upon receipt of the associated input signal.

43. (New) The mobile phone of claim 42, wherein the actuator is configured to produce a function failure notification tactile sensation upon receipt of a function input signal and a notification of failure of that function.

REMARKS

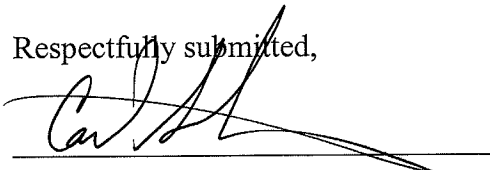
Applicant has amended claims 1 and 18, and added claims 26-43. No new matter is added by these amendments, and support for the amendments may be found in the specification and claims as originally filed.

CONCLUSION

Applicant respectfully asserts that all pending claims are allowable and Applicant respectfully requests the allowance of all claims.

Should the Examiner have any comments, questions, or suggestions of a nature necessary to expedite the prosecution of the application, or to place the case in condition for allowance, the Examiner is courteously requested to telephone the undersigned at the number listed below.

Date: 10/30/2007

Respectfully submitted,


Carl Sanders
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KILPATRICK STOCKTON LLP
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Electronic Patent Application Fee Transmittal

Application Number:	11693117
Filing Date:	29-Mar-2007
Title of Invention:	Method and Apparatus for Providing Tactile Sensations
First Named Inventor/Applicant Name:	Kenneth M. Martin
Filer:	Carl Sanders/Sue Memory
Attorney Docket Number:	IMM147.C1

Filed as Large Entity

Utility Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Claims in excess of 20	1202	18	50	900
Independent claims in excess of 3	1201	2	210	420

Miscellaneous-Filing:

Petition:

Patent-Appeals-and-Interference:

Post-Allowance-and-Post-Issuance:

APPLE INC.

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1320

Electronic Acknowledgement Receipt

EFS ID:	2396864
Application Number:	11693117
International Application Number:	
Confirmation Number:	8743
Title of Invention:	Method and Apparatus for Providing Tactile Sensations
First Named Inventor/Applicant Name:	Kenneth M. Martin
Customer Number:	34300
Filer:	Carl Sanders/Sue Memory
Filer Authorized By:	Carl Sanders
Attorney Docket Number:	IMM147.C1
Receipt Date:	30-OCT-2007
Filing Date:	29-MAR-2007
Time Stamp:	17:51:51
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment was successfully received in RAM	\$ 1320
RAM confirmation Number	4045
Deposit Account	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)
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1	Miscellaneous Incoming Letter	IMMTrans.pdf	42824 c68615a71e1ec91d3bdd8278717fca63d959c8a3	no	1
Warnings:					
Information:					
2	Suggested Restriction Requirement	IMMSRR.pdf	74654 91fc42bec631361166b34d1194289ec9302aecdd1	no	2
Warnings:					
Information:					
3	Preliminary Amendment	IMMPA.pdf	364374 1798e6ad0358cd9325e8c166d72699c856cfe22c	no	12
Warnings:					
Information:					
4	Fee Worksheet (PTO-06)	fee-info.pdf	8278 23ea09e1bb7793fb171ef65a526ac8ba7201174c	no	2
Warnings:					
Information:					
Total Files Size (in bytes):			490130		
<p>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</p> <p><u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</p>					

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of : Kenneth M. Martin
 Application No. : 11/693,117
 Filed : March 29, 2007
 For : METHOD AND APPARATUS FOR PROVIDING
 TACTILE SENSATION
 Examiner : To be Assigned
 Art Unit : 2817

Commissioner for Patents
 P.O. Box 1450
 Alexandria, VA 22313-1450

TRANSMITTAL

Sir:

Transmitted herewith is a copy of the following document for filing in the above-identified application:

Preliminary Amendment; and
 Suggested Restriction Requirement Under 37 C.F.R. §§ 1.75(b) and 1.142(c)

Shown below are the fees for the presentation of the amended claims:

	Claims Remaining	Highest # Previously Paid For	Extra	Rate	Fee
TOTAL	43	25	18	\$50	\$ 900
Ind. Cls.	5	3	2	\$210	\$ 420
Multiple Dependent Claim Added.....					NO
TOTAL					\$1,320

The Commissioner is hereby authorized to charge any deficiency to Deposit Account Number 16-1435.


Respectfully submitted,

By: 
 Carl Sanders (Reg. No. 57,203)

Date: 10/30/2007
 KILPATRICK STOCKTON LLP
 1001 West Fourth Street
 Winston-Salem, NC 27101-2400
 Telephone: (336) 607-7474
 Fax: (336) 734-2629

Certificate of Electronic Filing

I hereby certify that this correspondence is being electronically filed with The United States Patent Office via EFS-Web, on October 30, 2007.


 Sue H. Memory

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 11/693,117	Filing Date 03/29/2007	<input type="checkbox"/> To be Mailed
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APPLICATION AS FILED – PART I			OTHER THAN SMALL ENTITY			
	(Column 1)	(Column 2)	SMALL ENTITY <input type="checkbox"/>	OR		
FOR	NUMBER FILED	NUMBER EXTRA	RATE (\$)	FEE (\$)	RATE (\$)	FEE (\$)
<input type="checkbox"/> BASIC FEE <small>(37 CFR 1.16(a), (b), or (c))</small>	N/A	N/A	N/A		N/A	
<input type="checkbox"/> SEARCH FEE <small>(37 CFR 1.16(k), (l), or (m))</small>	N/A	N/A	N/A		N/A	
<input type="checkbox"/> EXAMINATION FEE <small>(37 CFR 1.16(o), (p), or (q))</small>	N/A	N/A	N/A		N/A	
TOTAL CLAIMS <small>(37 CFR 1.16(i))</small>	minus 20 =	*	X \$ =		OR	X \$ =
INDEPENDENT CLAIMS <small>(37 CFR 1.16(h))</small>	minus 3 =	*	X \$ =		OR	X \$ =
<input type="checkbox"/> APPLICATION SIZE FEE <small>(37 CFR 1.16(s))</small>	If the specification and drawings exceed 100 sheets of paper, the application size fee due 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).					
<input type="checkbox"/> MULTIPLE DEPENDENT CLAIM PRESENT <small>(37 CFR 1.16(j))</small>						
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL		TOTAL	

APPLICATION AS AMENDED – PART II					OTHER THAN SMALL ENTITY			
	(Column 1)	(Column 2)	(Column 3)		SMALL ENTITY	OR		
AMENDMENT	10/30/2007	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	RATE (\$)	ADDITIONAL FEE (\$)
	Total <small>(37 CFR 1.16(i))</small>	* 43	Minus	** 25 = 18	X \$ =		OR	X \$50= 900
	Independent <small>(37 CFR 1.16(h))</small>	* 5	Minus	***3 = 2	X \$ =		OR	X \$210= 420
	<input type="checkbox"/> Application Size Fee <small>(37 CFR 1.16(s))</small>						OR	
	<input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <small>(37 CFR 1.16(j))</small>						OR	
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE 1320

APPLICATION AS AMENDED – PART II					OTHER THAN SMALL ENTITY			
	(Column 1)	(Column 2)	(Column 3)		SMALL ENTITY	OR		
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	RATE (\$)	ADDITIONAL FEE (\$)
	Total <small>(37 CFR 1.16(i))</small>	*	Minus	** =	X \$ =		OR	X \$ =
	Independent <small>(37 CFR 1.16(h))</small>	*	Minus	*** =	X \$ =		OR	X \$ =
	<input type="checkbox"/> Application Size Fee <small>(37 CFR 1.16(s))</small>						OR	
	<input type="checkbox"/> FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <small>(37 CFR 1.16(j))</small>						OR	
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
 ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
 *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
 The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
 /CAROL BARNES/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

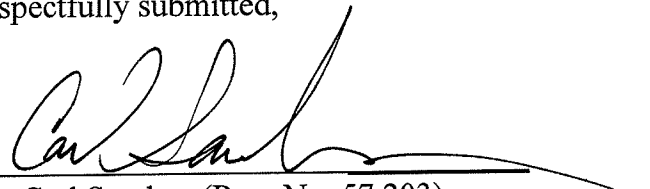
In re Application of : Martin et al.
Serial No. : 11/693,117
For : **Method and Apparatus for Providing
Tactile Sensations**
Filed : March 29, 2007
Examiner : Unassigned
Art Group : 2817

Information Disclosure Statement Letter

This Information Disclosure Statement is being submitted prior to the mailing date of a first Office Action in this application. Accordingly, no fee is believed to be required. However, should any fees be due, the Commissioner is authorized to charge such fees to Deposit Account No. 16-1435.

Respectfully submitted,

Date: 7/23/2008


Carl Sanders (Reg. No. 57,203)

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Substitute for form 1449A/PTO			Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT			Application Number	11/693,117
			Filing Date	March 29, 2007
			First Named Inventor	Martin et al.
			Art Unit	2817
			Examiner Name	Unknown
			Attorney Docket Number	IMM147C1
Sheet	1	of	2	
<i>(Use as many sheets as necessary)</i>				

U.S. PATENT DOCUMENTS

Examiner Initials *	Cite No. ¹	Document Number	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number - Kind Code ² (if known)			
	1.	US- 4,362,408	12/7/1982	Cordes et al.	
	2.	US- 6,292,173	9/18/2001	Rambaldi et al.	
	3.	US- 6,344,791	2/5/2002	Armstrong	
	4.	US- 6,369,803	4/9/2002	Brisebois et al.	
	5.	US- 6,597,347	7/22/2003	Yasutake	
	6.	US- 6,657,617	12/2/2003	Paolini et al.	
	7.	US- 6,781,569	8/24/2004	Gregorio et al.	
	8.	US- 6,801,191	10/5/2004	Mukai et al.	
	9.	US- 6,976,562	12/20/2005	Perret et al.	
	10.	US- 2002/0171621	11/21/2002	Johnson	
	11.	US- 2005/0099393	5/12/2005	Johnson	
		US-			
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		US-			

FOREIGN PATENT DOCUMENTS

Examiner Initials *	Cite No. ¹	Foreign Patent Document	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T ⁶
		Country Code ³ - Number ⁴ - Kind Code ⁵ (if known)				
	12.	JP 11-085400	3/30/1999	Sony Corp		
	13.	JP 8221173	8/30/1996	Taima Shinobu		
	14.	JP 10171586	6/26/1998	Hosokawa Mikio		
	15.	JP 1124834	1/29/1999	Fujiyama Teruki		
	16.	JP 2001-222379	8/17/2001	Fujitsu Ltd.		
	17.	JP 2001-265485	9/28/2001	Suganuma Toshio		
	18.	JP 2001-290572	10/19/2001	Fuji Xerox Co. Ltd.		
	19.	JP 2001-296950	10/26/2001	Fuji Xerox Co. Ltd.		
	20.	JP 2002-528831	9/3/2002	unknown		
	21.	WO 99/49443	09-30-1999	Immersion Corp.		
	22.	WO 01/54109	07-26-2001	Immersion Corp.		
	23.	EP 0 817 110	01-07-1998	Nokia Mobile Phones Ltd.		
	24.	GB 2 180 342	03-25-1987	Alcom Limited		

Examiner Signature	Date Considered
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Substitute for form 1449B/PTO		Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT		<i>Application Number</i>	11/693,117
		<i>Filing Date</i>	March 29, 2007
		<i>First Named Inventor</i>	Martin et al.
		<i>Art Unit</i>	2817
		<i>Examiner Name</i>	Unknown
		<i>Attorney Docket Number</i>	IMM147C1
Sheet	2	of	2
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NON PATENT LITERATURE DOCUMENTS			
Examiner Initials *	Cite No. ¹	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
	25.	U.S. Office of China Sinda Intellectual Property Ltd., Notification of First Office Action, Chinese Application No. 02821854.X, mailed September 5, 2007.	
	26.	Japanese Patent Office, Response to Notice of Reasons for Rejection for January 29, 2008, Japanese Patent Application No. 2003-540973, mailed February 20, 2008.	
	27.	Japanese Patent Office, Notice of Reasons for Rejection of September 11, 2007, Japanese Patent Application No. 2003-540973, mailed September 26, 2007.	
	28.	United States Patent and Trademark Office, Office Action, Application No. 10/285,450, mailed December 23, 2005.	
	29.	United States Patent and Trademark Office, Office Action, Application No. 10/285,450, mailed May 18, 2006.	
	30.	United States Patent and Trademark Office, Office Action, Application No. 10/285,450, mailed November 15, 2006.	
	31.	United States Patent and Trademark Office, Office Action, Application No. 10/285,450, mailed June 1, 2007.	
	32.	European Patent Office, Supplemental Search Report, European Application No. 02773960.6, mailed July 1, 2008.	

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¹ Applicant's unique citation designation number (optional). ² Applicant is to place a check mark here if English language Translation is attached.

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(11) EP 0 817 110 A2

(12) EUROPEAN PATENT APPLICATION

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(84) Designated Contracting States:
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- Lekkala, Jukka
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- Poramo, Risto
 33500 Tampere (FI)

(30) Priority 28.06.1996 FI 962692

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 • Terho, Mikko
 33820 Tampere (FI)

(54) Terminal device with touch screen

(57) The scope of the present invention is touch sensitive display construction (50) in connection of which touch sensitive element (20, 40) is used. In touch sensitive display construction (50) according to the invention touch sensitive element (20, 40) has been placed

in a protected space under display (12, 101). When display (12, 101) is touched, the force is transferred to touch sensitive film (20, 40) through display (12, 101). For the detection of touching preferably e.g. EMF- (Electro Mechanical Film) film (20, 40, 106) is used and as a display e.g. a LCD-display

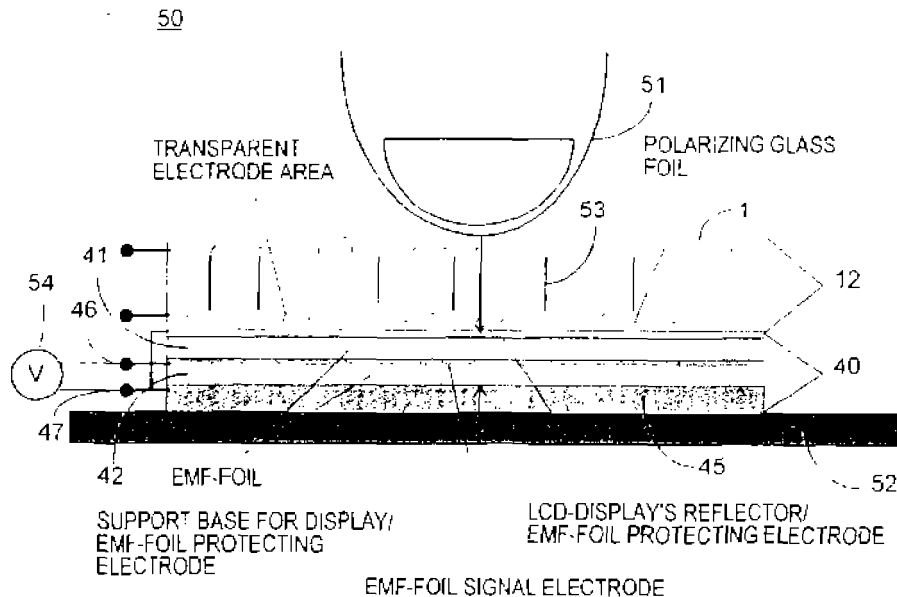


Fig. 5

a LCD display of "twisted nematic" type.

figure 2 presents the structure of a touch sensitive EMF- (Electro Mechanical Film) film

Figure 3 presents a charge amplifier used for amplifying the impulse generated by an EMF film

figure 4 presents an alternative structure of an EMF film and distribution of charges inside the film.

figure 5 presents a touch screen according to the invention and its components,

figure 6 presents an exemplary realization used at testing of the touch screen according to the invention,

figures 7A and 7B present test results of the touch screen according to the invention

figures 8A and 8B present ways of realizing electrodes applicable for use in a touch screen according to the invention,

figures 9A and 9B present processing of impulses received from the electrodes of an EMF film and detection of a touch, and

figures 10A to 10E present applying of the touch screen according to the invention to a terminal device

In the following the invention is described in detail using as an example one preferable embodiment of the touch screen, in which a LCD display is used as the display and an EMF film is used as the touch sensitive element.

Figure 1 presents a cross section of the most commonly used liquid crystal display 12 of the so-called "twisted nematic" type. Liquid crystal display 12 consists of transparent electrodes 3, liquid crystal layer 5 containing liquid crystal molecules 15 and polarization filters 1 and 9. Closest to the user of the display (topmost in the figure) is polarization filter 1, which is on top of the glass plate 2 protecting liquid crystal layer 5. Electrodes 3 (the patterns seen in the display) are arranged under glass plate 2 using a conductive, transparent layer (e.g. indiumtinoxide, ITO). So-called orientation layer 4 has been integrated on the surface of electrode 3. Liquid crystal molecules 15 in liquid crystal layer 5 touching it are oriented and in this way orient the molecules in whole liquid crystal layer 5 (the layer between orientation layers 4 and 6 containing liquid crystal molecules 15) in a desired way. On the other side of liquid crystal layer 5 there is orientation layer 6, and as next transparent electrode 7, alike electrode 3. The next layer is protective glass layer 8, in the bottom surface of which po-

larization filter 9 is arranged. The polarization axis of polarization filter 9 is essentially parallel to the polarization axis of polarization filter 1. On the other side of polarization filter 9 there is reflector 10, which in the figure reflects light upward

An electric field controlling the display is arranged by connecting an electric field using voltage supply 13 and switch 11, between display elements, or electrodes 3 and electrode 7, arranged in desired pattern. The function of a liquid crystal display is based upon the phenomenon that when there is no electric field in the display, light passes through layers 1 to 9 and is reflected back from reflector 10. In this case the background of the display seems light. When control voltage 13 is connected between electrodes 3 and 7, the electric field generated by it turns liquid crystal molecules 15 in medium 5 in such a way that light polarized in polarization filters 1 and 9 cannot pass through the structure but is absorbed in the structure. In this case the background next to electrode 3 seems black. Different grades of darkness can be obtained by regulating the level of the control voltage. This is the description of the function of a monochrome display, but there is nothing to limit using the invention in connection with color displays and displays of other types.

Figure 2 presents the structure of EMF (Electro Mechanical Film) 20. EMF film 20 is a bi-axially oriented plastic film 24, in which micro-bubbles 23 have been formed in manufacturing stage. One method of manufacturing EMF-film is to add on purpose impurities into plastic 24 in manufacturing stage, which cause small cracks (microbubbles 23) in plastic 24 when the film is stretched. The bi-axial orientation of microbubbles 23 has been achieved by stretching the plastic film during production in both breadth- and longitudinal directions, causing the microbubbles 23 to become flat and oval. Typically microbubble 23 is approximately 100 μm in diameter and approximately 0,5 μm in thickness.

In manufacturing plastic film 24 has been made an electret by creating through corona discharge inside plastic film 24 a permanent charge of e.g. approximately 1 mC/m^2 . In corona discharge, due to a very strong electric field, air is ionized and free charges are trapped in potential pits born in the boundary surfaces of microbubbles 23 and plastic 24. On both sides of EMF-film 20 there are thin, either vapour-deposited or laminated metal film electrodes 21, 22. The structure and manufacturing method of EMF-film 20 are described in patent publication US 4.654 546. A force or pressure directed at EMF-film 20 initiates a change of internal charge distribution, which is seen as a corresponding change of mirror charge distribution on electrodes 21 and 22.

A change in mirror charge distribution can be measured using several methods. One of the methods is to measure the voltage between electrodes 21 and 22. The internal resistance of an EMF-film is in the order of giga- or teraohms, and accordingly, in order to achieve good measurement results the input impedance of the meas-

time and removal time in milliseconds and the values on the vertical axis present the relative voltages from electrodes A1 to A4. It has been proved by the measurements that touching surface 1 of display 12 is transferred through display 12 to EMF-film 20 40

The sensitivity of a typical EMF-film is approximately 27 pC/N but the values vary depending on the structure of the film and on manufacturing process. In the touch sensitive display construction 50 according to the invention the coupling used for detecting a touch is capacitive, meaning that dual EMF-film 40 reacts to changes of forces directed at the film, not to an even pressing force or pressure. It is exactly like this that also single EMF-film 20 operates. Detection based upon the change of force preferably makes possible collecting of versatile information from changes of potential differences measured between electrode (figures 4 and 5) outputs 46 and 47

Because a potential difference is proportional to the force directed at EMF-film 40, it is possible to realize touch sensitive display construction 50, in which pressing LCD-display 12 using a different force initiates a different function. This feature according to the invention can be utilized e.g. in a situation in which it is wanted to acknowledge that information supplied by touching LCD-display 12 has been input correctly. In this case by pressing LCD-display 12 strongly at a chosen point, or if so desired, at any point, a certain input acknowledgment function is executed. A stronger pressing of LCD-display 12 is detected e.g. by using a multi-level detector. Equally, a multi-level level detector can be used in devices of different types to eliminate too big forces directed at a LCD-display. In this case damage to LCD-display 12 can preferably be avoided by generating a warning signal when the signal detected from EMF-film 20, 40 exceeds a certain, predetermined limit value.

Detection according to the invention based upon detection of change of force directed at touch sensitive display construction 50, is very fast and accurate and it operates as well while pressing the display with a finger as when removing the finger from the display surface. Thus the duration of a press is easy to define. Each of the 12 sections of LCD-display 12 of touch sensitive display construction 50 can thus be allocated several functions, dependent on the duration of a press. The ability to indicate pressing and lifting of finger, and the locations at which they occur, makes it possible to realize also the "drag and drop" function prior known from computers. In the "drag and drop" function e.g. the user of a computer presses a mouse button with his finger and keeps it down, causing the pointer to capture the display element at which the pointer was at the moment. After this the user can drag the element he selected to a desired point and release it by lifting his finger from the mouse button. According to the same principle the touch sensitive display structure 50 according to the invention makes it possible to move effortlessly text

strings or graphics figures in LCD-display 12 by just moving a finger or a special pointing device on the surface of LCD-display 12

Figures 8A and 8B present two different ways of creating patterns on conducting film 21 22, 44 on the surface of EMF-film 20 40. If the information handled with the display does not require high resolution, which is the case if only a few separate graphic icons for selecting certain functions are generated in the display it is preferable to arrange for each area intended to be pressed individual electrodes 80 to 80'''' as presented in figure 8A. In this case there is an individual signal amplifier for each area, e.g. a charge amplifier according to figure 3. In this case each press is corresponded by individual signal S1 to S6. If high resolution is required it is useful to detect touching of touch sensitive display construction 50 using a matrix, through using of which the number of signals Y1 to Y4 and X1 to X5 can preferably be reduced, as each area to be indicated does not require an electrode of its own. In this embodiment presented in figure 8B single EMF-film 20 is used. The electrodes corresponding to horizontal rows Y1 to Y4 have been patterned in top surface 21 of this film 20. Respectively, the electrodes corresponding to vertical columns X1 to X5 have been patterned in the bottom surface 22 of film 20. One amplifier 30 is reserved for each electrode Y1 to Y4 and X1 to X5 and one terminal of each of the nine amplifiers is connected to the same potential, e.g. the negative terminal of amplifier 30 to ground potential. A contact point is detected from horizontal signals Y1 to Y4 and vertical signals X1 to X5 by comparing them with the ground potential. For example, when EMF-film 20 is pressed at point X1/Y4, a change of charges is caused between the ground potential and electrodes Y4 and X1. The change of charges initiates a change of logic status of electrodes Y4 and X1, and processor 97 detects a press at point Y4/X1. In the matrix method a higher intelligence is required of the logics used, but on the other hand savings are achieved in the amount of amplifiers 30 and electrodes Y1 to Y4 and X1 to X5.

Regardless of whether in touch sensitive display construction 50 according to the invention individual signals S1 to S4 are used for electrodes 80 to 80'''' of EMF-film 20 according to figure 8A, or the matrix solution according to figure 8B, the signals obtained from electrodes 80 to 80'''' Y1 to Y4 and X1 to X5 are amplified in preamplifiers 91A and 91B and preamplification stage 91C (figures 9A and 9B). It is possible to realize each preamplifier using e.g. the charge amplifier connection presented in figure 3. If there is individual signal S1 to S6 for each electrode simple level detectors 92A and 92B can preferably be used for detection. Level detectors 92A and 92B compare the signal levels received from preamplifiers 91A and 91B with a predetermined limit value and give an indication by outputting logic "0" or "1", depending on whether the predetermined limit value was exceeded or not. If necessary, also multi-level

ples should be regarded as illustrating, not as limiting. Thus the possibilities of realizing and using the invention are limited only by enclosed patent claims. Thus the various embodiments of the invention defined by the claims, including equivalent embodiments, are included in the scope of the invention

Claims

1. Terminal device (100, 110), which comprises a touch screen (101) for displaying information and for inputting information to the terminal device (100, 110), which touch screen (101) comprises arranged one after another, a display unit (12) and force sensitive means (20, 40, 106) for detecting a touch based on force, the force sensitive means (20, 40, 106) have been arranged behind the display unit (12) seen from the side of touching surface (1), and the display unit (12) has been arranged to transfer force to the force sensitive means (20, 40, 106). **characterized** in that the display unit (12) has been arranged to form the touching surface (1) of the touch screen (101) for receiving the touch
2. Terminal device (100, 110) according to claim 1, **characterized** in that it is a mobile terminal
3. Terminal device (100, 110) according to claim 1, **characterized** in that the display unit (12) is a LCD-display (12)
4. Terminal device (100, 110) according to claim 1, **characterized** in that the force sensitive means (20, 40, 106) is an EMF- (Electro Mechanical Film) film.
5. Terminal device (100, 110) according to claim 1 or 4, **characterized** in that metal film electrodes (21, 22, 80-80'') having separate conducting wires (S1-S6) have been arranged on top of the force sensitive means (20, 40, 106) to indicate the touch and the location of the touch (1).
6. Terminal device (100, 110) according to claim 1 or 4, **characterized** in that parallel, oblong first metal film electrodes (21, Y1, Y2, Y3, Y4) having conducting wires (Y1, Y2, Y3, Y4) have been arranged on top of a first surface (21) of the force sensitive means (20, 40, 106), parallel, oblong second metal film electrodes (22, X1, X2, X3, X4, X5) having conducting wires (Y1, Y2, Y3, Y4) have been arranged on top of a second surface (22) of said force sensitive means (20, 40, 106), the first metal film electrodes (21, Y1, Y2, Y3, Y4) and the second metal film electrodes (22, X1, X2, X3, X4, X5) are essentially in perpendicular position towards each other, and that the first metal film electrodes (21, Y1, Y2,

Y3, Y4) and the second metal film electrodes (22, X1, X2, X3, X4, X5) form a matrix structure to indicate the touch and the location of the touch (1).

7. Terminal device (100, 110) according to claim 1, **characterized** in that the force sensitive means (20, 40, 106) have been arranged behind the keys (102, 103), marked in the cover (105) of the terminal device (100, 110), for detecting pressing of the keys (102, 103) based upon force, through the cover (105) and that the force sensitive means (20, 40, 106) have been placed in one of the following parts of the terminal device (100, 110), the inner surface of the cover (105) and the cover (105)
8. Touch screen (101) for displaying information and for inputting information, which comprises arranged one after another, a display unit (12) and force sensitive means (20, 40, 106) for detecting a touch based on force, the force sensitive means (20, 40, 106) have been arranged behind the display unit (12) seen from the side of touching surface (1), and the display unit (12) has been arranged to transfer force to the force sensitive means (20, 40, 106) **characterized** in that the display unit (12) has been arranged to form the touching surface (1) of the touch screen (101) to receive the touch.
9. Method of detecting a touch and the location of the touch in connection with a terminal device (100, 110) having a touch screen (101), in which
 - the touch and the location of the touch (1) is detected by touch sensitive means (20, 40, 106) located behind the display unit (12) of the touch screen (101),
 - said display unit (12) is transferring force to the touch sensitive means (20, 40, 106),**characterized** in that
 - the surface (1) of the display unit (12) receives the touch of the user of the terminal device (100, 110)

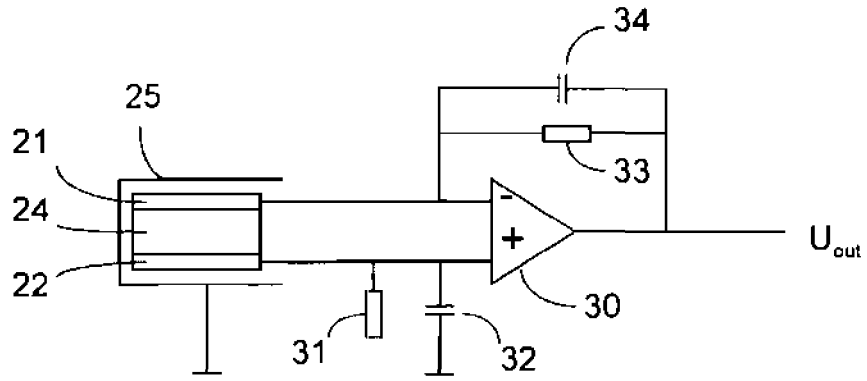


Fig. 3

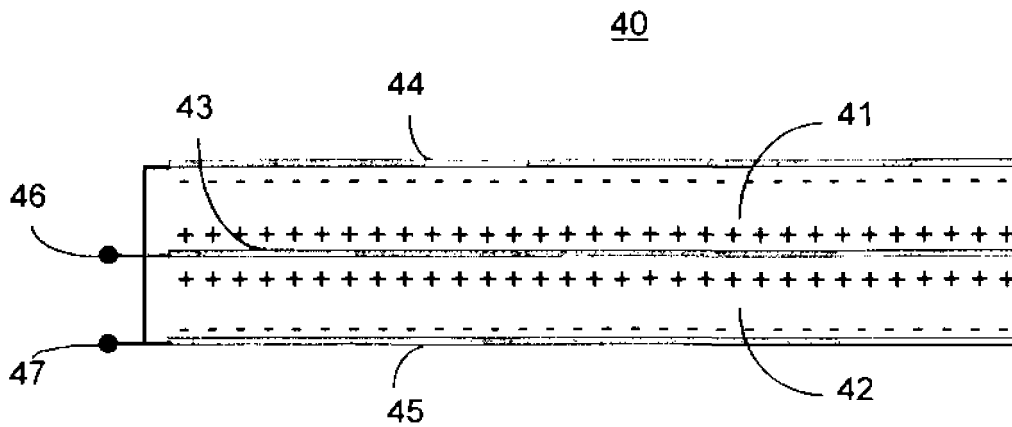


Fig. 4