"off". Fluid pressure is maintained in cavities **520***a*, **520***b*, **520***c* . . . **520***r* to keep them inflated.

Conversely, deflating pump **576** is activated for a predetermined period of time whenever cavities **520***a*, **520***b*, **520***c* . . . **520***r* need to be deflated. Inflating pump **572** remains "off" during deflation of cavities **520***a*, **520***b*, **520***c* . . . **520***r*. As a result, deflating pump **576** is able to transfer fluid from cavities **520***a*, **520***b*, **520***c* . . . **520***r* back to fluid reservoir **574** to, until the required fluid pressure returns to the original value when deflating pump **576** is turned "off".

Other pump configurations are also possible. For example, it is possible to replace pumps **572**, **576** with a single bi-directional pump. It may also be possible to deflate cavities by opening value(s) to the fluid reservoir and let the fluid pressure decrease without the need for a separate deflating pump.

FIG. **7** is a block diagram illustrating one exemplary implementation of a device **700** incorporating a touch sensitive user interface in accordance with the present invention. Device **700** includes a microprocessor (CPU) **710**, a button array controller **720**, pump(s) **721**, and button array **100**. Depending on the implementation, device **700** may also include pressure sensor(s) **722** and valve(s) **723** coupled to pump(s) **720**. Device **700** also includes a display controller **730** coupled to a display screen **280**, and a touch screen controller **740** coupled to touch sensing layer **260**.

FIG. **8** is a flowchart illustrating the operation of touch screen assemblies of the present invention, including the embodiments shown in FIGS. **2**, **3**A, **3**B and **4**. Referring to FIGS. **5** through **8**, and using the embodiment of FIG. **2** as an example, in step **820**, when display controller **730** causes display screen **280** to display a keypad, e.g., a telephone interface, button array controller **720** activates pump(s) **721** which causes button array **100**, corresponding to the keys of keypad, to be inflated by increasing the pressure of the button fluid in cavities **220***a*, **220***b*, **220***c* (step **830**).

In step **840**, touch sensing layer **260** senses the location(s) of the user's depressions on one or more of corresponding membrane portions **210***a*, **210***b*, **210***c* of button array **100**. Touch sensing layer **260** then outputs the coordinate(s) of the sensed location(s) to processor **710** via touch screen controller **740** (step **840**).

If processor **710** recognizes that the sensed location(s) correspond to an "EXIT" type key, for example, a "CALL" key or an "END" key in this exemplary telecom implementation, then button array **200** is deflated (step **860**). Otherwise, touch sensing layer **260** continues to sense location(s) of subsequent user depression(s) and outputting the sensed location(s) coordinates to touch screen controller **740** (repeat step **840**, **850**).

Many modifications and additions are contemplated within the spirit of the present invention. For example, it is possible to add distortion correction capability to display screens **280**, **380**, **480** for correcting any optical distortion that may be introduced by button array **100**. It may also be possible to include a set of pressure sensors coupled to each of the corresponding cavities of button array **100** thereby eliminating the need for touch sensing layers **260**, **360**, **460**.

While the present invention has been described with reference to particular embodiments, it will be understood that the embodiments are illustrative and that the inventive scope is not so limited. In addition, the various features of the present invention can be practiced alone or in combination. Alternative embodiments of the present invention will also become apparent to those having ordinary skill in the art to which the present invention pertains. Such alternate embodiments are considered to be encompassed within the spirit and scope of the present invention. Accordingly, the scope of the present invention is described by the appended claims and is supported by the foregoing description.

What is claimed is:

1. A user interface system comprising:

a volume of fluid;

a membrane including a first region, a second region, and a third region, wherein the first region is interposed between the second and third regions, and wherein the second and third regions are operable between a retracted state and an expanded state, the second and third regions flush with the first region in the retracted state and proud of the first region in the expanded state;

a substrate joined to and retaining a portion of the first region of the membrane in planar form, the substrate cooperating with the second region and the third region to define and substantially enclose a first cavity and a second cavity;

a pump configured to manipulate a portion of the fluid into the first and second cavities to transition the second and third regions from the retracted state to the expanded state;

a tactile layer, separate and distinct from the substrate and the membrane, joined to a portion of the membrane opposite the substrate, and defining a tactile surface touchable by a user, and comprising a deformable area operable between

a lowered state, wherein the deformable area is in contact with the first region, and

an elevated state, wherein the deformable area is lifted off of the first region by the second and third regions in the expanded state; and

a touch sensor configured to detect a user touch on the tactile surface; and

a display separate and distinct from the tactile layer, coupled to the substrate, and configured to output an image through the tactile layer.

2. The user interface of claim **1**, further comprising a valve arranged between the pump and the first cavity, wherein the valve is configured to release a portion of the fluid from the first cavity to transition the second region from the expanded state to the retracted state.

3. The user interface of claim **2**, wherein the valve is in a first state when the pump manipulates the fluid into the first cavity, and wherein the valve is in a second state when the pump manipulates the fluid out of the first cavity.

4. The user interface of claim **1**, wherein the pump is further configured to manipulate a portion of the fluid out of the first cavity to transition the second region from the expanded state to the retracted state.

5. The user interface of claim **1**, further comprising a reservoir coupled to the pump and configured to contain a portion of the fluid.

6. The user interface of claim **1**, wherein the display is coupled to the substrate opposite the membrane.

7. The user interface of claim **6**, wherein the substrate, the membrane, and the tactile layer are each of a substantially transparent material and cooperate to transmit the image to the user.

8. The user interface of claim **7**, wherein the fluid is of a refractive index substantially similar to the refractive index of the tactile layer.

9. The user interface of claim **1**, wherein the touch sensor comprises a pressure sensor coupled to the first cavity.

10. The user interface of claim **1**, wherein, in the elevated state, the deformable area defines a button of a volume substantially greater than the volume of the fluid displaced into