electrically efficient Braille cells in accordance with the present invention allow a full page Braille display to be fabricated. Additionally, modern microelectronic processing technology can be used to manufacture the devices.

With reference to FIG. **1**, in an exemplary embodiment of the Braille cell in accordance with the present invention, the device includes a rectangular fluid-tight housing **15**, the fluid-tight housing having two substantially continuous sides **20** and two windowed sides further including a support strip **25**, the positioning of the support strip resulting in a top aperture **30** and a bottom aperture **35** for each windowed side. An opening exits in the top end of the housing **40**. The opening is dimensioned to accommodate a Braille dot.

With reference to FIG. **2**, the Braille cell is shown with one continuous side displaced. The Braille cell further includes a flexible diaphragm **45** positioned to cover the opening in the top of the housing. A rubber membrane, a preformed membrane or other means of providing a flexible diaphragm are within the scope of the invention. Four electroactive polymer bending elements **50** are positioned to cover the top aperture and bottom aperture of each windowed side. One edge of each bending element is secured to the support strip and the other end secured to the housing. Additional fluid-tight membrane material enclosing the housing establishes the fluid tight condition of the housing. The housing contains, a gas, or water or another appropriate liquid or gas to serve as the pressure transferring medium. A novel latching mechanism with two supporting blocks **55** attached to the electroactive bending elements **50** and a thin actuator rod **65** attached at one end to the flexible diaphragm **45** and at the other end to a stabilizer block **60** provides over 30 grams of supporting force with which to support the Braille dot. As such, the Braille cell apparatus transfers the bending of the electroactive polymer actuator into the linear motion of the Braille dot.

The 30 grams supporting force for the Braille dot is necessary only when the reader is palpating the Braille dot. The force that is needed to move the Braille dot to a readable position is much less than 30 grams. Based on this observation, a novel hydraulic and latching mechanism is employed to make a Braille cell that can provide 30 grams supporting force to give the reader a comfortable feeling when brushing their finger tip on the Braille dot. As shown with reference to FIG. **3**, the four electroactive polymer bending elements **50** are fixed at the supporting strip **25** at two sides. As shown, upon application of an electric field, the top of the bending elements covering the top aperture **30** can bend towards the inside and the outside of the housing and the bottom of the bending elements covering the bottom aperture **35** can also bend towards the inside and the outside of the housing. The four bending elements are attached to a rubber membrane or preformed membrane **70**, which is used to seal the housing. A gas or a liquid, such as water or other liquids, may be used to fill up the housing to serve as the pressure transferring media. Additionally, a gas may also be used to fill the housing to serve as the pressure transferring media. The actuator rod **65** is attached to the bottom of the flexible diaphragm **45** to seal the opening **40** at the top of the housing. The stabilizer block **60** is secured to the bottom of the actuator rod **65**. The support blocks **55** are secured to the bottom edge of the electroactive polymer bending element **50** covering the bottom aperture **35**. The Braille dot **75** is positioned on top of the flexible diaphragm. FIG. **3** in combination with FIG. **4** illustrates the working sequence of the Braille cell based on the bending of the electroactive polymer. At a first step, as shown in FIG. **3**, the four bending elements **50** will bend towards the inside the housing when power is applied. As the bending elements bend towards the inside, pressure will be exerted on the liquid or gas, which will then push up the flexible diaphragm **45** at the opening on the top of the housing **15**. The movement of the flexible diaphragm **45** will result in a movement of the actuator rod **65** and subsequently the stabilizer block **60**. Concurrently, the two supporting blocks **55** which are secured to the lower part of the bending elements **50** and will move towards the center of the housing. Upon sufficient displacement of the fluid, the actuator rod **65** secured to the bottom of the flexible diaphragm **45** will rest on the two supporting blocks **55**. The height of the supporting blocks is sufficient to provide the support required for the Braille dot. Therefore a very large supporting force can be generated while keeping the Braille dot at its ideal latching position because the two support blocks underneath support the actuator rod. The bending angle of the electroactive polymer bending elements can be calculated by solving the equation in which the volumetric change caused by the removal of the volume of the liquid or gas inside the cavity and the volumetric change caused by the inflation of the rubber membrane on the top of the cavity are equal.

At a second step, as shown in FIG. **4**, when the power orientation supplied to the bending elements **50** is switched, the four bending elements will bend towards the outside of the housing **15**. As such, a negative pressure will be generated inside the housing. The combination of this negative pressure and the pressure from the flexible diaphragm will move the Braille dot to its rest position. The two supporting blocks **55** will be moved away from the center of the housing **15** and the actuator rod **65** will drop back to its rest position.

The combination of the first and second steps of the operation of the novel Braille cell as outlined above provides the actuation necessary to present a palpable Braille cell dot for use in a Braille cell display.

The electroactive polymer bending elements of the present invention are fabricated based on the bending mechanism of the electrostrictive polymer and ionic conducting (IPMC) polymer actuator. In an exemplary embodiment with reference to FIG. **5**, the construction of the polymer bending elements includes providing a flexible electroactive polymer layer **85** secured to a substantially rigid material layer **90**. The electroactive polymer layer **85** further includes an array of microelectrodes **95** to enable the application of power to the bending element. In this exemplary embodiment, the array of microelectrodes **95** are manufactured on the PVDF polymer thin film. The microelectrode conductors are placed on one side of the polymer thin film using a photolithograph process. The positive and negative electrode conductors exist in alternate sequence with a common positive bus **100** and a common negative bus **105**. The space between positive and negative electrodes is in a range of micrometers to allow a substantial electric field to be exerted between the electrodes. With this configuration of electrodes on the surface of the polymer film, the working voltage necessary for the operation of the device can be lowered dramatically. The asymmetric stress caused by the asymmetric electric field produces the bending of the polymer thin film and therefore the subsequent bending of the electroactive polymer bending element.

Highly integrated, low cost, microelectronic processing technology is employed to make an array of the Braille cells for a Braille cell display. With reference to FIG. **6**, a row of Braille cells are placed in an array resulting in a full page Braille display. As shown in FIG. **6**, the Braille cells, when incorporated into an array, further include a tactile member cover **110**. A tactile member cover **110** may be adapted for