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122706

PTO/SB/16 (07-06)

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET – Page 1 of 2

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

Express Mail Label No. EV 517 992 961 US

INVENTOR(S)		
Given Name (first and middle (if any))	Family Name or Surname	Residence (City and either State or Foreign Country)
Michael D.	Levin	Los Altos, CA

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

TITLE OF THE INVENTION (500 characters max):

VIRTUAL DETENTS THROUGH VIBROTACTILE FEEDBACK

113264 U.S. PTO
60/877833
122706

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

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ENCLOSED APPLICATION PARTS (check all that apply)

☐ Application Data Sheet. See 37 CFR 1.76 ☐ CD(s), Number of CDs _____

☒ Drawing(s) Number of Sheets 4 ☐ Other (specify) _____

☒ Specification (e.g. description of the invention) Number of Pages 10

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METHOD OF PAYMENT OF THE FILING FEE AND APPLICATION SIZE FEE FOR THIS PROVISIONAL APPLICATION FOR PATENT

☐ Applicant claims small entity status. See 37 CFR 1.27. 200.00

☐ A check or money order is enclosed to cover the filing fee and application size fee (if applicable).

☒ Payment by credit card. Form PTO-2038 is attached **TOTAL FEE AMOUNT (\$)**

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Valve Exhibit 1005
Valve v. Immersion

PROVISIONAL APPLICATION COVER SHEET

Page 2 of 2

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SIGNATURE

Christopher W. Bosken

Date December 27, 2006

TYPED or PRINTED NAME Christopher W. Bosken

REGISTRATION NO. 58,887
(if appropriate)

TELEPHONE (336) 607-7366

Docket Number: 51851/338712

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Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

**FEE TRANSMITTAL
for FY 2005**☐ Applicant claims small entity status. See 37 CFR 1.27**TOTAL AMOUNT OF PAYMENT** (\$) 200.00**Complete if Known**

Application Number	To Be Assigned
Filing Date	Herewith
First Named Inventor	Michael D. Levin
Examiner Name	To Be Assigned
Art Unit	To Be Assigned
Attorney Docket No.	IMM253P (51851/338712)

METHOD OF PAYMENT (check all that apply)

☐ Check ☒ Credit Card ☐ Money Order ☐ None ☐ Other (please identify) : _____

☒ Deposit Account Deposit Account Number: 16-1435 Deposit Account Name: _____

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FEE CALCULATION**1. BASIC FILING, SEARCH, AND EXAMINATION FEES**

Application Type	FILING FEES		SEARCH FEES		EXAMINATION FEES		Fees Paid (\$)
	Fee (\$)	Small Entity Fee (\$)	Fee (\$)	Small Entity Fee (\$)	Fee (\$)	Small Entity Fee (\$)	
Utility	300	150	500	250	200	100	_____
Design	200	100	100	50	130	65	_____
Plant	200	100	300	150	160	80	_____
Reissue	300	150	500	250	600	300	_____
Provisional	200	100	0	0	0	0	_____

2. EXCESS CLAIM FEES**Fee Description**

Each claim over 20 (including Reissues)

Each independent claim over 3 (including Reissues)

Multiple dependent claims

Total Claims**Extra Claims****Fee (\$)****Fee Paid (\$)**

_____ -20 or HP= _____ x _____ = _____

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims**Extra Claims****Fee (\$)****Fee Paid (\$)**

_____ - 3 or HP= _____ x _____ = _____

HP = highest number of independent claims paid for, if greater than 3.

Small Entity**Fee (\$)****Fee (\$)**

50 25

200 100

360 180

Multiple Dependent Claims**Fee (\$)****Fee Paid (\$)****3. APPLICATION SIZE FEE**

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), 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).

Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof	Fee (\$)	Fee Paid (\$)
10	- 100 = _____	/ 50 = _____ (round up to a whole number) x _____	_____	_____

4. OTHER FEE(S)

Non-English Specification, \$130 fee (no small entity discount)

Other (e.g., late filing surcharge) : _____

Fees Paid (\$)**SUBMITTED BY**

Signature	<i>Christopher W. Bosken</i>	Registration No. (Attorney/Agent)	58,887	Telephone	(336) 607-7366
Name (Print/Type)	Christopher W. Bosken	Date	December 27, 2006		

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EXPRESS MAIL CERTIFICATE

"Express Mail" label number: EV 517 992 961 US

Date of Deposit: December 27, 2006

Type of Document(s): Provisional Patent Application Cover Sheet;
Fee Transmittal (*in duplicate*);
Specification (10 pages);
Drawings (4 sheets);
Credit Card Payment Form (PTO-2038)
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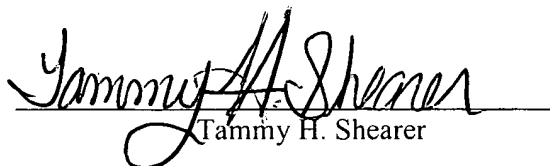
Serial No.: Unassigned

Date Filed: Herewith

Applicant: Michael D. Levin

Title: Virtual Detents Through Vibrotactile Feedback

I hereby certify that the documents identified above are being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and are addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.


Tammy H. Shearer

VIRTUAL DETENTS THROUGH VIBROTACTILE FEEDBACK

FIELD OF THE INVENTION

[001] The present invention relates generally to input devices that provide haptic feedback. The present invention more particularly relates to systems and methods for virtual detents through vibrotactile feedback method.

BACKGROUND

[002] Traditional mechanical device controls include switches, knobs, levels and the like. In the past, such controls have been essentially mechanical in nature, e.g., a knob turning a shaft coupled to a potentiometer to control an electrical input to a device such as a radio or audio amplifier, a knob turning a shaft coupled to a fan control or heating/air conditioning control in an automobile, a lever controlling the opening and closing of a vent in an automobile, etc.

[003] With many traditionally mechanical functions being replaced by electronics, operation of electronic controls has been made less intuitive to users. For example, without click-stops or “detents,” or otherwise a sense of mechanical resistance, it may be difficult to obtain a similar experience from an electronic substitute for a traditional mechanical control device or even effectively and efficiently operate such a device.

[004] Accordingly, what is needed is a cost-effective device and method to provide effective haptic effects to an input device.

SUMMARY OF INVENTION

[005] Embodiments of the present invention provide systems and methods for virtual detents through vibrotactile feedback.

[006] In one embodiment, an actuator is controlled to produce a vibrotactile feedback effect in synchronization with sensed motion on an input. The vibrotactile feedback is perceived by the user to be similar to the feel of a mechanical detent. In another embodiment, a plurality of actuators are controlled to produce vibrotactile feedback effects.

[007] Some embodiments of the invention may be used in products that utilize input devices without mechanical feedback. An illustrative application would be to simulate rotary or linear encoders and potentiometers or faders. This could be a cost effective way to eliminate the precision mechanical detent components required in some applications. Such embodiments can also provide enhanced functionality over mechanically produced detents.

[008] The vibrotactile feedback provided by such an embodiment can aid a user in selection of menus, level control (i.e. volume, speed, or strength), tone control (i.e. bass, treble, hue, balance, or fade), frequency control, climate control, and navigation of lists. The vibrotactile feedback may be synchronized with changes in a system, such as an audio system.

DETAILED DESCRIPTION

An Illustrative Device for Providing Virtual Detents Through Vibrotactile Feedback

[009] One embodiment of the present invention simulates mechanical detents through vibrotactile feedback. Figure 1 is a top plan view of a rotary input control device of such an

embodiment. The device 100 in Figure 1 is a media device which includes a body 102 having a graphical user interface display 104 as well as an input device 106.

[0010] In the embodiment shown, the input device 106 is a knob capable of being rotated clockwise or counterclockwise. In other embodiments, the input device 106 may have various designs, including, but not limited, to conical shapes, spherical shapes, oval shapes, dials, cubical shapes, rods, etc. In other embodiments, the input device may have one or more textures on its circumferential surface, including but not limited to, bumps, lines, grooves, or other grips, or even projections or members extending from the circumferential surface. Such shapes and textures may allow a user to easily grip or contact the input device 106 and rotate it a desired amount. Alternatively, the input device 106 may be a vertical or horizontal slider, or a touchpad.

[0011] In the embodiment shown, as a user rotates the input device 106, vibrotactile feedback in the form of virtual mechanical detents are provided to the knob. For example, as a user rotates the knob to adjust the volume, virtual mechanical indents are provided to the knob. As a further example, once the volume is at a maximum or minimum level, no virtual mechanical detents may be provided, indicating to the user that a threshold level has been reached.

Illustrative Examples of Virtual Detent Profiles

[0012] A simulated mechanical detent, or virtual detent, may be a hard stop perceived by a user as the user manipulates an input device. The perception of a virtual detent might be a jolt or bump. The virtual detent may be closer to a hard stop, serving to provide a strong resistance to further manipulation of the input device, or the virtual detent may be a soft stop that provides some resistance to the user which may be overcome by applying enough force on the input device.

[0013] Figures 2A, 2B, 2C, 2D, 2E, 2F, 2G, and 2H each illustrate examples of a detent profile in one or more embodiments. In Figures 2A-2H, the input device 106 is shown as a knob on the right along with a representation of the vibrotactile feedback profile corresponding to the input device 106 shown on the left. It should be noted that the following vibrotactile feedback profiles are merely examples and that the input device 106 may be configured to output other vibrotactile feedback profiles not specifically described. It should be noted that the input device 106 may output a combination of two or more of the vibrotactile effect profiles based on the application.

[0014] Figure 2A depicts a virtual detent effect haptic profile in accordance with one embodiment. As shown in Figure 2A, virtual detents A-E may emulate the feel and function of mechanical detents.

[0015] Figure 2B depicts a hard stop haptic effect profile in accordance with one embodiment. Virtual hard stops may be used to emulate the feel and function of mechanical hard stops, and may be selectively output by the input device 106 based on the application of the input device 106.

[0016] Figure 2C depicts a hill effect haptic profile in accordance with one embodiment. A hill is a plateau style of wide detent. A hill effect could be used for menu wrap-around features as well as informing the user that he or she has moved from a last menu item to a first menu item. The hill effect may also be used to indicate a return from a sub-menu back to the main menu or to signal the crossing of a boundary.

[0017] Figure 2D depicts a compound effect haptic profile in accordance with one embodiment. A compound effect includes two or more effects such as barriers and detents. Compound effects help designers to closely match tactile sensations to operational steps, which may enhance usability. For the example shown in Figure 2D, the compound effect,

which would be appropriate for Fade Control on a car stereo, may include small detents (shown as “A” and “C”) with a deeper center detent (shown as “B”) and barriers on each end.

[0018] Figure 2E depicts a spring effect haptic profile in accordance with one embodiment. The spring effect force profile provides a good return-to-default position like that used for shuttle control to regulate speed. In the embodiment shown in Figure 2E, the input device 106 has a virtual spring at position A. It should be noted, however, that the input device 106 may have virtual springs in various positions on the input device 106. As the input device 106 is sensed being rotated toward position A in Figure 2E, a gradual resistive force is applied to input device 106. As the movement of the input device 106 approaches position A, the resistive force applied the input device 106 will approach infinity such that the user is no longer able to move the input device 106. If the user releases the input device 106 the input device 106 may spring back to its default position C.

[0019] Figure 2F depicts a damper effect force profile in accordance with one embodiment. A damper effect is a force that increases or decreases with controller speed. Damper effects create the sensation of drag or weight and may be used to emulate the feel of high-quality controls such as those found on expensive audio equipment. A damper effect might also emulate a jog control used to move through music tracks, menu items, video frames, or data stacks. The damping force may be used to slow the input device 106 down or provide feedback to the user that the input device 106 is near the end selection on a menu list.

[0020] Figure 2G depicts a constant force effect profile in accordance with an embodiment. A constant force effect is a continuous force independent of the instantaneous position of the input device 106. In other words, the force applied by the actuator does not necessarily change as the input device 106 is rotated toward or away from a certain position, such as spring force or damping effects. The constant force profile may be used by the device to simulate dynamics such as gravity, friction, or momentum.

[0021] Figure 2H depicts a periodic force effect profile in accordance with one embodiment. A periodic force effect is a vibration lasting for a set period of time, whereby the vibration has a sine, square, or triangular wave characteristic. In one embodiment, the wave characteristics of the vibration are randomly generated.

An Illustrative Diagram for Providing Virtual Detents Through Vibrotactile Feedback

[0022] Figure 3 is a block diagram of one embodiment of the invention. A virtual detent system according to the embodiment shown in Figure 1 comprises an input device 302, at least one actuator 304, a processor 306, and at least one system to be manipulated 308 (shown as systems 308a, 308b, and 308c).

[0023] In the embodiment shown, the processor 306 is in communication with the input device 302, the at least one system to be manipulated 308, and the at least one actuator 304. The processor 306 may be configured to receive an input signal from the input device 302, transmit a system signal to a system to be manipulated 308, and transmit an actuator signal to the actuator 304. In one embodiment, the system signal may be based at least in part on the input signal. In a further embodiment, the actuator signal may be based at least in part on the input signal. In one embodiment, the system signal and/or the actuator signal may be transmitted in response to the input signal.

The Processor

[0024] The processor comprises a computer-readable medium, such as a random access memory (RAM) coupled to the processor. The processor executes computer-executable program instructions stored in memory, such as executing one or more computer programs for generating haptic effects. Such processors may comprise a microprocessor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), field programmable

gate arrays (FPGAs), and state machines. Such processors may further comprise programmable electronic devices such as PLCs, programmable interrupt controllers (PICs), programmable logic devices (PLDs), programmable read-only memories (PROMs), electronically programmable read-only memories (EPROMs or EEPROMs), or other similar devices.

[0025] Such processors may comprise, or may be in communication with, media, for example computer-readable media, that may store instructions that, when executed by the processor, can cause the processor to perform the steps described herein as carried out, or assisted, by a processor. Embodiments of computer-readable media may comprise, but are not limited to, 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 media comprise, 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, such as a router, private or public network, or other transmission device or channel. The processor, and the processing, described may be in one or more structures, and may be dispersed through one or more structures. The processor may comprise code for carrying out one or more of the methods (or parts of methods) described herein.

The System to be Manipulated

[0026] A virtual detent system according to the present invention may be configured to manipulate a variety of systems. For example, a user might want to adjust the volume of a stereo system, change the channel of a television, or select an item in a menu. Further

examples of changes to a system may include changes in a display, menu selection, climate control, radio or television tuning, control of an electromechanical system, or changes to the volume, speed, strength, frequency, or tone.

The Input Device

[0027] An input device suitable for use in various embodiments of the present invention may comprise a mechanical or non-mechanical device. For example, an input device may be any of a number of mechanical devices such as a potentiometer, a rotary optical encoder, or a linear optical encoder. The input device may also be non-mechanical, such as a touchpad, touch screen, or non-contact sensor.

The Actuator

[0028] In one embodiment, an input device may be coupled to an actuator. In other embodiments, an input device may be coupled to a plurality of actuators. The at least one actuator may be configured to provide a haptic effect to the input device. The at least one actuator may be, for example, an eccentric rotating mass motor (ERM) or a linear resonant actuator (LRA). The at least one actuator may be configured to produce a vibrotactile feedback effect in synchronization with sensed motion on an input.

[0029] The vibrotactile feedback may be programmed to only respond when a valid input is received. For example, vibrotactile feedback in the form of mechanical detents may only occur when the control is enabled and within a valid range. If the controlled function is at a minimum or maximum and the user wishes to exceed this value, the vibrotactile feedback may be disabled, providing valuable information to the user that they are no longer operating in a valid range. Similarly, if the input control is not active or the device is not powered on, the absence of feedback may notify the user of this state. In other embodiments, the vibrotactile feedback responds when invalid input is received.

[0030] The frequency and strength of the simulated detents may also be varied to inform the user of differing levels of control. For example, strength can represent the level of the menu structure (big decision versus small decisions) or amplitude of the function (i.e. volume). High and low strength tactile feedback can be combined to show divisions in a list (i.e. separate names by letter, or numbers at every multiple of 10) or highlighted points in a range (i.e. center position in a balance control). Frequency can represent the speed of navigation, or number of elements in a list.

An Illustrative Method for Providing Virtual Detents Through Vibrotactile Feedback

[0031] Another embodiment of the present invention can be seen in Figure 4. In the first step, an input signal motion is received 402. As an example, an input signal may be generated when a user rotates a knob in order to navigate a menu structure. In one embodiment, an input device may send an input signal to a processor indicating motion on the input device.

[0032] A sensor may provide information regarding aspects of the user's manipulation of an input device, such as torque applied to a knob, rotary position obtained by a knob, time at which an input device is manipulated, velocity of a knob rotation, and acceleration of a knob rotation.

[0033] Next, it is determined whether a user desires to manipulate a system function or parameter 404. For example, the processor may receive an input and determine that a user wants to decrease the volume of an audio system.

[0034] If the user wants to manipulate a system function or parameter, a system signal and an actuator signal may be output 406. In one embodiment, the processor outputs a system signal and an actuator signal.

[0035] Operation of the actuator and manipulation of a system may occur substantially simultaneously. For example, the processor may send a signal to the actuator and to a system to be manipulated at substantially the same time. In particular, the processor may send a signal to an audio system to increase the volume, while substantially simultaneously sending a signal to the actuator, causing the actuator to simulate a vibrotactile detent.

[0036] In a further example, the operation of the actuator may be synchronized with changes in a display. In particular, a user may desire to change levels in a menu. When the processor determines the user wants to navigate the menu system, the processor updates the menu display and simultaneously pulses the actuator to simulate a mechanical detent.

General

[0037] The foregoing description of the embodiments, including preferred embodiments, of the invention has been presented only for the purpose of illustration and description and is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Numerous modifications and adaptations thereof will be apparent to those skilled in the art without departing from the spirit and scope of the this invention.

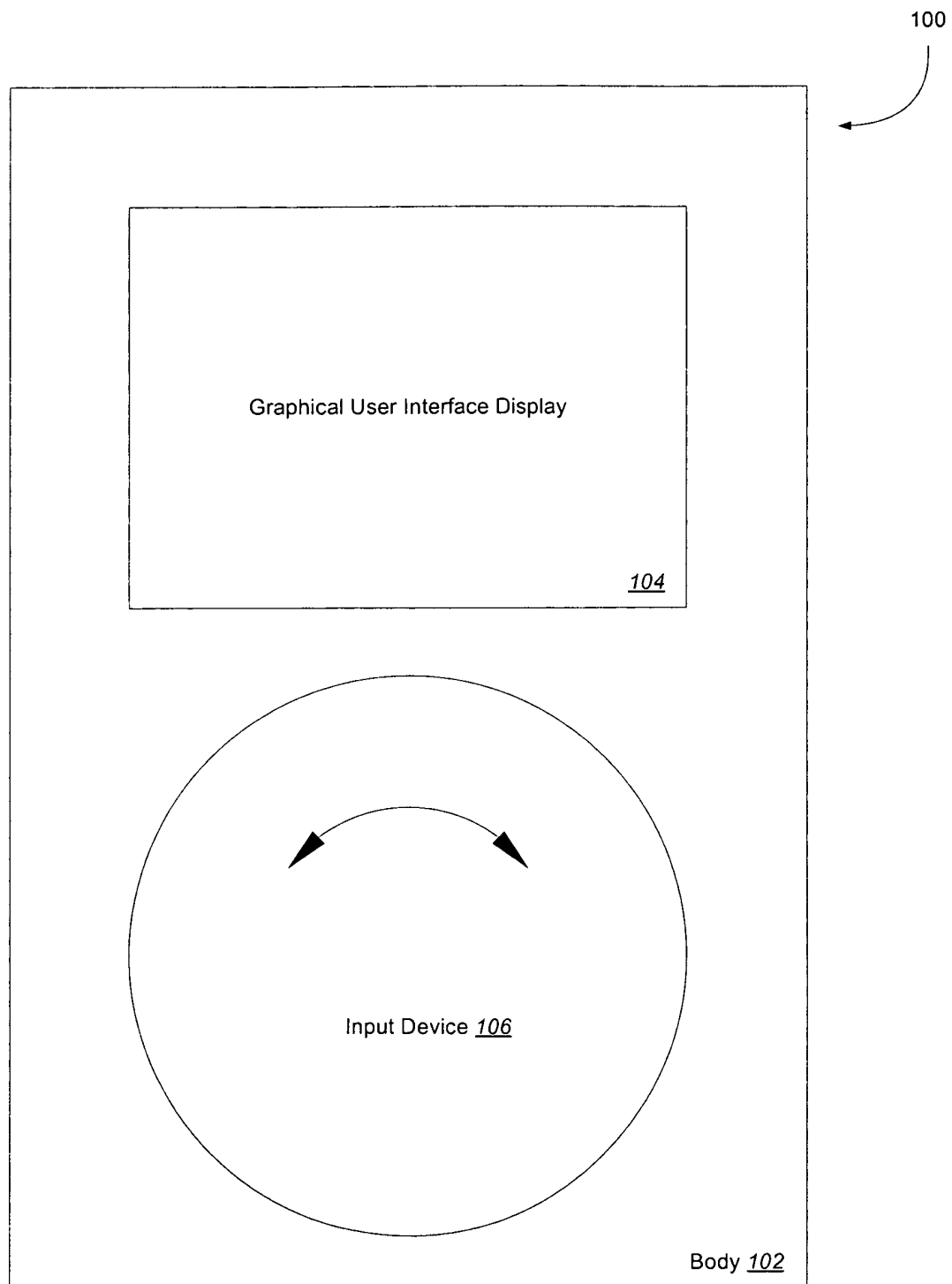


Figure 1

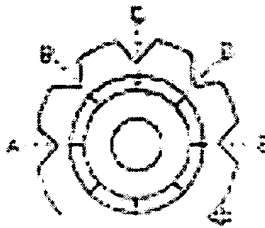
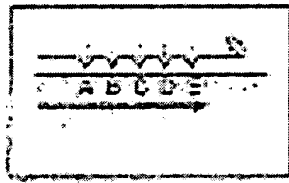


Figure 2A

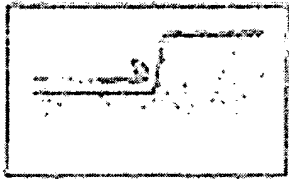


Figure 2B

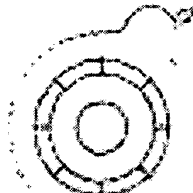
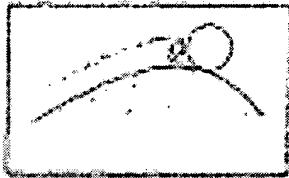


Figure 2C

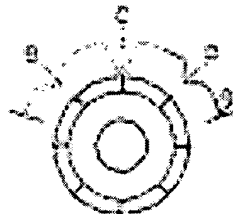
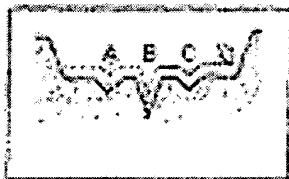


Figure 2D

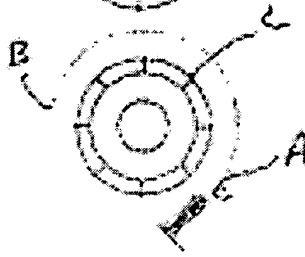
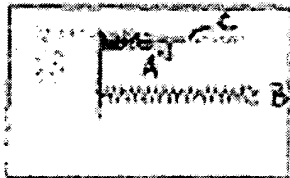


Figure 2E

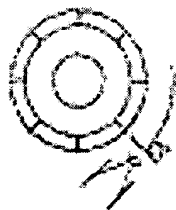
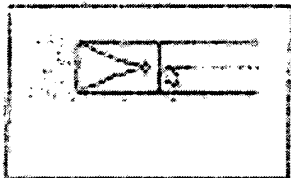


Figure 2F

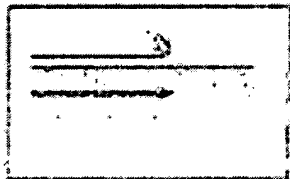


Figure 2G

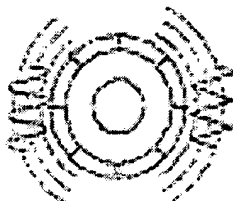
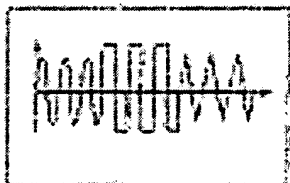


Figure 2H

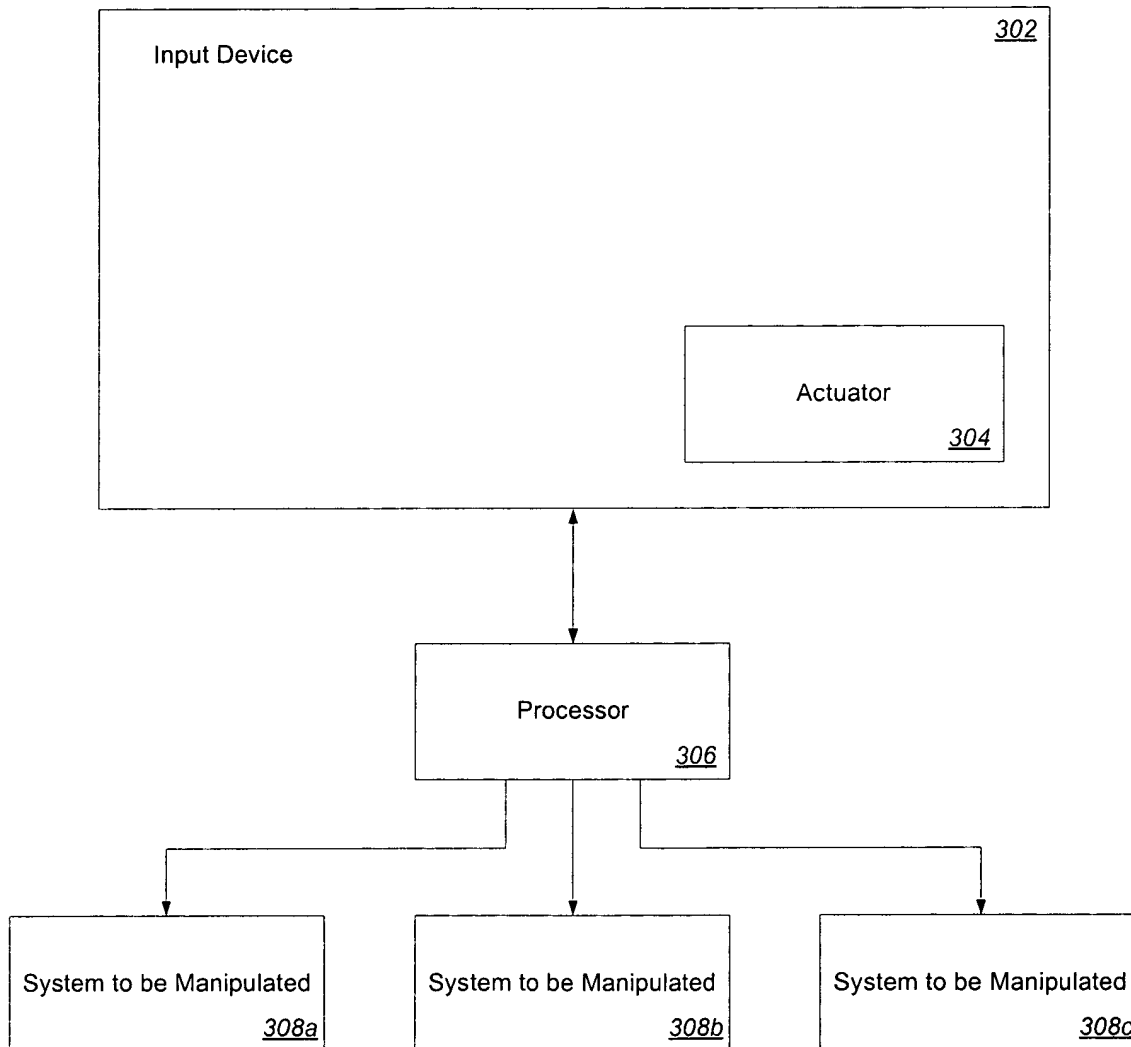


Figure 3

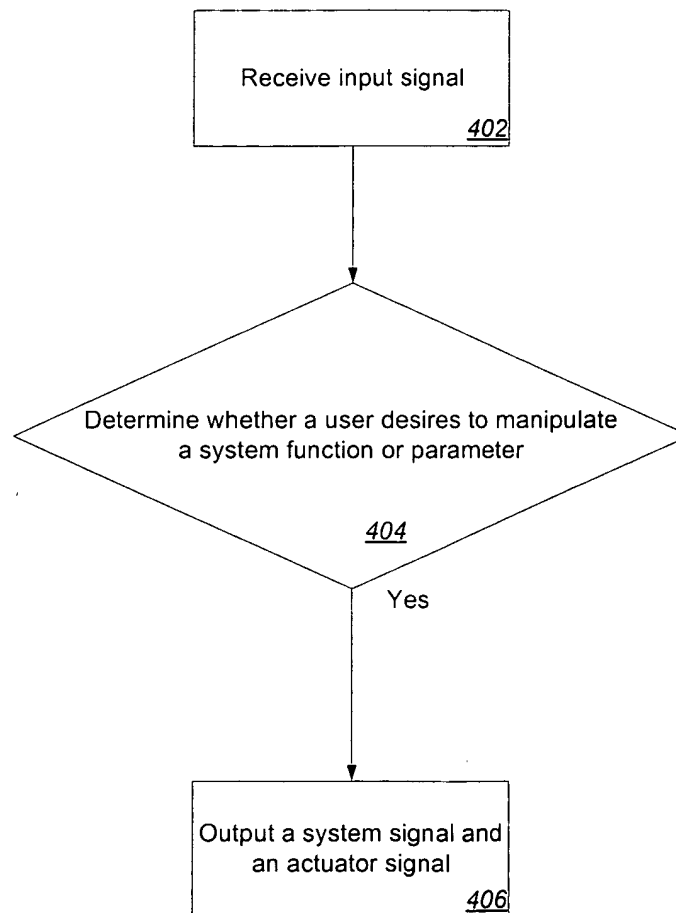


Figure 4

PATENT APPLICATION SERIAL NO. _____ G

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	DRAWINGS	TOT CLAIMS	IND CLAIMS
60/877,333	12/27/2006		200	51851/338712	4		

CONFIRMATION NO. 8817

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

FILING RECEIPT

Date Mailed: 01/18/2007

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Applicant(s)

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Power of Attorney:

Christopher Bosken--58887

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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US60/877,333**

Projected Publication Date: None, application is not eligible for pre-grant publication

Non-Publication Request: No

Early Publication Request: No

Title

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