

backward order at a display area including the steps of effecting relative movement in either of two directions between a station and a display surface, 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, and effecting relative movement in either the first or a second of the two directions 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.

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;

FIG. 8 is a simplified illustration of an actuator embodiment usable in the apparatus of FIG. 6;

FIG. 9 is a simplified illustration of another actuator embodiment usable in the apparatus of FIG. 6;

FIG. 10 is a simplified illustration of another actuator embodiment usable in the apparatus of FIG. 6;

FIG. 11 is a simplified illustration of yet another actuator embodiment usable in the apparatus of FIG. 6;

FIG. 12 is a simplified illustration of yet another actuator embodiment usable in the apparatus of FIG. 6;

FIG. 13 is a simplified illustration of a passive default positioning device usable with the apparatus of FIG. 2;

FIG. 14 is a simplified illustration of a passive default positioning device usable with the apparatus of FIG. 6;

FIG. 15 is top view of the default positioning device of FIG. 14;

FIG. 16 is a simplified illustration of a position retaining device usable with the apparatus of this invention;

FIG. 17 is partial bottom view of the retaining device of FIG. 16;

FIG. 18 is a side view of an alternative pin design usable with the apparatus of this invention;

FIG. 19 is a simplified illustration of an alternative pin/aperture arrangement usable with the apparatus of this invention;

FIG. 20 is a simplified illustration of an actuator grouping implementation usable with the apparatus of FIG. 6;

FIG. 21 is a simplified illustration of another actuator grouping implementation usable with the apparatus of FIG. 6;

FIG. 22 is a simplified illustration of a combination actuator/position retention device alternatively usable with the apparatus of FIG. 6;

FIG. 23 is a simplified illustration of a linear tactile display apparatus in accord with this invention;

FIG. 24 is a simplified illustration of a position retaining device used to retain multiple pin elevations in apparatus of this invention;

FIG. 25 is a simplified diagrammatic illustration showing a first embodiment of a bi-directional implementation of the apparatus of this invention;

FIG. 26 is a simplified diagrammatic illustration showing a second embodiment of a bi-directional implementation of the apparatus of this invention;

FIG. 27 is a simplified diagrammatic illustration showing an actuator for an actuator grouping implementation usable with the apparatus of FIG. 27; and

FIG. 28 is a simplified diagrammatic illustration showing an offset arrangement for an actuator assembly as shown in FIG. 27.

#### DESCRIPTION OF THE INVENTION

The most common method of reading Braille is to slide one or more fingertips across a line of Braille characters, relative motion of the Braille text and the fingertip being necessary for the sensation of touch that permits the most efficient reading of Braille. The user may tend to skip quickly over "expected" characters, and occasionally to backtrack to re-read or confirm some characters. Reading is usually on a word by word basis.

In its most general terms as shown in FIG. 1, the preferred embodiment of the invention described herein replaces a line of refreshable Braille characters with a rotatable assembly streaming text across a reading area, for example (in one embodiment) including a wheel or cylinder 27. Wheel 27 (a cylinder, disk or the like) has an outer rim with height at its outer edge (or face) 29 at least equal to the height of a Braille character, with refreshable Braille characters definable at a selected surface characteristic 31 at tactile display surface 33 along outer edge 29 of the wheel 27 (around the cylinder face) and rotatable about the axis of the cylinder.

Wheel 27 is recessed into surface 35 of housing 37 so that only a small portion of the cylinder (for example, the width of two Braille characters) is exposed above surface 35 at a display area (or reading aperture) 39 (see FIG. 2). The user places a finger on the exposed surface of the wheel. Instead of the user sliding a finger along a motionless line of Braille characters, the rotation of the wheel causes the Braille characters to slide (or stream) past the finger, allowing them to be read.

With the primary objectives of this design in mind (to create a Braille reader with greater mechanical simplicity and reliability and at a lower cost than existing Braille readers), several alternative embodiments for implementation of the objectives are realized.

Actuators may be placed within cylinder 27 or along a shaft on which the cylinder rotates. Braille cells 41 are