

controlled pin movement in the openings for steaming Braille text in the forward order and the second actuator set causes controlled pin movement in the openings for streaming Braille text in the backward order.

The method for streaming Braille text in either forward or backward order at a display area of this invention includes the steps of effecting relative movement in either of two directions between a station and a display surface and selectively activating actuators at the station while effecting the relative movement in a first of the two directions to set pins at selected positions relative to the display surface by contact with the pins. Relative movement in either the first or a second of the two directions is continually effected to selectively reset the pins at selected positions relative to the display surface by selectively activating the actuators at the station to cause contact with the pins.

The implementation of the apparatus of this invention embodied for streaming of Braille text at a display surface and characterized as a rotating cylinder refreshable Braille reader would produce computer-refreshable Braille text for tactile reading by the blind and visually impaired. This implementation will improve accessibility to computer services such as electronic books, e-mail and other network access, and general computer use. The apparatus is designed to be mechanically simpler than existing refreshable Braille reader devices, while providing much of their functionality as well as additional features. The design of this apparatus allows for greatly lowered cost and improved reliability in comparison to existing systems and can be implemented in such a way as to provide refreshable Braille text to the user from a typical reading rate of 60 to 125 words per minute up to a high reading rate of 250 words per minute and in either forward or backward text streams (i.e., forward or reverse cylinder rotation).

The rotating cylinder refreshable Braille reader of this invention addresses cost and reliability issues of heretofore known systems by greatly reducing the number of actuators utilized to set Braille text at a reading surface, from hundreds in heretofore known implementations, to as few as three or four (though as many as sixteen may be desirable) depending on the particular configuration. Instead of a static linear array of Braille cells that the user reads by moving one or more fingers along the line, the rotatable wheel Braille reader herein disclosed sets the Braille dots on the surface of a wheel or disk, which rotates under the user's finger, giving the user the sensation of a line of static Braille text moving under the user's finger. The Braille text on the wheel is refreshed as the wheel rotates, either in a repeating pattern around the wheel, or (using actuators internal or external to the wheel) at a specific point in the rotation of the wheel, setting a pattern of Braille dots on the wheel that are passively retained until they have passed under the reader's finger, after which they may be erased and then rewritten in the next rotation.

The preferred embodiments of the reader apparatus of this invention use a passive pin displacement approach, which can be used as the basis for either an external or internal actuator stationed refreshable Braille display. It can also be adapted to a linear Braille display, to certain types of tactile graphic displays, and may be applicable for non-accessibility application. Multiple Braille cells (potentially a large number) may be deployed displaying a valid text stream to the user. Improved control, precision, reliability of the device, greater versatility of operation, rapid display, long useful service life for the device, and extremely low cost of manufacture compared to now known systems will be achieved. The apparatus of this invention also utilizes

means for replacing substantially continuously powered actuators with passive position retention, thereby greatly lowering the cost of manufacture and operation of a Braille display in a robust and mechanically simple manner.

It is therefore an object of this invention to provide improved apparatus and methods for producing a refreshable tactile display.

It is another object of this invention to provide apparatus and methods for streaming a tactile display at a display area.

It is another object of this invention to provide apparatus and methods for producing refreshable Braille text that can be streamed at a display surface in either forward or backward order by utilizing bi-directional relative movement of components of the apparatus.

It is another object of this invention to provide improved tactile display apparatus producing computer-refreshable Braille text for reading by the blind and visually impaired to improve access to computer services such as electronic books, e-mail and other network access, and general computer use.

It is still another object of this invention to provide a refreshable Braille reader apparatus that is mechanically simple and reliable, compact, lower in cost, fast, and that provides improved control, precision, and versatility of operation including providing either forward or backward text streaming capability.

It is another object of this invention to provide a refreshable Braille reader including a display assembly having an outer surface, the surface having a plurality of openings therethrough with the openings arranged at the surface in rows, a plurality of pins having first and second ends, each one of the pins mounted in a different one of the openings and movable therein, and actuating means maintained at a station adjacent to the surface of the display assembly for moving the pins, the pins selectively contactable by the actuating means to move the pins in the openings so that the first ends of the pins are selectively raised from or not raised from the surface, at least one of the actuating means and the display assembly being movable relative to the other of the actuating means and the display assembly in either of two directions, the actuating means capable of causing controlled pin movement in the openings while relative movement occurs in either of the two directions.

It is still another object of this invention to provide a refreshable Braille reader including a cylinder connected with a motor for rotation thereof in either of two directions, the cylinder having a cylindrical outer surface a part of which defines a tactile display area and a cylindrical inner surface, the cylinder having a plurality of openings therethrough between the surfaces, the openings arranged in at least three endless rows, a plurality of pins having first and second ends, each one of the pins mounted in a different one of the openings and movable therein, static actuators at least equal in number to the rows of openings through the cylinder maintained at a station adjacent to the cylinder, the actuators positioned and configured so that the pins are selectively contactable at either of the ends by different ones of the actuators during cylinder rotation in either of the two directions so that the first ends of the pins are selectively positioned relative to the outer surface of the cylinder thereby streaming Braille text across the display area in either forward or backward order depending upon selected direction of cylinder rotation, and user controls allowing control at least of direction of rotation of the cylinder.

It is yet another object of this invention to provide a method for streaming Braille text in either forward or