ABSTRACT

Described herein are one or more techniques related to active tactile feedback ("haptic") technologies. The technologies include a movement-effecting mechanism designed to move a user-engagement surface, typically, in response to a user touching the surface. The described techniques include those designed to return the surface back to its original position (before the surface's movement), to seal the movement-effecting mechanism to protect it from ingress of contaminants, and/or to retain the surface in a manner that allows movement of the surface in directions away from the surface (which includes, for example, substantially normal to the surface) while restricting movement of the surface in at least one other direction (e.g., a direction parallel to the surface). This Abstract is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims.
Fig. 1
Fig. 3
1600 Sense user input

1602 Apply electrical signal to conductive layers

Fig. 16
Fig. 19
TECHNIQUES FOR TACTILE FEEDBACK TECHNOLOGY

RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application No. 61/293,137, filed on Jan. 7, 2010, the disclosure of which is incorporated by reference herein. This application is related to and is a continuation of U.S. Non-Provisional patent application Ser. No. 12/580,002, filed on Oct. 15, 2009, the disclosure of which is incorporated by reference herein.

BACKGROUND

Some devices such as cell phones, laptop computers, tablet computers, computer displays, electronic kiosks, and the like can employ a tactile feedback to provide tactile feedback to a user. However, configuring a tactile surface to provide suitable tactile feedback to a user of the device is far from trivial. That is, components of a tactile surface, either individually or in combination, are difficult to configure such that the tactile surface can provide suitable tactile feedback, survive environmental exposure, be cost effective, meet power requirements, and/or support surfaces of varying size and/or orientation.

SUMMARY

Described herein are one or more techniques related to active tactile feedback (“haptic”) technologies. Such technologies are designed to actively provide tactile feedback to a user contacting (e.g., touching) a user-engagement surface. As described herein, the technologies effect an active movement of the surface in directions away from the plane of surface (e.g., normal to the surface). Some of the described techniques include those to return the surface back to its original position (before the surface’s movement), to seal the movement-effecting mechanism to protect it from ingress of contaminates, and to retain the surface in a manner that allows movement of the surface in directions away from the surface (which includes, for example, substantially normal to the surface) while restricting movement of the surface in at least one other direction (e.g., a direction parallel to the surface).

This Summary is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

The same numbers are used throughout the drawings to reference like features.

FIG. 1 illustrates an example device in accordance with one or more embodiments.

FIG. 2 illustrates a side sectional view of an example material assembly in accordance with one or more embodiments.

FIG. 3 illustrates some example components in accordance with one or more embodiments.

FIG. 4 illustrates some example spring mechanism geometries in accordance with one or more embodiments.

FIG. 5 illustrates a side sectional view of an example material assembly in accordance with one or more embodiments.

FIG. 6a illustrates a side sectional view of an example material assembly in accordance with one or more embodiments.

FIG. 6b illustrates a side sectional view of an example material assembly in accordance with one or more embodiments.

FIG. 7 illustrates a side sectional view of an example material assembly in accordance with one or more embodiments.

FIG. 8 illustrates a side sectional view of an example material assembly in accordance with one or more embodiments.

FIG. 9a illustrates an isometric sectional view of an example seal mechanism in accordance with one or more embodiments.

FIG. 9b illustrates an isometric sectional view of an example seal mechanism in accordance with one or more embodiments.

FIG. 10 illustrates a side sectional view of an example material assembly in accordance with one or more embodiments.

FIG. 11a illustrates an example adhesive strip retainer layout in accordance with one or more embodiments.

FIG. 11b illustrates an example adhesive strip retainer layout in accordance with one or more embodiments.

FIG. 12 illustrates a side sectional view of an example material assembly in accordance with one or more embodiments.

FIG. 13a illustrates an example adhesive strip retainer layout in accordance with one or more embodiments.

FIG. 13b illustrates an example adhesive strip retainer layout in accordance with one or more embodiments.

FIG. 14 illustrates a side sectional view of an example material assembly in accordance with one or more embodiments.

FIG. 15 illustrates a side sectional view of the FIG. 14 material assembly in accordance with one or more embodiments.

FIG. 16 is a flow diagram that describes steps in a method in accordance with one or more embodiments.

FIG. 17 illustrates a side sectional view of an example material assembly in accordance with one or more embodiments.

FIG. 18 illustrates a side sectional view of the FIG. 17 material assembly in accordance with one or more embodiments.

FIG. 19 illustrates a high-level block diagram of example system in accordance with one or more embodiments.

DETAILED DESCRIPTION

Overview

Described herein are one or more techniques related to active tactile feedback (“haptic”) technologies. Such technologies are designed to actively provide tactile feedback to a user contacting (e.g., touching) a user-engagement surface (e.g., touch screen, keycap, or button) of a system. Examples of such systems include (by way of example only and not limitation): a mobile phone, computer, laptop, keyboard, input device, monitor, electronic kiosk, automated teller machine (ATM), vehicle dashboard, control panel, or medical or industrial workstation.
As described herein, the technologies include a movement-effecting mechanism designed to move a user-engagement surface, typically, in response to a user contacting (e.g., touching) the surface. The surfaces move in one or more directions that are towards and/or away from the surface. That direction is often also towards and/or away from the user. Some of the described techniques include those to return the surface back to its original position (before the surface’s movement), to seal the movement-effecting mechanism to protect it from ingress of contaminants, and to return the surface in a manner that allows movement of the surface in directions away from the surface (which includes, for example, substantially normal to the surface) while restricting movement of the surface in at least one other direction (e.g., a direction parallel to the surface).

As described herein, the movement-effecting mechanism is an actuator mechanism that is operatively associated with the surface to provide active tactile feedback to the user via the surface. The actuator mechanism accomplishes that feedback, at least in part, by the movement of at least a pair of spaced-apart substrates, which are permitted to move relative to each other. In doing so, the actuator mechanism also moves the surface in some of the described examples. In at least some described instances, the substrates have conductive properties.

In some of the described instances, the pair of substrates (with conductive properties) is suitably driven to provide movement of at least one of the substrates through attractive and/or repellant forces. Any suitable type of material can be used for the conductive substrates. For example, the conductive substrates can be formed as part of a transparent substrate (e.g., glass or plastic). Alternately or additionally, the conductive substrates can be formed from material that is not transparent (e.g., a metal material).

Some of the described techniques include those utilizing a return mechanism that is designed to return the pair of substrates, after a movement of the substrates relative to each other, back to their original spaced-apart position relative to each other and, thereby restoring the defined gap therebetween. In so doing, the return mechanism also returns the surface back to its original position, in some of the described examples. In some of the described instances, the return mechanism includes at least one spring.

Some of the described techniques include those employing a seal mechanism designed to seal the actuator mechanism and thereby protecting the actuator mechanism from ingress of contaminants (such as dust and debris).

Some of the described techniques include those involving a surface retention mechanism that allows movement of the surface in directions away from the surface (which includes, for example, substantially normal to the surface) while restricting movement of the surface in at least one other direction (e.g., a direction parallel to the surface).

In the discussion that follows, a section entitled “Example Device” is provided and gives but one example of a device that can utilize the inventive principles described herein. After this, a section entitled “Example Material Assembly” describes a material assembly, including an actuator mechanism, in accordance with one or more embodiments. Following this, a section entitled “Example Components” describes example components in accordance with one or more embodiments. Next a section entitled “Example Spring Mechanisms” describes example spring mechanisms in accordance with one or more embodiments. After this, a section entitled “Example Seal Mechanisms” describes example seal mechanisms in accordance with one or more embodiments. Following this, a section entitled “Example Surface Retention Mechanisms” describes example retention mechanisms in accordance with one or more embodiments. Last, a section entitled “Example Method” describes an example method in accordance with one or more embodiments.
FIG. 2 illustrates a side sectional view of an example material assembly in accordance with one or more embodiments generally at 200. In this example, material assembly 200 includes a user-engagement surface 202, which may take the form of a touch surface 202. The assembly 200 includes a display 204 such as, for example, a liquid crystal display (LCD). Any suitable type of display can, however, be used for this display and other exemplary embodiments described herein. For context, a fingertip 205 of a user is shown in anticipation of touching the user-engagement surface 202.

Material assembly 200 also includes an actuator mechanism 206 operably associated with surface 202. The actuator mechanism is configured to provide tactile feedback to a user responsive to a user touching or otherwise engaging the surface 202. In at least some embodiments, the actuator mechanism 206 includes one or more spaced-apart substrates. For example, in this particular embodiment, the actuator mechanism includes at least a pair of substrates 208, 210 that the actuator mechanism holds in a spaced-apart position relative to each other and with a defined gap 211 therebetween. In this example assembly, the gap 211 defines the distance that the substrates are spaced apart. Typically, the gap 211 is substantially smaller than the width of the expanse of the substrates. In some implementations, the defined gap 211 is 0.02 to 5 millimeters. In other implementations, the defined gap 211 is 0.2 to 2 millimeters. Each of the substrates supports a conductive layer of material 212, 214 respectively. It is to be appreciated and understood, however, that substrates 208, 210 may individually include conductive material. In either instance, the substrates have conductive properties.

Alternatively or additionally, in at least some embodiments, substrates 208, 210 may include surface 202 and/or display 204 respectively. For example, in at least some embodiments, a suitably configured surface 202 may support conductive layer of material 212.

As depicted in FIG. 2, the screen 202, substrate 208, and conductive layer of material 212 are shown as three separate strata operatively layered together. However, other embodiments may use more or less separate layers (than what is depicted). For example, some embodiments may use one, two, four, or more layers. Regardless of the number of layers used, the top surface of the top-most layer is configured for engagement by the user and one or more layers have conductive properties.

As depicted in FIG. 2, the display 204, substrate 210, and conductive layer of material 214 are shown as three separate strata operatively layered together. Similar to the above paragraph, other embodiments may use more or less separate layers (than what is depicted). Regardless of the number of layers used, one or more layers have conductive properties.

Display 204 is disposed operably adjacent to substrate 210. Additionally, in at least some embodiments, substrate 210 may support an additional conductive layer of material, opposite of conductive layer of material 214, effective to shield display 204 from interference. In at least some embodiments, the additional conductive layer of material can be terminated using any suitable means such as a resistor network, metallic contacts, conductive adhesive, and the like.

In at least some embodiments, a dielectric material 216 and an adjacent air gap 218 are interposed between the substrates 208, 210 within the defined gap 211. In addition, actuator mechanism 206 may also include a return mechanism 220, 222 interposed between substrates 208, 210. Alternatively or additionally, in at least some embodiments, return mechanism 220, 222 may be operably connected to at least one of the substrates 208, 210. In at least some embodiments, return mechanism 220, 222 is configured to permit movement of surface 202 under influence of drive circuitry in accordance with one or more embodiments. In this example, this movement is in one or more directions out from a plane of the surface, as depicted by double-headed arrow 223. This direction may be substantially normal and/or normal to the surface. Alternatively or additionally, in at least some embodiments, return mechanism 220, 222 may be operably coupled to a surface, such as surface 202.

Alternatively or additionally, in at least some embodiments, dielectric material 216 can be offset from an edge of substrate 210 to allow greater return mechanisms to be utilized. In at least some embodiments, return mechanism 220, 222 can be configured to return either or both substrates 208, 210 to what can be considered an unbiased disposition relative to one another in accordance with one or more embodiments. That is, return mechanism 220, 222 is configured to return the pair of substrates, after a movement of the substrates relative to each other, back to the spaced-apart position relative to each other. In so doing, the return mechanism 220, 222 effectively restores the defined gap 211 between the substrates.

Any suitable type of material can be utilized to provide components of the material assembly 200.

For example, in at least some embodiments, substrates 208, 210 can be formed from a clear material such as plastic or glass. Additionally or alternatively, substrates 208, 210 may individually include an opaque material such as (by way of example and not limitation): FR4, fibreglass, plastic, laminates, and the like.

Alternatively or additionally, the substrates may include material with conductive properties. For example, in at least some embodiments, at least one of the substrates can be formed from a conductive material such as sheet metal or copper. Other materials can, of course, be utilized without departing from the spirit and scope of the claimed subject matter.

Additionally, the conductive layers of material 212, 214 can include any suitable type of conductive material. In at least some embodiments, the conductive material is a clear conductive material. Alternatively or additionally, in at least some embodiments, the conductive material is a spray-on material, film, or tape that is applied, coated or otherwise deposited (as through any of a variety of deposition techniques such as (by way of example and not limitation): CVD, PECVD, lamination, and the like) onto the surfaces of substrates 208, 210. Alternatively or additionally, in at least some embodiments, the conductive material can include indium tin oxide, silver, copper, or any other suitable type of conductive material.

Dielectric material 216 can include any suitable type of dielectric material such as (by way of example and not limitation): air, glass, ceramic, mica, piezo materials, FR4, plastic, elastomeric material, gel and/or other fluidic or non-fluidic material. Alternatively or additionally, in at least some embodiments, return mechanism 220, 222 can be formed from any suitable material, such as thermoplastic elastomer, sheet metal and the like.
In one or more embodiments, various parameters associated with the material assembly 200 can be selected in order to provide desired operating characteristics. For example, parameters associated with the dimension of air gap 218, the dimension of the dielectric material 216, and the dielectric constant of dielectric material 216 can be selected in order to provide desired operating characteristics. In at least some embodiments, the following parameter values can be used:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gap dimension</td>
<td>0.1 to 1.0 mm</td>
</tr>
<tr>
<td>Dielectric constant</td>
<td>Greater than or equal to 1</td>
</tr>
</tbody>
</table>

The example material assembly 200 may also be described as including the user-engagement surface 202 presented for contact by a user (as represented by fingertip 205) and the actuator mechanism 206, which is operably associated with the surface 202. In this instance, the operable association includes a mechanical connection or coupling between the actuator mechanism and the surface.

The actuator mechanism 206 includes at least the pair of substrates 208, 210 held in a spaced-apart position relative to each other and with a defined gap 211 therebetween. The pair of substrates is operatively associated (e.g., mechanically connected and/or coupled) with the user-engagement surface 202. The actuator mechanism 206 is configured to permit at least one of the substrates to move relative to the other (e.g., like in directions shown by 223). That movement is being effective to provide tactile feedback to the user.

The actuator mechanism 206 also includes the return mechanism, which is configured to return the pair of substrates, after a movement of the substrates relative to each other, back to the spaced-apart position relative to each other and restore the defined gap 211 therebetween.

Alternative assemblies may include more than just the pair of substrates. Those alternative assemblies may include a defined gap between each pair of stacked-up and spaced-apart substrates.

Having considered an example material assembly, consider now example components that can be used in connection with the material assembly to provide a user with tactile feedback.

Example Components

FIG. 3 illustrates some example components in accordance with one or more embodiments generally at 300. Components 300 include a touch-sensing module 302, a drive module 304, and an actuator mechanism 306. Actuator mechanism 306 corresponds, in this example, to actuator mechanism 206 in FIG. 2. Any suitable hardware, software, and/or firmware can be used to implement touch-sensing module 302 and drive module 304.

With respect to touch-sensing module 302, any suitable type of technology can be utilized to implement the touch-sensing module such that it is capable of sensing when a user has touched or otherwise engaged the touch screen. Examples of suitable, known technologies include (by way of example and not limitation): capacitive field, resistive, optical, field effect, force/pressure, inductive, Hall effect, and the like.

Drive module 304 includes drive circuitry operably connected to the spaced-apart substrates of actuator mechanism 306. The drive circuitry is configured to drive the conductive layers of material with an electrical signal responsive to an input such as (by way of example and not limitation): sensing a touch input, software events, and/or other triggers or occurrences such as those mentioned above. Driving the conductive layers causes one or more of the corresponding substrates to be moved either or both of towards one another or away from one another. In at least some embodiments, moving the corresponding substrates either or both of towards or away from one another results in either or both of compression or extension of a spring or the seal interposed between said corresponding substrates. Alternatively or additionally, in at least some embodiments a return mechanism can be configured to return the substrates to what can be considered as an unbiased disposition relative to one another.

In some embodiments, the drive circuitry can use different drive profiles to drive the conductive layers to, in at least some embodiments, provide various tactile feedbacks to the user. The drive profiles can include (by way of example and not limitation): a series of voltage pulses having various frequencies.

Example Return Mechanisms

In the discussion above, an example return mechanism was illustrated. It is to be appreciated and understood that any suitable type of return mechanism can be utilized in connection with the principles described herein. Some of the instances of the return mechanism include one or more springs.

As an example, consider FIG. 4 which illustrates, generally at 400, example springs of the example return mechanisms in accordance with one or more embodiments. In the view shown in FIG. 4, example geometries are shown into which any suitable material, such as thermoplastic elastomer, can be formed. Example spring geometries include (by way of example and not limitation): cubic 402, spherical 404, cylindrical 406, conical 408, and 410 hemispherical. Any suitable number of springs can be employed in order to provide desired operating characteristics. In at least some embodiments, a number of springs can be located proximate to a perimeter of spaced-apart substrates in order to provide desired operating characteristics. Alternately or additionally, in at least some embodiments, the spring geometry can be hollow or otherwise include hollow chambers. It is to be appreciated and understood that any suitable geometry can be utilized to provide a spring of the example return mechanism.

Alternately or additionally, in at least some embodiments, springs can be formed from silicone, rubber, elastomers, or any other suitable type of material. In at least some embodiments, springs can be formed by injection molding or compression molding. Alternately or additionally, springs can be configured to provide additional features such as (by way of example and not limitation): seals, strain relief, retention, assembly aids, and the like.

In at least some embodiments, various parameters associated with the material from which the spring is formed can be selected in order to provide desired operating characteristics. For example, parameters associated with the material such as durometer, compression set, elastic modulus, shear modulus, Poißson’s ratio and elongation factor can be selected in order to provide desired operating characteristics such as simulated snap-over or simulated wheel/knob clicks. Different spring rate profiles will produce different haptic
outputs. Table 1, below, lists examples of how spring rate, preload distance, actuator travel, and desired feel correlate.

<table>
<thead>
<tr>
<th>Spring Rate</th>
<th>Preload Distance</th>
<th>Actuator Travel</th>
<th>Desired Feel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear, Soft</td>
<td>Large</td>
<td>Large</td>
<td>Long Travel, Smooth, Lower Natural Frequency</td>
</tr>
<tr>
<td>Regressive</td>
<td>Small</td>
<td>Large</td>
<td>Long Travel, Smooth, Lower Natural Frequency</td>
</tr>
<tr>
<td>Linear, Stiff</td>
<td>Small</td>
<td>Small</td>
<td>Short Travel, Sharp, Higher Natural Frequency</td>
</tr>
<tr>
<td>Progressive</td>
<td>Large</td>
<td>Medium</td>
<td>Medium Travel, Smooth and Crisp, Medium Natural Frequency</td>
</tr>
</tbody>
</table>

[0074] Spring rate describes the amount of force required to displace the spring a given distance. Springs can be categorized as linear, progressive and regressive based on this rate of change and its variance over the entire usable range. Preload distance is a function of the initial spring rate and the applied load on the spring in its neutral state. For a given mass, a softer spring will displace more than a stiffer spring. Actuator travel is a function of the spring rate after preload and the applied actuator force applied to the springs. For a given mass and applied force, a softer spring will displace more than a stiffer spring.

[0075] Desired feel is a trait that is based on the amount of travel, acceleration profiles, and natural frequency of the actuator. For a given mass and applied force, a softer spring will produce a feel that provides longer travel, smoother/rounded acceleration profiles, and a lower natural frequency. To the user, this is perceived as a smooth, longer travel tactile feedback.

[0076] As another example, consider FIG. 5 which illustrates a side sectional view of an example material assembly in accordance with one or more embodiments generally at 500. In this example, material assembly 500 includes a surface in the form of a touchpad 502 such as one would find on a computer keyboard. For context, a fingertip 505 of a user is shown in anticipation of touching the touchpad 502.

[0077] Material assembly 500 includes an actuator mechanism 506 operably associated with touchpad 502. The actuator mechanism is configured to provide tactile feedback to a user responsive to a user touching or otherwise engaging the touchpad 502. The actuator mechanism 506 is configured to permit at least one of the substrates to move relative to the other (e.g., like in directions shown by 523). In at least some embodiments, actuator mechanism 506 includes a pair of spaced-apart substrates 508, 510 each of which supports a conductive layer of material 512, 514 respectively. A defined gap 511 is shown between the spaced-apart substrates.

[0078] In the present example substrates 508, 510 can include any suitable type of material of which examples are provided above. In this particular example, substrates 508, 510 include a non-conductive material such as FR4. Additionally, conductive layers of material 512, 514 can include any suitable type of conductive material of which examples are provided above. In this particular example, conductive layers of material 512, 514 include a metal such as copper. In at least some embodiments, a dielectric material 516 and an adjacent air gap 518 are interposed between substrates 508, 510. Dielectric material 516 can include any suitable material examples of which are provided above.

[0079] Actuator mechanism 506 also includes a return mechanism that includes a leaf spring mechanism 520. For example, in this particular embodiment, leaf spring mechanism 520 is disposed between substrates 508 and 510. Alternatively or additionally, leaf spring mechanism 520 may be operably coupled to a substrate or surface. Leaf spring mechanism 520 may be configured to provide a restoring force to a surface, such as touch pad 502. Leaf spring may be a separate component as shown or integrated into other elements of the assembly such as one of the substrates.

[0080] Leaf spring mechanism 520 can include any suitable type of material. For example, in at least some embodiments, leaf spring mechanism 520 can include a metallic material such as (by way of example and not limitation): stainless steel, spring steel, beryllium copper, and the like. In at least some embodiments, leaf spring mechanism 520 can be coated with a layer of non-conductive material to prevent electrical shorts between components of actuator mechanism 506.

[0081] Alternatively or additionally, in at least some embodiments, leaf spring mechanism 520 can include any suitable non-conductive material such as (by way of example and not limitation): fiberglass, polycarbonate, FR4, and the like.

[0082] It is to be appreciated and understood that other types of springs of the return mechanism can be utilized without departing from the spirit and scope of claimed subject matter. Other types of spring contemplated include (by way of example and not limitation): leaf spring, coil spring, helical spring, volute spring, compression spring, cantilever spring, V-spring, conical spring, torsion spring, flat spiral spring, ribbon torsion spring, gas spring, ideal spring, Belleville spring, washer spring, split spring, air cushion, wave spring, hair spring, negator spring, concentric spring, rolamine spring, spindle spring, liquid spring, rubber spring, and foam spring. For example, coil springs may be configured to provide suitable feedback in accordance with material assemblies described above and below. In at least some embodiments, coil springs may be placed around a perimeter of an actuator mechanism. Alternatively or additionally, coil springs may be counter-sunk into a mounting surface effective to achieve desired tactile characteristics while reducing the height of an actuator mechanism.

[0083] It is to be appreciated and understood that other types of return mechanisms can be utilized without departing from the spirit and scope of claimed subject matter. For example, alternative return mechanisms might return the substrates back to their original position without biasing or spring forces. This return action may be accomplished via repulsion, attraction, or other magnetic or electromagnetic forces. Also, other mechanical actions may restore the gap between the substrates.

[0084] Having described example return mechanisms, consider now a discussion of example seal mechanisms that can be utilized to seal an actuator mechanism from contaminants and/or debris.

[0085] Example Seal Mechanisms

[0086] FIG. 6a illustrates a side sectional view of an example material assembly in accordance with one or more embodiments generally at 600a. In this example, material assembly 600a includes a surface in the form of a screen 620a, a framework ledge 630a, 632a, and a display 640a such as, for example, an LCD. For context, a fingertip 650a of the user is shown in anticipation of touching the screen 620a. In this example, framework ledge 630a, 632a can include any
suitable framework ledge such as (by way of example and not limitation): a bezel, button deck, instrument panel, housing, chassis, and the like.

[0087] Material assembly 600a also includes an actuator mechanism 606a operably associated with screen 602a. The actuator mechanism is configured to provide tactile feedback to a user responsive to a user touching or otherwise engaging the screen 602a. In at least some embodiments, actuator mechanism 606a includes a pair of spaced-apart substrates 608a, 610a each of which supports a conductive layer of material 612a, 614a respectively. It is to be appreciated and understood, however, that substrates 608a, 610a may individually include conductive material. In either instance, the substrates have conductive properties.

[0088] In the present example, substrates 608a, 610a can include any suitable type of material of which examples are provided above. Additionally, in the present example, conductive layers of material 612a, 614a can include any suitable type of conductive material of which examples are provided for above. In this particular example, conductive layers of material 612a, 614a include indium tin oxide.

[0089] In at least some embodiments, a dielectric material 616a and an adjacent air gap 618a are interposed between substrates 608a, 610a. Dielectric material 616a can include any suitable dielectric material examples of which are provided above. Additionally, actuator mechanism 606a may also include a gasket seal mechanism 620a, 622a. In at least some embodiments, gasket seal mechanism 620a, 622a is interposed between substrates 608a, 610a. Gasket seal mechanism 620a, 622a is configured to protect actuator mechanism 606a from contaminants and/or debris.

[0090] Alternately or additionally, in at least some embodiments, material assembly 600a may include an additional gasket seal mechanism 624a, 626a interposed between screen 602a and framework ledge 630a, 632a. Gasket seal mechanism 620a, 622a and/or gasket seal mechanism 624a, 626a can be individually formed from any suitable flexible and/or resilient material such as (by way of example and not limitation): elastomeric materials, open or closed cell foams, rubber, silicone, and the like. In this particular example, gasket seal mechanism 620a, 622a and 624a, 626a are formed from resilient form.

[0091] Additionally, gasket seal mechanism 620a, 622a and/or gasket seal mechanism 624a, 626a can be formed in any suitable width and/or profile shape such as (by way of example and not limitation): square, rectangle, ellipse, concave, and the like. Alternately or additionally, a gasket seal mechanism can be configured to provide features such as (by way of example and not limitation): return mechanisms, retention, strain relief, assembly aids, and the like.

[0092] In at least some embodiments, gasket seal mechanism 620a, 622a can also be configured to provide a return mechanism effective for providing tactile feedback in accordance with one or more embodiments. Alternately or additionally, in at least some embodiments, actuator mechanism 606a can include a return mechanism of which examples are provided above. In at least some embodiments, gasket seal mechanism 620a, 622a can be configured to assist the return mechanism effective to allow the use of fewer and/or smaller springs. In other embodiments, gasket seal mechanism 620 can be configured as a return mechanism effective to eliminate the need of a separate return mechanism. Alternately or additionally, in at least some embodiments, gasket seal mechanism 620a, 622a can be configured to not affect operation of the return mechanism.

[0093] Alternately or additionally, in at least some embodiments, gasket seal mechanism 624a, 626a can additionally be configured to provide a return mechanism. In at least some embodiments, gasket seal mechanism 624a, 626a can be configured to pre-load a spring of the return mechanism of actuator mechanism 606a effective to reduce actuator force utilized to create suitable tactile feedback.

[0094] The springs of the return mechanisms depicted herein (for example in FIG. 6a) biases a surface (e.g., surface 602a) away from a substrate (e.g., substrate 610a). When not actuated, the depicted spring of the return mechanisms urge the surface against the framework ledge (e.g., 630a, 632a). In addition and possibly in the alternative, the surface (such as 602a) may be thought of as being compressed between biasing components (e.g., between 624a, 626a and 620a, 622a) of the return mechanism. In addition and possibly in the alternative, the surface (such as 602a) may be thought of as being pulled and/or pulled by biasing components (e.g., by 624a, 626a and 620a, 622a) of the return mechanism. That is, the biasing components (e.g., 624a, 626a and 620a, 622a) might be relaxed and the surface might be relaxed therebetween.

[0095] As another example, configure FIG. 6b which illustrates a side sectional view of an example material assembly in accordance with one or more embodiments generally at 600b. In this example, material assembly 600b includes a surface in the form of a screen 602b, a framework ledge 630b, 632b, and a display 640b such as, for example, an LCD. For context, a fingerprint 605b of the user is shown in anticipation of touching the screen 602b. In this example, framework ledge 630b, 632b can include any suitable framework ledge such as (by way of example and not limitation): a bezel, housing, button deck, instrument panel, chassis, and the like.

[0096] Material assembly 600b also includes an actuator mechanism 606b operably associated with screen 602b. The actuator mechanism is configured to provide tactile feedback to a user responsive to a user touching or otherwise engaging the screen 602b. In at least some embodiments, actuator mechanism 606b includes a pair of spaced-apart substrates 608b, 610b each of which supports a conductive layer of material 612b, 614b respectively. It is to be appreciated and understood, however, that substrates 608b, 610b may individually include conductive material. In either instance, the substrates have conductive properties.

[0097] In the present example, substrates 608b, 610b can include any suitable type of material of which examples are provided above. Additionally, in the present example, conductive layers of material 612b, 614b can include any suitable type of conductive material of which examples are provided for above. In this particular example, conductive layers of material 612b, 614b include indium tin oxide.

[0098] In at least some embodiments, a dielectric material 616b and an adjacent air gap 618b are interposed between substrates 608b, 610b. Dielectric material 616b can include any suitable dielectric material examples of which are provided above. Additionally, actuator mechanism 606b may also include a gasket seal mechanism 620b, 622b. In at least some embodiments, gasket seal mechanism 620b, 622b is
interposed between display 604b and framework ledge 630b, 632b. Gasket seal mechanism 620b, 622b can be configured to protect actuator mechanism 606b from contaminants and/or debris. Gasket seal mechanism 620b, 622b can be formed from any suitable flexible and/or resilient material such as (by way of example and not limitation): elastomeric materials, open or closed cell foams, gas permeable material, rubber, silicone, and the like.

[0099] Alternately or alternatively, gasket seal mechanism 620b, 622b can be configured to equalize pressure variances of an air volume of material assembly 600b. In at least some embodiments, sealing material assembly 600b may create an air volume. In at least some instances, changes in temperature, altitude, barometric pressure, actuation motion, and the like may result in a pressure variance of the air volume of material assembly 600b.

[0100] In at least some embodiments, gasket seal mechanism 620b, 622b can include breathable venting effective to equalize a pressure variance and/or prevent debris ingress, such as a Gore membrane vent, a spring loaded pressure valve, or a combination of one-way valves, just to name a few. Alternately or alternatively, in at least some embodiments, material assembly 600b may be configured to contain an air volume much larger than a reduced air volume caused by motion associated with actuation (e.g. a decrease in air gap 618b associated with actuation).

[0101] Alternately or alternatively, in at least some embodiments, material assembly 600b may include a flexible surface gasket 624b, 626b interposed between screen 602b and framework ledge 630b, 632b. Flexible surface gasket 624b, 626b can be formed from any suitable flexible and/or resilient material such as (by way of example and not limitation): elastomeric materials, rubber, silicone, poron, and the like. In this particular example, flexible surface gasket 624b, 626b is formed from rubber.

[0102] Additionally, flexible surface gasket 624b, 626b can be formed in any suitable geometry and/or profile shape such as (by way of example and not limitation): flat, curved, folded and the like. In at least some embodiments, a flexible surface gasket 624b, 626b having folded geometry may reduce a pressure variance by creating additional air space when unfolding and/or expanding. Alternately or alternatively, flexible surface gasket 624b, 626b can be configured to provide features such as (by way of example and not limitation): return mechanisms, retention, strain relief, assembly aids, and the like.

[0103] As yet another example, consider FIG. 7 which illustrates a side sectional view of an example material assembly in accordance with one or more embodiments generally at 700. In this example, material assembly includes a surface in the form of screen 702 and a display 704 such as, for example, an active-matrix organic light emitting diode (AMOLED) display. Any suitable display, however, can be used. For context, a fingertip 705 of a user is shown in anticipation of touching the screen 702.

[0104] Material assembly 700 also includes an actuator mechanism 706 operably associated with screen 702. The actuator mechanism is configured to provide tactile feedback to a user responsive to a user touching or otherwise engaging the screen 702. In a least some embodiments, actuator mechanism 706 includes a pair of spaced-apart substrates 708, 710 each of which support a conductive layer of material 712, 714 respectively. It is to be appreciated and understood, however, that substrates 708, 710 may individually include conductive material. In either instance, the substrates have conductive properties.

[0105] In the present example, substrates 708, 710 can include any suitable type of substrate examples of which are provided above. In this particular example, substrates 708, 710 include a clear material, such as glass. Additionally, in the present example, conductive layers of material 712, 714 can include any suitable type of conductive material of which examples are provided for above. In this particular example, conductive layers of material 712, 714 include indium tin oxide.

[0106] In at least some embodiments, a dielectric material 716 and an adjacent air gap 718 are interposed between substrates 708, 710. Dielectric material 716 can include any suitable type of dielectric material examples of which are provided above. In this particular example, dielectric material 716 includes a clear dielectric material such as glass. Alternately or additionally, in at least some embodiments, actuator mechanism 706 also includes a return mechanism 720, 722 of which examples are provided above.

[0107] In at least some embodiments, actuator mechanism 706 includes a bellow seal mechanism 734, 736. Bellow seal mechanism 734, 736 is interposed between substrates 708, 710. Bellow seal mechanism 734, 736 is configured to project components of actuator mechanism 706 from contaminants and/or debris.

[0108] In at least some embodiments, bellow seal mechanism 734, 736 includes one or more pleats configured to allow bellow seal mechanism 734, 736 to compress and/or expand as substrates 708, 710 move in accordance with one or more embodiments. Alternately or additionally, the one or more pleats can be configured in any suitable geometry which can include, by way of example and not limitation, triangular, curved, and/or any combination thereof. In at least some embodiments, return mechanism 720, 722 may be interposed between pleats of bellow seal mechanism 734, 736 as shown in FIG. 7. In other embodiments, the pleats of the bellow seal mechanism 734, 736 may point inward and toward each other rather than outward and away from each other as depicted in FIG. 7.

[0109] Bellow seal mechanism 734, 736 can include any suitable type of flexible material such as (by way of example and not limitation): rubber, fabric, elastomeric, polyamides and the like.

[0110] As yet another example, consider FIG. 8 which illustrates a side sectional view of an example material assembly in accordance with one or more embodiments generally at 800. In this example, material assembly 800 includes a surface in the form of a screen 802, and a display 804 such as, for example, an LCD. For context, a fingertip 805 of a user is shown in anticipation of touching the screen 802. In this example, material assembly also includes bezel 844, 846 and a framework ledge 848, 850. In this example framework ledge 848, 850 can include any suitable surface such as (by way of example and not limitation): button deck, instrument panel, housing, device enclosure, vehicle dash board, chassis, and the like.

[0111] Material assembly 800 also includes an actuator mechanism 806 operably associated with screen 802. The actuator mechanism is configured to provide tactile feedback to a user responsive to a user touching or otherwise engaging the screen 802. In at least some embodiments, actuator mechanism 806 includes a pair of spaced-apart substrates
808, 810 each of which supports a conductive layer of material 812, 814 respectively. It is to be appreciated and understood, however, that substrates 808, 810 may individually include conductive material. In either instance, the substrates have conductive properties.

[0112] In the present example, substrates 808, 810 can include any suitable type of substrate material, examples of which are provided above. In this particular example, substrates 808, 810 include a clear material such as plastic. Additionally, in the present example, conductive layers of material 812, 814 can include any suitable type of conductive material of which examples are provided for above. In this particular example, conductive layers of material 812, 814 include indium tin oxide.

[0113] In at least some embodiments, a dielectric material 816 and an adjacent air gap 818 are interposed between substrates 808, 810. Dielectric material 816 can include any suitable dielectric material, examples of which are provided above. Alternatively or additionally, in at least some embodiments, actuator mechanism 806 also includes a flexible seal mechanism 840, 842 interposed between substrates 808, 810. Flexible seal mechanism 840, 842 is configured to protect actuator mechanism 806 from contaminants and/or debris. Alternatively or additionally, in at least some embodiments, the flexible seal mechanism can be configured to support a surface, such as screen 802 and/or substrate 808. In at least some embodiments, the flexible seal mechanism is configured to allow the supported surface to move in accordance with one or more embodiments. Alternatively or additionally, in at least some embodiments, flexible screen mechanism 840, 842 includes a flexible seal lip 852, 854 interposed between screen 802 and framework ledge 848, 850.

[0114] Flexible seal mechanism 840, 842 can be formed from any suitable material such as (by way of example and not limitation): elastomeric materials, rubber, silicone, and the like. In at least some embodiments, flexible seal mechanism 840, 842 can be formed from a material impregnated with conductive particles, such as nickel-graphite, effective to mitigate interference generated by display 802.

[0115] In at least some embodiments, actuator mechanism 806 includes a return mechanism 820, 822 of which examples are provided above. In this particular example, return mechanism 820, 822 is interposed between flexible seal mechanism 840, 842. Alternatively or additionally, in at least some embodiments, flexible seal mechanism 840, 842 can be configured to provide integral return mechanisms.

[0116] Alternatively or additionally, in at least some embodiments, flexible seal mechanism 840, 842 can be configured to provide features such as (by way of example and not limitation): strain relief, assembly aids, spring retention, spring mounting, and the like.

[0117] FIG. 9a illustrates an example flexible seal mechanism in more detail in accordance with one or more embodiments generally at 900. In the view shown in FIG. 9a, an isometric cross sectional view of a portion of flexible seal mechanism 900 is shown. Flexible seal mechanism 900, in this example, corresponds to flexible seal mechanism 840, 842 in FIG. 8.

[0118] In the present example, flexible seal mechanism 900 includes a mounting area 902. In at least some embodiments, mounting area 902 is configured to be disposed adjacent a suitable mounting surface such as (by way of example and not limitation): a substrate, display, display frame, and the like. Alternatively or additionally, in at least some embodiments, mounting area 902 may support a layer of adhesive effective to mount or bond flexible seal mechanism 900 to a suitable mounting surface.

[0119] Flexible seal mechanism 900 also includes a resilient intermediary section 904 interposed between mounting area 902 and a surface receptacle area 906. In at least some embodiments, surface receptacle area 906 is configured to receive and support a screen and/or substrate, such as screen 802 and substrate 808 as shown in FIG. 8. Alternatively or additionally, in at least some embodiments, resilient intermediary section 904 is configured to compress and/or extend allowing a supported surface to move in accordance with one or more embodiments.

[0120] In some embodiments, flexible seal mechanism 900 can also be configured to provide a return mechanism mounting area 908 on which a return mechanism can be mounted. Return mechanism mounting area 908 may support any suitable return mechanism, examples of which are provided above. In at least some embodiments, return mechanism mounting area 908 may support a layer of adhesive effective to retain return mechanisms.

[0121] Alternatively or additionally, in at least some embodiments, flexible seal mechanism 900 may be properly configured effective to provide functionality of a return mechanism. For example, a flexible seal membrane may be constructed from any suitable resilient material effective to provide sealing and spring functionality eliminating the need for return mechanism components.

[0122] Alternatively or additionally, in at least some embodiments, flexible seal mechanism 900 includes a flexible seal lip 910 interposed between surface receptacle area 906 and a proximate framework ledge, for example, framework ledge 848, 850 of FIG. 8. In at least some embodiments, flexible seal lip 910 can be configured to maintain contact with the proximate surface effective to provide a seal between the framework ledge and flexible seal mechanism 900.

[0123] FIG. 9b illustrates another example flexible seal mechanism in accordance with one or more embodiments generally at 900b. In the view shown in FIG. 9b, an isometric cross sectional view of a portion of flexible seal mechanism 900b is shown.

[0124] In the present example, flexible seal mechanism 900b includes a mounting area 902b. In at least some embodiments, mounting area 902b is configured to be disposed adjacent a suitable mounting surface such as (by way of example and not limitation): a substrate, display, display frame, and the like. Alternatively or additionally, in at least some embodiments, mounting area 902b may support a layer of adhesive effective to mount flexible seal mechanism 900b to any suitable mounting surface.

[0125] Flexible seal mechanism 900b also includes resilient intermediary section 904b. Resilient intermediary section 904b is interposed between mounting area 902b and surface receptacle area 906b. In at least some embodiments, surface receptacle area 906b is configured to receive and support a screen and/or substrate, such as screen 802 and substrate 808 as shown in FIG. 8. Alternatively or additionally, in at least some embodiments, resilient intermediary section 904b is configured to compress and/or extend allowing movement of the supported surface in accordance with one or more embodiments.

[0126] In at least some embodiments, flexible seal mechanism 900b can be configured to provide a return mechanism mounting area 908b on which a return mechanism can be
mounted. Return mechanism mounting area 908b may sup-
port any suitable return mechanism, examples of which are
provided above. In at least some embodiments, return mecha-
nism mounting area 908b may support a layer of adhesive
effective to retain return mechanisms. Alternately or addi-
tionally, return mechanism mounting area 908b may include
return mechanism retaining features, such as (by way of
example and not limitation): recesses, cavities, channels, and
the like, effective to retain suitable return mechanisms.

[0127] Alternately or additionally, in at least some embodi-
ments, flexible seal mechanism 906b may be properly con-
figured effective to provide functionality of a return mecha-
nism. For example, a flexible seal membrane may be con-
structed from any suitable resilient material effective to
provide sealing and spring functionality eliminating the need
for return mechanism components.

[0128] Alternately or additionally, in at least some embodi-
ments, flexible seal mechanism 906b includes flexible seal lip
910b effective to seal a surface such as (by way of example
and not limitation): a screen, touch screen, and the like.

[0129] Having described example sealing mechanisms, con-
sider now a discussion of example retention mechanisms
that can provide retention for a surface.

[0130] Example Surface Retention Mechanisms

[0131] FIG. 10 illustrates a side sectional view of an
example material assembly in accordance with one or more
embodiments generally at 1000. In this particular example,
material assembly 1000 includes a surface in the form of a
screen 1002, and a display 1004 such as, for example, an
LCD. For context, a fingerprint 1005 of a user is shown in
anticipation of touching the screen 1002.

[0132] Material assembly 1000 also includes an actuator
mechanism 1006 operably associated with screen 1002. The
actuator mechanism is configured to provide tactile feedback
to a user responsive to a user touching or otherwise engaging
the screen 1002. In at least some embodiments, actuator
mechanism 1006 includes a pair of spaced-apart substrates
1008, 1010 each of which supports a conductive layer of
material 1012, 1014 respectively. It is to be appreciated and
understood, however, that substrates 1008, 1010 may indi-
vidually include conductive material. In either instance,
the substrates have conductive properties.

[0133] In the present example, substrates 1008, 1010 can
include any suitable type of substrate examples of which are
provided above. In this particular example, substrates 1008,
1010 include a clear material such as glass. Additionally, in
the present example, conductive layers of material 1012,
1014 can include any suitable type of conductive material
of which examples are provided for above. In this particular
example, conductive layers of material 1012, 1014 include
indium tin oxide.

[0134] In at least some embodiments, a dielectric material
1016 and an adjacent air gap 1018 are in the defined gap
between the substrates 1008, 1010. In addition, actuator
mechanism 1006 may also include a return mechanism 1020.
In at least some embodiments, return mechanism 1020 is
interposed between substrates 1008, 1010 to permit move-
mant of screen 1002 under influence of drive circuitry in
accordance with one or more embodiments.

[0135] In the present example, material assembly 1000 also
includes an adhesive strip retainer 1030. In at least some
embodiments, adhesive strip retainer 1030 is configured to
provide retention for a surface such as, for example, screen
1002. Alternately or additionally, in at least some embodi-
ments, adhesive strip retainer 1030 allows a retained surface,
such as screen 1002, to move in directions normal to the
retained surface (which include both in and out movements).
The adhesive strip retainer allows this movement while
restricting movement in other directions. In this particular
element, the direction normal to the retained surface can be
a direction of actuation for actuator mechanism 1006. In some
implementations, the adhesive strip retainer 1030 allows a
retained surface, such as screen 1002, to move in a direction
away from the plane of the retained surface.

[0136] In addition or in still other embodiments, the adhe-
hesive strip retainer may permit movement of the surface in one
or more of the following directions:

[0137] out from a plane of the surface;
[0138] toward a plane of least one of the substrates;
[0139] out from a plane of least one of the substrates;
[0140] consistent with the movement of at least one sub-
strate permitted by the actuator mechanism;
[0141] substantially orthogonal to the surface; and/or
[0142] orthogonal to the surface.

[0143] With these and other embodiments, the adhesive
strip retainer restricts the specified movements while restrict-

ing movement of the surface in all other directions or restrict-
ing movement in particular directions. An example of such
restricted directions includes movements that are parallel
with the plane of the surface and/or the substrates.

[0144] Adhesive strip retainer 1030 can also support layers
of adhesive 1038, 1040 effective to mount adhesive strip
retainer 1030 between a pair of spaced-apart substrates such
as, in this example, the pair of spaced-apart substrates 1008,
1010.

[0145] In at least some embodiments, adhesive strip
retainer 1030 includes a flexible section 1032 interposed
between adhesive supporting sections 1036, 1038 of adhesive
strip retainer 1030. In at least some embodiments, flexible
section 1032 permits movement of a retained surface by flex-
ing and/or articulating. Alternately or additionally, in at least
some embodiments, flexible section 1032 can be configured
to control aspects of movement of a retained surface such as
(by way of example and not limitation): maximum and/or
minimum travel distance in directions normal to and/or out
from the retained surface. Alternately or additionally, in at
least some embodiments, return mechanism 1020 can be
interposed between adhesive supporting sections 1036, 1038.

[0146] Adhesive strip retainer 1030 may include any suit-
able material such as (by way of example and not limitation):
polycarbonate, polyester, fabric, sheet metal and the like. It is
to be appreciated and understood that any suitable type of
flexible material can be utilized to provide adhesive strip
retainer 1030.

[0147] FIG. 11a illustrates a top down view of an example
adhesive strip retainer in more detail in accordance with one
or more embodiments generally at 1100. Adhesive strip
retainer 1100, in this example, corresponds to adhesive strip
retainer 1030 in FIG. 10. Adhesive strip retainer 1100 is
configured to provide retention for a surface such as, for
example, a screen operably coupled to an actuator mech-
nism, examples of which are provided above. In at least some
embodiments, adhesive strip retainer 1100 is configured to
allow movement of the retained surface in directions nor-
tal to and/or out from the surface, while restricting movement
in other directions. Alternately or additionally, in at least some
embodiments, the direction normal to the surface may be a direction of actuation for an actuator mechanism configured to provide tactile feedback.

[0148] Adhesive strip retainer 1100 can also support a layer of adhesive 1102 effective to mount adhesive strip retainer 1100 to a surface to be retained, such as, for example, a touch screen. Additionally, in at least some embodiments, adhesive strip retainer 1100 can support a layer of adhesive 1104 effective to mount a retaining mechanism to a base surface such as, for example, a display. In this particular example, layers of adhesive 1102 and 1104 are supported on the same side of adhesive strip retainer 1100. Alternately or additionally, in at least some embodiments, layers of adhesive 1102, 1104 may be supported on opposite sides of adhesive strip retainer 1100.

[0149] Adhesive strip retainer 1100 can be formed into any suitable geometry such as (by way of example and not limitation): square and L-shaped geometries. Alternately or additionally, in at least some embodiments, adhesive strip retainer 1100 may be formed into folded geometries comprising one or more overlapping and/or non-overlapping folds. In this particular example, retainer mechanism 1000 can be folded along axis 1106.

[0150] In at least some embodiments, adhesive strip retainer 1100 includes a flexible material such as, by way of example and not limitation: polycarbonate, polyester, fabric, sheet metal and the like. Alternately or additionally, in at least some embodiments, the retaining mechanism includes one or more flexible or articulating sections such as, flexible sections 1108, 1110, 1112 and/or 1114, which allow a retained surface to move in directions normal to and/or out from the retained surface. It is to be appreciated and understood that any suitable type of flexible material can be utilized to provide adhesive strip retainer 1100.

[0151] As another example, consider FIG. 11b which illustrates a top view of an example adhesive strip retainer in more detail in accordance with one or more embodiments generally at 1100b. In this particular example, adhesive strip retainer 1100b corresponds to adhesive strip retainer 1300 which has been folded along axis 1106. Adhesive strip retainer 1100b is configured to provide retention for surface such as, for example, a substrate of an actuator mechanism. In at least some embodiments, adhesive strip retainer 1100b is configured to allow movement of the retained surface in directions normal to and/or out from the surface, while restricting movement in other directions. Alternately or additionally, in at least some embodiments, the direction normal to the surface can be a suitable direction for an actuator mechanism to provide tactile feedback. In other implementations, the adhesive strip retainer 1100b is configured to allow movement of the retained surface in a direction parallel with the plane of the surface.

[0152] Adhesive strip retainer 1100b can also support a layer of adhesive 1104b effective to mount adhesive strip retainer 1100b to a surface to be retained such as, for example, a first substrate of a pair of spaced-apart substrates or a surface, such as a touch screen. In at least some embodiments, flexible sections 1110b and/or 1114b allow the retained surface to move. Alternately or additionally, in at least some embodiments, adhesive strip retainer 1100b can support a layer of adhesive effective to mount the opposite side of adhesive strip retainer 1100b to a base surface such as, for example, a second substrate of a pair of spaced-apart substrates, a bezel, or housing.

[0153] Alternately or additionally, in at least some embodiments, adhesive strip retainer 1100b can be formed into any suitable geometry such as (by way of example and not limitation): square and L-shaped geometries. Alternately or additionally, in at least some embodiments, adhesive strip retainer 1100b can be mounted at one or more corners of a surface effective to retain the surface. Alternately or additionally, in at least some embodiments, adhesive strip retainer 1100b may include geometric features such as (by way of example and not limitation): square inside corner 1116b to reduce intrusion into viewing area of a display and/or rounded corner 1116b effective to increase rigidity of adhesive strip retainer 1100b.

[0154] Adhesive strip retainer 1100b may include any suitable flexible material, examples of which are provided above.

[0155] FIG. 12 illustrates a side sectional view of an example material assembly in accordance with one or more embodiments generally at 1200. In this particular example, material assembly 1200 includes a surface in the form of a screen 1202, and a display 1204 such as, for example, an LCD. For context, a fingertip 1205 of a user is shown in anticipation of touching the screen 1202.

[0156] Material assembly 1200 also includes an actuator mechanism 1206 operably associated with screen 1202. The actuator mechanism is configured to provide tactile feedback to a user responsive to a user touching or otherwise engaging the screen 1202. In at least some embodiments, actuator mechanism 1206 includes a pair of spaced-apart substrates 1208, 1210 each of which supports a conductive layer of material 1212, 1214 respectively. It is to be appreciated and understood, however, that substrates 1208, 1210 may individually include conductive material. In either instance, the substrates have conductive properties.

[0157] In the present example substrates 1208, 1210 can include any suitable type of substrate, examples of which are provided above. In this particular example, substrates 1208, 1210 include a clear material such as glass. Additionally, in the present example, conductive layers of material 1212, 1214 can include any suitable type of conductive material, of which examples are provided above. In this particular example, conductive layers of material 1212, 1214 include indium tin oxide.

[0158] In at least some embodiments, a dielectric material 1216 and an adjacent air gap 1218 are in the defined gap between the substrates 1208, 1210. In addition, actuator mechanism 1206 may also include a return mechanism 1220. In at least some embodiments, return mechanism 1220 is interposed between substrates 1208, 1210 to permit movement of screen 1202 under influence of drive circuitry in accordance with one or more embodiments.

[0159] In the present example, material assembly 1200 also includes an adhesive strip retainer 1230. In at least some embodiments, adhesive strip retainer 1230 is configured to provide retention for a surface such as, for example, screen 1202. Alternately or additionally, in at least some embodiments, adhesive strip retainer 1230 allows a retained surface, such as screen 1202, to move in directions normal to and/or out from the retained surface, while restricting movement in other directions. In this particular example, the direction normal to the retained surface can be a direction of actuation for actuator mechanism 1206. In other implementations, the adhesive strip retainer 1230 is configured to allow movement
of the retained surface in a direction away from the plane of the surface, while restricting movement in directions parallel with the plane of the surface.

[0160] Adhesive strip retainer 1230 can also support layers of adhesive 1238, 1240 effective to mount adhesive strip retainer 1230 between a pair of spaced-apart substrates such as, in this example, the pair of spaced-apart substrates 1208, 1210.

[0161] In at least some embodiments, adhesive strip retainer 1230 includes a flexible section 1232 interposed between adhesive supporting sections 1236, 1234 of adhesive strip retainer 1230. In at least some embodiments, flexible section 1232 permits movement of a retained surface by flexing and/or articulating. Alternatively or additionally, in at least some embodiments, flexible section 1232 can be configured to control aspects of movement of a retained surface such as (by way of example and not limitation): maximum and/or minimum travel distance in directions normal to and/or out from the retained surface.

[0162] Adhesive strip retainer 1230 may include any suitable material such as (by way of example and not limitation): polycarbonate, polyester, fabric, sheet metal and the like. It is to be appreciated and understood that any suitable type of flexible material can be utilized to provide adhesive strip retainer 1230.

[0163] FIG. 13a illustrates a top down view of an example adhesive strip retainer in more detail in accordance with one or more embodiments generally at 1300. Adhesive strip retainer 1300, in this example, corresponds to adhesive strip retainer 1230 in FIG. 12. In this particular example, adhesive strip retainer 1300 is configured to retain a surface such as, for example, a touch screen operably associated with an actuator mechanism. In at least some embodiments, adhesive strip retainer 1300 allows movement of the retained surface in directions normal to and/or out from the surface, while restricting movement in other directions. In at least some embodiments, the direction normal to the surface can be a direction suitable for an actuator mechanism to provide tactile feedback. In other implementations, the adhesive strip retainer 1300 is configured to allow movement of the retained surface in a direction away from the plane of the surface, while restricting movement in directions parallel with the plane of the surface.

[0164] Adhesive strip retainer 1300 also supports layers of adhesive 1302, 1304 effective to mount the retaining mechanism between a pair of spaced-apart surfaces such as, for example, a pair of substrates. In at least some embodiments, layers of adhesive 1302, 1304 can be supported on opposing sides of adhesive strip retainer 1300. In other embodiments, layers of adhesive 1302, 1304 can be supported on the same side of adhesive strip retainer 1300.

[0165] In at least some embodiments, adhesive strip retainer 1300 includes a flexible section 1306 interposed between sections of adhesive strip retainer 1300 supporting layers of adhesive 1302, 1304. In at least some embodiments, flexible section 1306 permits movement of a retained surface by flexing and/or articulating. Alternatively or additionally, in at least some embodiments, flexible section 1306 can be configured to control aspects of movement of a retained surface such as (by way of example and not limitation): maximum and/or minimum travel distance in directions normal to and/or out from the retained surface.

[0166] Adhesive strip retainer 1300 may include any suitable material such as (by way of example and not limitation): polycarbonate, polyester, fabric, sheet metal and the like. It is to be appreciated and understood that any suitable type of flexible material can be utilized to provide adhesive strip retainer 1300.

[0167] Alternatively or additionally, in at least some embodiments, adhesive strip retainer 1300 can be formed into any suitable geometry such as (by way of example and not limitation): strips, L-shaped, square, and the like. In at least some embodiments, each section of adhesive strip retainer 1300 may be configured individually for mounting on surfaces of varying widths. Alternatively or additionally, in at least some embodiments, adhesive strip retainer 1300 may be formed into folded geometries comprising one or more overlapping and/or non-overlapping folds.

[0168] In at least some embodiments, adhesive strip retainer 1300 can be configured to provide features such as (by way of example and not limitation): return mechanism retention 1308 and/or hard stops for movement of the retained surface.

[0169] As another example, consider FIG. 13b which illustrates a top down view of another example retaining mechanism in accordance with one or more embodiments generally at 1300b. In this particular example, adhesive strip retainer 1300b is configured to retain a surface, such as, for example, a screen operably associated with an actuator mechanism of which examples are provided above. In at least some embodiments, adhesive strip retainer 1300b allows movement of the retained surface in directions normal to and/or out from the surface, while restricting movement in other directions. For example, in at least some embodiments, the direction normal to the surface can be a direction suitable for an actuator mechanism to provide tactile feedback. In other implementations, the adhesive strip retainer 1300b is configured to allow movement of the retained surface in a direction away from the plane of the surface, while restricting movement in directions parallel with the plane of the surface.

[0170] Adhesive strip retainer 1300b also supports layers of adhesive 1302b, 1304b effective to mount retaining mechanism between a pair of spaced-apart surfaces such as, for example, a pair of substrates. In at least some embodiments, layers of adhesive 1302b, 1304b can be supported on opposing sides of adhesive strip retainer 1300b. In other embodiments, layers of adhesive 1302b, 1304b can be supported on the same side of adhesive strip retainer 1300b.

[0171] Alternatively or additionally, in at least some embodiments, adhesive strip retainer 1300b includes a flexible section 1306b interposed between sections of adhesive strip retainer 1300b supporting layers of adhesive 1302b, 1304b. In at least some embodiments, flexible section 1306b permits movement of a retained surface by flexing or articulating at folds and/or creases. Alternatively or additionally, in at least some embodiments, flexible section 1306b can be configured to control aspects of movement of a retained surface such as (by way of example and not limitation): maximum and/or minimum travel distance in directions normal to and/or out from the retained surface.

[0172] Adhesive strip retainer 1300b may include any suitable material such as (by way of example and not limitation): polycarbonate, polyester, fabric, sheet metal and the like. It is to be appreciated and understood that any suitable type of flexible material can be utilized to provide adhesive strip retainer 1300b.

[0173] Alternatively or additionally, in at least some embodiments, adhesive strip retainer 1300b can be formed into any
suitable geometry such as (by way of example and not limitation): rectangle, L-shaped, square, and the like. In at least some embodiments, sections of the retaining mechanism can be configured individually for mounting on surfaces of varying widths. Alternately or additionally, in at least some embodiments, adhesive strip retainer 1300b may be formed into folded geometries comprising one or more overlapping and/or non-overlapping folds.

[0174] In at least some embodiments, adhesive strip retainer 1300b can be configured to provide features such as (by way of example and not limitation): assembly aids, one or more return mechanism retention features 1308b and/or hard stops for movement of a retained surface.

[0175] FIG. 14 illustrates a side sectional view of an example material assembly in accordance with one or more embodiments generally at 1400. In this particular example, material assembly 1400 includes a surface in the form of a screen 1402, and a display 1404 such as, for example, an LCD. For context, a fingertip 1405 of a user is shown in anticipation of touching the screen 1402.

[0176] Material assembly 1400 also includes an actuator mechanism 1406 operably associated with screen 1402. The actuator mechanism is configured to provide tactile feedback to a user responsive to a user touching or otherwise engaging the screen 1402. In at least some embodiments, actuator mechanism 1406 includes a pair of spaced-apart substrates 1408, 1410 each of which supports a conductive layer of material 1412, 1414 respectively. It is to be appreciated and understood, however, that substrates 1408, 1410 may individually include conductive material. In either instance, the substrates have conductive properties.

[0177] In the present example, substrates 1408, 1410 can include any suitable type of substrate, examples of which are provided above. In this particular example, substrates 1408, 1410 include a clear material such as glass. Additionally, in the present example, conductive layers of material 1412, 1414 can include any suitable type of conductive material, of which examples are provided for above. In this particular example, conductive layers of material 1412, 1414 include indium tin oxide.

[0178] In at least some embodiments, a dielectric material 1416 and an adjacent air gap 1418 are in the defined gap between the substrates 1408, 1410. In addition, actuator mechanism 1406 may also include a return mechanism 1420. In at least some embodiments, return mechanism 1420 is interposed between substrates 1408, 1410 to permit movement of screen 1402 under influence of drive circuitry in accordance with one or more embodiments.

[0179] In the present example, material assembly 1400 also includes a bearing guide assembly 1460. In at least some embodiments bearing guide assembly 1460 is configured to provide retention for a surface such as, for example, screen 1402. Alternately or additionally, in at least some embodiments, bearing guide assembly 1460 allows a retained surface, such as screen 1402, to move in directions normal to and/or out from the retained surface, while restricting movement in other directions. In this particular example, the direction normal to the retained surface can be a direction of actuation for actuator mechanism 1406. In other implementations, the adhesive strip retainer 1460 is configured to allow movement of the retained surface in a direction away from the plane of the surface, while restricting movement in directions parallel with the plane of the surface.

[0180] In at least some embodiments, bearing guide assembly 1460 includes a frame 1462 operably coupled to a surface to be retained. Alternately or additionally, in at least some embodiments, bearing guide assembly 1460 includes chassis 1464 disposed adjacent to a suitable base, such as, in this particular example display 1404.

[0181] Additionally, bearing guide assembly 1460 may include a bearing mechanism 1466, 1468 disposed operably between frame 1462 and chassis 1464. In at least some embodiments, bearing mechanism 1466, 1468 is configured to allow movement of a retained surface in directions normal to and/or cut from the retained surface. Alternately or additionally, bearing mechanism 1466, 1468 may restrict movement of the retained surface in directions other than those normal to the retained surface. In this particular example, bearing guide assembly 1460 is configured to support screen 1402 vertically while allowing movement of screen 1402 in accordance with one or more embodiments. In other implementations, the bearing mechanism 1466, 1468 is configured to allow movement of the retained surface in a direction away from the plane of the surface, while restricting movement in directions parallel with the plane of the surface.

[0182] Bearing mechanism 1466, 1468 may include any suitable type of bearing such as (by way of example and not limitation): ball bearings, roller bearings, cylindrical bearings, shaft and bearing systems, guide blocks and rail systems, linear motion slides, and the like. Additionally, in at least some embodiments, bearing guide assembly 1460 includes a bearing stop 1470 interposed between frame 1462 and chassis 1464 effective to limit movement of bearing mechanism 1466, 1468 in one or more directions.

[0183] As an example, consider FIG. 15, which continues the example in FIG. 14. There, bearing stop 1470 is configured to limit movement of bearing mechanism 1466, 1468, as well as screen 1402 retained by bearing guide assembly 1460, to a distance 1472 in at least one direction of actuation of actuator mechanism 1406 as can be seen by comparison of FIG. 14 and FIG. 15.

Example Method

[0184] FIG. 16 is a flow diagram that describes steps in a method in accordance with one or more embodiments. The method can be implemented in connection with any suitable hardware, software, firmware, or combination thereof. In at least some embodiments, the method can be implemented in connection with systems such as those that are described above.

[0185] Step 1600 senses user input. This step can be performed in any suitable way. For example, in at least some embodiments, a user's input can be sensed responsive to the user touching a touch surface such as a touch screen or touch pad. In addition, examples of various technologies that can be utilized to sense a user's input have been provided above.

[0186] As an example, consider FIG. 17 which illustrates the FIG. 2 embodiment. In this example, a finger 1700 has touched touch surface 202.

[0187] Responsive to sensing the user's input, step 1602 applies an electrical signal, such as a voltage or a voltage profile, to conductive layers that are supported by substrates, such as those conductive layers and substrates that are described above. Any suitable type of electrical signal can be applied including those that are defined by voltage profiles
such as the profiles that are described above. Applying voltage to the conductive layers provides tactile feedback to user as described above.

As an example, consider FIG. 18 which continues the FIG. 17 example. There, a voltage has been applied to the conductive layers of material 212, 214 thus causing an attractive force between the layers and hence, the substrates 208, 210 respectively, on which they reside. Responsive to the applied voltage, in this example, substrate 208 moves towards substrate 210 thus compressing return mechanism 220, 222. As can be seen by a comparison of FIGS. 17 and 18, air gap 218 and hence, the distance between substrates 208 and 210 has been reduced.

When the voltage is removed from the conductive layers of the resiliency of return mechanism 220, 222 causes substrates 208, 210 to return to what can be considered as an unbiased disposition relative to one another. It is to be appreciated and understood, however, that any resilient mechanism can be utilized without departing from the spirit and scope of claimed subject matter. The movement of the substrates as just described provides tactile feedback to the user which can simulate a button click or rotary knob click. Alternately or additionally, at least in some embodiment, other suitable types of tactile feedback, such as a buzz or vibration, can be provided with suitable voltage profiles.

The steps of the method illustrated in FIG. 16 can be implemented in connection with any suitable hardware, software, firmware, or combination thereof. For example, consider FIG. 19 which illustrates a high-level block diagram of a system that can be incorporated into a device and utilized to implement the functionality described above and below. In the illustrated and described example, system 1900 includes a microcontroller 602 which, in turn, includes a haptics customizing engine 1904, a computer-readable storage media in the form of an EEPROM 1906, a touch sense module 1908, and a haptics engine 1910. In addition, system 1900 includes an adjustable DC/DC converter 1912, high side switches 1914, 1916, low side switches 1918, 1920, and an actuator 1922. The various components of system 1900 can be configured in any suitable manner in order to provide haptic feedback as described above.

Concluding Notes

In the above description of exemplary implementations, for purposes of explanation, specific numbers, materials configurations, and other details are set forth in order to better explain the invention, as claimed. However, it will be apparent to one skilled in the art that the claimed invention may be practiced using different details than the exemplary ones described herein. In other instances, well-known features are omitted or simplified to clarify the description of the exemplary implementations.

The inventors intend the described exemplary implementations to be primarily examples. The inventors do not intend these exemplary implementations to limit the scope of the appended claims. Rather, the inventors have contemplated that the claimed invention might also be embodied and implemented in other ways, in conjunction with other present or future technologies.

Moreover, the word “exemplary” is used herein to mean serving as an example, instance, or illustration. Any aspect or design described herein as “exemplary” is not necessarily to be construed as preferred or advantageous over other aspects or designs. Rather, use of the word exemplary is intended to present concepts and techniques in a concrete fashion. The term “techniques,” for instance, may refer to one or more devices, apparatuses, systems, methods, articles of manufacture, and/or computer-readable instructions as indicated by the context described herein.

As used in this application, the term “or” is intended to mean an inclusive “or” rather than an exclusive “or.” That is, unless specified otherwise or clear from context, “X employs A or B” is intended to mean any of the natural inclusive permutations. That is, if X employs A; X employs B; or X employs both A and B, then “X employs A or B” is satisfied under any of the foregoing instances. In addition, the articles “a” and “an” as used in this application and the appended claims should generally be construed to mean “one or more,” unless specified otherwise or clear from context to be directed to a singular form.

These processes are illustrated as a collection of blocks in a logical flow graph, which represents a sequence of operations that can be implemented in mechanics alone or a combination with hardware, software, and/or firmware. In the context of software/firmware, the blocks represent instructions stored on one or more computer-readable storage media that, when executed by one or more processors, perform the recited operations.

Note that the order in which the processes are described is not intended to be construed as a limitation, and any number of the described process blocks can be combined in any order to implement the processes or an alternate process. Additionally, individual blocks may be deleted from the processes without departing from the spirit and scope of the subject matter described herein.

The term “computer-readable media” includes computer-storage media. For example, computer-storage media may include, but are not limited to, magnetic storage devices (e.g., hard disk, floppy disk, and magnetic strip), optical devices (e.g., compact disk (CD) and digital versatile disk (DVD)), smart cards, flash memory devices (e.g., thumb drive, stick, key drive, and SD cards), and volatile and non-volatile memory (e.g., random access memory (RAM), read-only memory (ROM)). Unless the context indicates otherwise, the terms “normal” as used in discussions herein regarding movements of a surface, substrate, or the like in a direction relative towards, from, away from, or out of a surface, substrate, or the like includes one or more directions which are orthogonal from or towards the stated surface, substrate, or the like. Unless the context indicates otherwise, the term “normal” also includes directions which are substantially orthogonal or substantially normal (which includes a range of twenty degrees plus or minus of orthogonal).

Unless the context indicates otherwise, the term “towards” as used in discussions herein regarding movements of a surface, substrate, or the like in a direction that is towards a surface, substrate, or the like includes direction which is less than ninety degrees from being orthogonal towards the stated surface, substrate, or the like. Unless the context indicates otherwise, the term “away” or “out” as used in discussions herein regarding movements of a surface, substrate, or the like in a direction that is away or out from the plane of a surface, substrate, or the like includes direction which is less than ninety degrees from being orthogonal away from the stated surface, substrate, or the like.
What is claimed is:

1. An active tactile feedback system comprising:
   a user-engagement surface presented for contact by a user;
   an actuator mechanism operably associated with the user-
   engagement surface, the actuator mechanism including:
   a pair of substrates held in a spaced-apart position rela-
   tive to each other and with a defined gap therebe-
   tween, wherein at least one of the pair of substrates is
   operatively associated with the user-engagement sur-
   face, the actuator mechanism being configured to per-
   mit at least one of the substrates to move relative to the
   other effective to provide tactile feedback to the user;
   a spring mechanism operably associated with at least
   one of the pair of substrates, the spring mechanism
   being configured to return the pair of substrates, after
   a movement of the substrates relative to each other,
   back to the spaced-apart position relative to each other
   and restore the defined gap therebetween; and
   a seal mechanism configured to protect the actuator
   mechanism from contaminant ingress; and
   a surface retention mechanism operably coupled to the
   user-engagement surface and configured to allow move-
   ment of the user-engagement surface in directions sub-
   stantially normal to the user-engagement surface and
   restrict movement of the user-engagement surface in at
   least one direction parallel to the user-engagement sur-
   face.

2. An active tactile feedback system of claim Error! Reference source not found., further comprising drive circuitry operably connected to the actuator mechanism and configured to drive the substrates, which have conductive properties, with an electrical signal to cause a permitted movement of at least one of the substrates relative to the other of the substrate effective to provide tactile feedback to the user.

3. An active tactile feedback system as recited in claim Error! Reference source not found., wherein the user receives an effective tactile feedback via the user-engagement surface by the permitted movement of at least one of the substrates relative to the other of the substrates.

4. An active tactile feedback system as recited in claim Error! Reference source not found., wherein the spring mechanism includes the seal mechanism.

5. An active tactile feedback system as recited in claim Error! Reference source not found., further comprising one or more additional substrates, wherein each substrate is held in a spaced-apart position relative to one or more other substrates and with at least a defined gap between each spaced-apart pair of substrates.

6. A user-interactive apparatus comprising:
   a housing;
   an active tactile feedback system as recited in claim Error! Reference source not found. supported by the housing.

7. A system comprising:
   a user-engagement surface presented for contact by a user;
   an actuator mechanism operably associated with the user-
   engagement surface, the actuator mechanism including:
   a pair of substrates with conductive properties, the pair
   of substrates being held in a spaced-apart position rela-
   tive to each other and with a defined gap therebe-
   tween; and
   a return mechanism operably associated with at least one
   of the pair of substrates; and
   drive circuitry operably connected to the actuator mecha-
   nism and configured to drive the substrates with an elec-
   trical signal to cause movement of at least one of the
   substrates relative to the other of the substrate effective
   to provide tactile feedback to the user,
   the return mechanism being configured to return the pair
   of substrates, after the movement driven by the drive cir-
   cuitry, back to the spaced-apart position relative to each
   other and restore the defined gap therebetween.

8. A system as recited in claim 7, wherein:
   at least one of the pair of substrates is operatively associ-
   ated with the user-engagement surface;
   the drive circuitry being further configured to move the
   user-engagement surface via the operative association
   between at least one of the pair of substrates and the
   user-engagement surface.

9. A system as recited in claim 7, further comprising a dielectric material interposed between the substrates.

10. A system as recited in claim 7, further comprising a dielectric material interposed between the substrates, wherein the dielectric material includes air.

11. A system as recited in claim 7, wherein the return mechanism is operably coupled to the user-engagement sur-
face.

12. A system as recited in claim 7, wherein the actuator mechanism is further configured to permit movement of the user-engagement surface—via the actuator mechanism's operable association with the surface—in directions out from a plane of the surface.

13. A system as recited in claim 7, wherein the return mechanism includes one or more springs that are configured to push at least one of the pair of substrates, after the move-
ment driven by the drive circuitry, back to the spaced-apart
position relative to the other substrate and restore the defined
gap therebetween.

14. A system as recited in claim 7, wherein the return mechanism includes one or more springs that are configured to pull at least one of the pair of substrates, after the move-
ment driven by the drive circuitry, back to the spaced-apart
position relative to the other substrate and restore the defined
gap therebetween.

15. A system as recited in claim 7, wherein the return mechanism includes at least one spring having a geometry selected from a group consisting of a cubic geometry, a spherical geometry, a cylindrical geometry, a hemispherical geometry, and a conical geometry.

16. A system as recited in claim 7, wherein the return mechanism includes at least one spring formed from a material selected from a group consisting of a thermoplastic elastomer material, a silicone material, and a rubber material.

17. A system as recited in claim 7, wherein the return mechanism includes a spring that is selected from a group consisting of a leaf spring, a coil spring, helical spring, volute spring, compression spring, cantilever spring, V-spring, conical spring, torsion spring, flat spiral spring, ribbon torsion spring, gas spring, ideal spring, belleville spring, washer spring, split spring, air cushion, wave spring, hair spring, negator spring, concentric spring, rolomite spring, spindle spring, liquid spring, rubber spring, and foam spring.

18. A system as recited in claim 7, further comprising one or more additional substrates, wherein each substrate is held in a spaced-apart position relative to one or more other substrates and with at least a defined gap between each spaced-apart pair of substrates.
19. A user-interactive apparatus comprising:
a chassis;
a system as recited in claim 7 supported by the chassis.
20. A system comprising:
a surface presented for engagement by a user;
an actuator mechanism operably associated with the sur-
face, the actuator mechanism including:
a pair of substrates held in a spaced-apart position rela-
tive to each other and with a defined gap therebe-
tween, the actuator mechanism being configured to
permit at least one of the substrates to move relative to
the other effective to provide tactile feedback to the
user; and
a seal mechanism configured to protect the actuator
mechanism from contaminant ingress; and
drive circuitry operably connected to the actuator mecha-
nism and configured to drive the substrates, which have
conductive properties, with an electrical signal to cause
a permitted movement of at least one of the substrates
relative to the other of the substrates effective to provide
tactile feedback to the user.
21. A system as recited in claim 20, wherein the seal
mechanism is operably associated with at least one of the
pair of substrates and the seal mechanism being further configured
to return the pair of substrates, after a movement of the sub-
strates relative to each other, back to the spaced-apart position
relative to each other and restore the defined gap therebe-
tween.
22. A system as recited in claim 20, wherein the seal
mechanism is selected from a group consisting of a gasket
seal mechanism, a bellows seal mechanism, and a flexible
seal mechanism.
23. A system as recited in claim 20, wherein the seal
mechanism comprises a gasket seal mechanism or flexible
seal mechanism formed from a material selected from a group
consisting of a resilient foam material, an elastomeric ma-
terial, a rubber material, and a silicone material.
24. A system as recited in claim 20, wherein the seal
mechanism comprises a bellows seal mechanism formed
from a material selected from a group consisting of a fabric
material, an elastomeric material, and a polyamide material.
25. A system as recited in claim 20, wherein the seal
mechanism comprises a flexible seal mechanism comprises a
substrate receptacle area configured to receivably support the
surface and a resilient intermediary section configured to
return the pair of substrates, after a movement of the sub-
strates relative to each other, back to the spaced-apart position
relative to each other and restore the defined gap therebe-
tween.
26. A system comprising:
a surface configured to be available to a user for engage-
ment;
an actuator mechanism operably associated with the sur-
face, the actuator mechanism including: a pair of sub-
strates held in a spaced-apart position relative to each
other and with a defined gap therebetween, the actuator
mechanism being configured to permit at least one of the
substrates to move relative to the other effective to pro-
vide tactile feedback to the user; and
a surface retention mechanism operably coupled to the
surface and configured to permit movement of the sur-
facer in directions out from a plane of the surface, while
restricting movement of the surface in other directions.
27. A system as recited in claim 26, wherein the surface
retention mechanism is further configured to permit move-
ment of the surface in one or more directions selected from a
group consisting of:
toward a plane of least one of the substrates,
out from a plane of least one of the substrates,
consistent with the movement of at least one substrate
permitted by the actuator mechanism,
substantially normal to the surface,
while restricting movement of the surface in other direc-
tions.
28. A system as recited in claim 26, wherein the surface
retention mechanism is further configured to restrict move-
ment of the surface in at least one direction parallel to the
surface.