[0054] The emulated keypads may, optionally, provide tactile feedback. For example, in a first exemplary embodiment, when the user depresses keypad "7", the microchambers located below the raised surface **317** are each configured to undergo a momentary reduction in microchamber volume before returning to a quiescent volume. This may be implemented using a pressure sensor located in each or some of the microchambers. The pressure sensor senses pressure and releases a defined volume of the air contained in the microchamber when finger pressure causes the pressure in the microchamber to exceed a threshold pressure. Subsequently, after a suitable delay, the air in the microchambers is replenished to bring the activated microchambers back to their quiescent height.

[0055] Attention is drawn once again to **FIG. 2C** to further explain tactile feedback. A pressure sensor (not shown) located in microchamber **210** senses pressure applied to surface **211**. When this pressure exceeds a certain threshold, bi-stable valve **242** is operated to release a defined volume of air from microchamber **210**. Subsequently, after a suitable delay, bi-stable valve **242** is operated again to re-fill the microchamber **210** with air.

[0056] In a second exemplary embodiment of tactile feedback in which each of the activated microchambers contains an electrogel, a pressure sensor is again located in each or some of the microchambers. The pressure sensor detects a finger pressure that causes the pressure in the chamber to exceed a threshold pressure. When such a finger pressure is detected, a suitable voltage is applied to the electrogel, causing the electrogel to have a reduced stiffiness. Consequently, the key "gives" under finger-pressure. After a predetermined delay a second voltage is applied to the electrogel causing the electrogel to revert to its original stiffness, thereby providing tactile feedback.

[0057] In a third exemplary embodiment of tactile feedback in which each of the microchambers contains a piezo-electric element, a pressure sensor is used to detect a finger pressure that causes the pressure in the chamber to exceed a threshold pressure. When such a finger pressure is detected, a voltage is applied to cause the piezo-electric element to vibrate. The vibration provides tactile feedback to the user of the keyboard. In other exemplary embodiments, other forms of feedback, such as audio feedback or visual feedback, are employed to confirm key depression. As examples, audio feedback can be implemented in the form of a beeping sound, while visual feedback can be implemented as a change in the appearance of the emulated hard key.

[0058] **FIGS. 4A and 4B** illustrate a second exemplary embodiment of an array **200** of microchambers configured as a media-player keypad **400**. Unlike the square keypads of the embodiment shown in **FIGS. 3A and 3B**, keypad **400** has rectangular keys. In the example shown, the "volume" key has been emulated by activating 32 microchambers in a 2×16 array. **FIG. 4B**, which is a cross-sectional view of keypad **400** along the "volume" key, shows a display screen **420** superimposed upon the array **200** of microchambers. Raised surface **417** corresponds to the raised keypad of the "volume" key, while text display **416** corresponds to the label "Volume." Unraised surface **418**, which is located above inactive microchambers, constitutes the inactive surface of keypad **400**. As in the embodiment shown in **FIG. 3A**, the embodiment shown in **FIG. 4A** may also include tactile feedback as an optional feature.

[0059] **FIG. 5** shows a keyboard emulator controller **515** communicatively coupled to an array **200** of microchambers. The keyboard emulator controller **515** includes a selector **512**, which is, for example, a slide-switch in one embodiment and a group of hard keys in another embodiment. Selector **512** is operated to select one of several keyboards for emulation by the array **200** of microchambers. In the example illustrated in **FIG. 5**, external selector **512** has been set to select emulation of an MP3 player. Consequently, keyboard emulator controller **515** configures array **200** to emulate an MP3 player keypad.

[0060] **FIGS. 6A and 6B** provide an alternative embodiment of a keyboard emulator controller. In **FIG. 6A**, keyboard emulator controller **650** incorporates array **200** of microchambers configured to provide the user a set of selector keys for selecting one of several keyboards for emulation by array **200** of microchambers. Once the user makes a selection, array **200** of microchambers is transformed by the keyboard emulator controller **650** into the appropriate emulated keyboard. For example, if media player **615** is selected, array **200** of microchambers is transformed into the media player keyboard shown in **FIG. 6B**.

[0061] **FIG. 7** shows an exemplary embodiment of a microchamber controller **705** incorporated into keyboard emulator controller **115**. Microchamber controller **705** comprises a system that facilitates the activation and de-activation of one or more microchambers of the array **200** of microchambers. Such a system may include, among various elements, one or more of the following: a gas injection system, a gas release system, a fluid injection system, a fluid release system, and a voltage generator system to apply voltage to a piezoelectric element or to an electrogel contained in a microchamber. The system further includes, if desired, a system to provide tactile feedback to the emulated keys as was explained above. In one embodiment, microchamber controller **705** includes manifold **244**, bi-stable valves such as bi-stable valve **242**, and ports such as port **222** which were described above with reference to **FIGS. 2C and 2D**.

[0062] Microchamber controller **705** is communicatively coupled to control logic **710**, which provides various logical functions that are used to operate microchamber controller **705**. For example, control logic **710** includes a system to obtain data from the pressure sensors and provide control signals for generating tactile feedback. Other functions include various touch-pad functions such as label generation and key activation sensing.

[0063] In one embodiment as shown in **FIG. 7**, control logic **710** is external to keyboard emulator controller **115** and in another embodiment is an integral part of keyboard emulator controller **115**. When external to the keyboard emulator controller **115**, control logic **710** may be a part of the logic circuitry contained in a device, such as device **100** shown in **FIG. 1**. In an embodiment in which device **100** is a PDA for example, control logic **710** is integrated into the microcontroller circuit contained inside the PDA. Similarly, control logic **710** can be integrated into the microcontroller circuit of a cellular phone. This type of integration permits optimal design of a new device having a reconfigurable keyboard, or permits retrofitting an existing device with a reconfigurable keyboard.