

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.

Embodied as a refreshable Braille reader, the display area of the housing is a reading aperture. The structure includes a rotatable wheel assembly with a wheel connected to a motor for rotation thereof, the wheel defining the tactile display surface at an outer edge thereof positioned to pass the reading aperture of the housing as the wheel is rotated. The surface characteristic is preferably a plurality of openings through the wheel to the display surface, the openings arranged at the display surface in at least three endless rows. A plurality of pins having first and second ends, are mounted in different ones of the openings and are movable therein by the actuators which are statically positioned adjacent to the wheel in advance of (relative to the direction of rotation) the reading aperture. Actuators at least equal in number to the rows of openings through the wheel but substantially fewer in number than the openings are provided. Selected pins in each row are moved by different ones of the actuators so that the first ends of the pins are positioned relative to the display surface for passage at the reading aperture of the housing. A passive retainer adjacent to the reading aperture of the housing maintains pin position during passage at the reading aperture of the housing.

The apparatus of this invention is more compact, facilitating use in portable devices such as portable electronic book readers. While the mechanism of reading will be different from that of heretofore known linear Braille arrays, and may require a period of familiarization, the lower cost and higher reliability of the herein disclosed apparatus and methods will lead to greatly increased usage of Braille as a machine-user interface thus improving accessibility to information to the vision impaired.

The methods for streaming a tactile display at a display area of this invention include the steps of effecting relative movement between a station and a display surface in a direction substantially parallel to one another and selectively activating actuators at the station to set tactile display characters at positions along the display surface. Relative movement is continued to selectively reset the tactile display characters at the positions along the display surface.

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 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 refreshable tactile display apparatus that are mechanically simple and reliable, compact, lower in cost, fast, and that provide improved control, precision, and versatility of operation.

It is another object of this invention to provide a refreshable Braille reader including a housing having a reading aperture, a rotatable wheel assembly in the housing and including a wheel connected to a motor for rotation thereof, the wheel defining a tactile display surface at an outer edge thereof positioned to pass the reading aperture of the hous-

ing as the wheel is rotated, the wheel having a plurality of openings therethrough to the display surface, the openings arranged at the display surface 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, and a static actuator assembly mounted at the housing and including actuators at least equal in number to the rows of openings through the wheel but substantially fewer in number than the openings, whereby selected pins in each row are moved by different ones of the actuators so that the first ends of the pins are positioned relative to the display surface for passage at the reading aperture of the housing.

It is still another object of this invention to provide a refreshable tactile display apparatus including a housing having a display area, structure maintainable at the housing and defining a tactile display surface and having a selected surface characteristic at the display surface, and actuators maintained at the housing for selective formation and repeated selective reformation of tactile display characters at the display surface of the structure in cooperation with the selected surface characteristic, at least one of the tactile display surface of the structure and the actuators being movable in a direction substantially parallel relative to the other of the tactile display surface of the structure and the actuators so that a tactile display is streamed at the display area of the housing.

It is yet another object of this invention to provide a method for streaming a tactile display at a display area that includes the steps of effecting relative movement between a station and a display surface in a direction substantially parallel to one another, selectively activating actuators at the station to set tactile display characters at positions along the display surface, and continuing the relative movement to selectively reset the tactile display characters at the positions along the display surface.

With these and other objects in view, which will become apparent to one skilled in the art as the description proceeds, this invention resides in the novel construction, combination, arrangement of parts and method substantially as hereinafter described, and more particularly defined by the appended claims, it being understood that changes in the precise embodiment of the herein disclosed invention are meant to be included as come within the scope of the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings illustrate a complete embodiment of the invention according to the best mode so far devised for the practical application of the principles thereof, and in which:

FIG. 1 is simplified illustration of an apparatus in accord with this invention;

FIG. 2 is simplified illustration of another apparatus in accord with this invention;

FIG. 3 is simplified illustration of yet another apparatus in accord with this invention;

FIG. 4 is a block diagram of implementation of the tactile display apparatus in accord with this invention;

FIG. 5 is a process flow diagram of a preferred embodiment of the tactile display apparatus of this invention;

FIG. 6 is a simplified illustration of a preferred embodiment of one display apparatus of this invention, with portions illustrated representationally and/or cut away and/or exaggerated for better illustration of the principles thereof;

FIG. 7 is a simplified illustration of an actuator grouping usable in the apparatus of FIG. 6;