aperture, but may result in a risk of accelerated or uneven wear of the pin or the opening in which the pin moves. Pin rotation can be eliminated by utilization of pin and opening configurations defined by a non-circular cross-section.

Conventional Braille uses two dot levels, extended (dot) and retracted (no dot). It is possible to generate additional levels, however, for other application utilizing the display device of this invention by employing actuators capable of multi-position extension and multiple position retention devices **219** (as illustrated in FIG. **24**, replacing the two position devices as shown in FIGS. **16** and **17**, for example).

As may be appreciated, the various line displays in accord with this invention could be combined in a single unit to produce multi-line displays. A single set of actuators could be shifted between pin set arrays to write a line at a time in sequence (separate pin retention and default positioning devices would be required for each pin set array, separate motors for each pin set array utilized to retract all the pin position retention devices simultaneously, thus speeding page refresh).

Alternative configurations of the wheel-based display could include configuration with the inner surface of the wheel as the reading surface rather than the outer surface (with appropriate provision of a reading aperture adjacent to the inner surface of the outer ring). Such configuration would simplify positioning of the non-rotating parts since they would be mounted outside the wheel rather than inside it. Another alternative configuration would include an optional user preprogrammed stop/start mode which would cause the Braille wheel to stop rotation at selected intervals until prompted by the user, allowing the user to read text of the selected length while the wheel is motionless.

The linear or wheel-based displays of this invention could be used for graphic applications by provision of more than three or four rows of pins. In such case, graphic capabilities would be enhanced by the ability to achieve multi-level positioning of the pins as discussed hereinabove with respect to FIG. **24**. Use of an elastic sheet stretched over the display area could be used to smooth out irregularities of the display cause by the discrete placement of the pins. Furthermore, non-display applications are possible utilizing the principles herein disclosed, for example in the field of mechanical data storage or other MEMS applications.

What is claimed is:

1. A refreshable Braille reader comprising:

a housing having a reading aperture;

a rotatable wheel assembly including a wheel connected to a stepper motor for rotation thereof, said wheel defining a tactile display surface at an outer edge thereof, said wheel having a plurality of openings therethrough to said display surface, said openings arranged at said display surface in at least three endless rows and said wheel mounted in said housing with said tactile display surface positioned to pass said reading aperture as said wheel is rotated;

a plurality of pins having first and second ends, each one of said pins mounted in a different one of said openings and movable therein;

a static actuator assembly concentrically mounted relative to said display surface of said wheel at said housing and adjacent to said display surface of said wheel and including actuators at least equal in number to said rows of openings through said wheel but fewer in number than said openings, said actuators positioned in advance of said reading aperture relative to the direction of wheel rotation and including shafts selectively extendible for contacting said second ends of said pins to move said pins, said second ends of said pins in said rows selectively contactable by different ones of said actuators so that said first ends of said pins are selectively positioned relative to said display surface; and

a static position retainer maintained adjacent to said reading aperture of said housing at a location adjacent to said wheel for passively securing position of said pins during a selected extent of rotation of said wheel.

2. The refreshable Braille reader of claim **1** wherein said actuator assembly includes a passive pin positioner for returning pins to a preselected default position relative to said display surface of said wheel.

3. The refreshable Braille reader of claim **1** further comprising an onboard controller connectable with an external text driver, wherein said motor and said actuators are connected with said onboard controller, said reader further comprising optical position registration connected with said onboard controller providing wheel position feedback to control actuator timing.

4. The refreshable Braille reader of claim **1** further comprising user controls connected with said motor providing user control of wheel rotation including at least one of rotation stop/start and rotation speed.

5. The refreshable Braille reader of claim **1** wherein said pins each include a head at said second end and a shaft between said first and second ends, said heads enlarged relative to said shafts and said first ends of said pins, and wherein said static position retainer includes retainer elements at least equal in number to said rows of openings at said wheel of said wheel assembly, said pin heads retained at one side or the other of said retainer elements depending on actuator contact or noncontact of said pins at said static actuator assembly.

6. A refreshable Braille reader comprising:

a housing having a display area;

a rotatable cylindrical structure maintainable at said housing and defining a tactile display surface at an outer cylindrical face, said cylindrical face having a selected surface characteristic at said display surface; and

an actuator assembly mounted at said housing concentrically relative to said cylindrical structure, said assembly including actuators positioned in advance of said display area of said housing relative to a direction of rotation of said cylindrical structure and having shafts selectively extendible for contacting said selected surface characteristic at said display area for selective formation and repeated selective reformation of tactile display characters at said display surface of said structure, said tactile display surface of said cylindrical structure rotatable relative to said actuators so that a tactile display is streamed across said display area of said housing.

7. The Braille reader of claim **6** wherein said selected surface characteristic of said structure comprises openings having pins movable therein by contact with said actuators.

8. The Braille reader of claim **7** wherein said selectively extendible shafts of said actuators contact and move said pins to a least one of extended or retracted positions relative to said display surface of said structure, the number of actuators being fewer than the number of pins.

9. The Braille reader of claim **6** wherein no more than sixteen actuators are provided.

10. The Braille reader of claim **6** wherein no more than four actuators are provided.

11. The Braille reader of claim **6** wherein said selected surface characteristic comprises a mechanically plastic cov-