BRAILLE DISPLAY DEVICE AND METHOD OF CONSTRUCTING SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of and claims the benefit of priority to co-pending application Ser. No. 12/856,253 filed on Aug. 13, 2010 and entitled "Electromechanical Tactile Braille Cell Assembly," which is a continuation of and claims the benefit of priority to application Ser. No. 12/189,449 filed on Aug. 11, 2008 and entitled "Electromechanical Tactile Braille Cell Assembly", now U.S. Pat. No. 7,775,797, issued Aug. 17, 2010, which is a continuation of Ser. No. 10/711,423 filed on Sep. 17, 2004 and entitled "Electromechanical Tactile Cell Assembly", now U.S. Pat. No. 7,410,359, issued Aug. 12, 2008, which claims priority to provisional application Ser. No. 60/481,979 filed on Jan. 30, 2004 and entitled "Electromechanical Braille Cell and Braille Cell Assembly." The contents of all the foregoing applications are fully incorporated herein for all purposes.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a Braille display device. More particularly, the present invention relates to a refreshable display device employing a construction that is easily manufactured, repaired, and/or serviced.

2. Description of the Background Art

A Braille display is an electromechanical device that connects to a computer by way of a wired or wireless connection. The display consists of a line of tactile cells. Typical displays include 20, 40, or even 80 cells. Each cell, in turn, contains six or eight tactile pins that move up and down in response to electrical voltage. The tactile pins can be driven by mechanical, electromechanical, piezoelectric, pneumatic, or magnetic effects. When in the raised position, the pins extend above a tactile surface and can be felt by a user. By raising certain pins and keeping others below the tactile surface, individual Braille characters can be generated. The series of cells together represent a line of text. After a line has been read the user can refresh the display to allow for additional lines to be presented and read. Braille displays are often combined with other hardware and software to make up an integrated unit. For instance Braille displays are connected in place of video monitors to serve as the display unit, and many units incorporate speech output of the screen prompts. In this regard, computer software is employed to convert a visual image in a screen buffer of the computer into text to be displayed on the Braille display.

Electromechanical tactile cells for use in refreshable Braille displays and graphical tactile displays are known in the art. An exemplary tactile cell as known in the art consists of eight piezoelectric reed elements corresponding to eight tactile pins. The necessary electrical connections and driving forces are provided to actuate the reeds, thereby causing the tactile pins to protrude above a tactile surface to allow the Braille character or graphic element to be displayed. The Braille cells known in the art have not been designed for manufacturability and ease of repair and replacement.

The present state of the art employs piezoelectric bimorph reeds to drive the tactile pins. The bimorph reeds have a common center conductor positioned between two piezoelectric transducers. A simple circuit drives the center conductor and fixes the outer conductor. This arrangement additionally

requires that special metallic plating be applied to the outer piezoceramic contacts to enable soldering of the leads to the printed circuit board.

The need for such special metallic plating and individual attachment of the leads increases the manufacturing costs associated with each Braille cell. Current technology requires the use of sixteen hand-soldered leads, requiring thirty two hand-soldered solder joints to establish the electrical connections for each Braille cell in the display. Precise positioning of the reeds is necessary to ensure that the tactile pins extend a definite distance beyond the tactile surface upon actuation of the reed and fully retract below the surface upon request. This precise positioning and alignment of the reeds with the upward trajectory of the tactile pins proves to be very difficult with hand-soldering manufacturing techniques. Additionally, replacement of the reeds for repair of the Braille cell is complicated due to the large number of hand-soldered leads employed in the design.

Prior art Braille cells employ one individual tactile pin cap per individual Braille cell. The tactile pin cap serves to position and align the pins, and provides the cursor control buttons. The Braille cells and associated tactile pins caps positioned adjacent to each other establish the tactile surface. The use of individual cell caps for each Braille cell increases the manufacturing cost and the cost of materials. Additional stabilizers are necessary to position and align the individual cell caps. Strict tolerances are required to provide an acceptable tactile feel for the reader. The reader is sensitive to the separation that is inherent between each cell with this design. This unevenness between each cell plagues all Braille displays known in the prior art. To tactile users, the tactility of the grooves and cell-to-cell unevenness is comparative to the noise or flicker on a computer monitor experienced by a visual user. Additionally, maintenance and replacement of the individual tactile pins is often necessary. Contaminants that build up on the pins must be removed or the pins must be replaced upon excessive wear.

Accordingly, there is a need in the art for an improved electromechanical tactile cell for use in a refreshable Braille display. Improvements in manufacturability and repair are necessary in addition to enhancements in the tactile experience of the user. There is a need for an improved means for securing the piezoelectric reeds to the printed circuit board and establishing the necessary electrical connections. There is additionally a need for an improved alignment procedure for the individual cells that enhances the user interface and allows for easy maintenance of the tactile pins.

However, in view of the prior art considered as a whole at the time the present invention was made, it was not obvious to those of ordinary skill in this field that the identified improvements should be made nor would it have been obvious as to how to make the improvements if the need for such improvements had been perceived.

SUMMARY OF THE INVENTION

One of the advantages afforded by the present Braille display is that it can be made in a very small form factor thereby permitting the display to be transportable and hand held.

Another advantage of the disclosed display is that it can be constructed with minimal labor thereby minimizing manufacturing time and costs.

Yet another advantage is realized by constructing a Braille cell assembly with the aid of an alignment guide, whereby contacts associated with the cell assembly can be quickly and properly oriented upon a printed circuit board.