actuators **260** is therefore used for both forward and reverse writing (under the control of properly programmed control implementation **65**/driver **81**), and the user reading the Braille text can thus request movement arbitrarily far forward or backward along the line of text by controlling cylinder rotation at user input **75** of controller **65** (FIG. **4**). Again, position retaining device **99** operates as before and is accessible in either direction of cylinder rotation.

FIG. **27** illustrates one way to implement the array of dual directional actuators **260** to control position of pins **81**. Actuator shafts **265** of individual actuators **266** in assembly **260** (only one of which is shown in FIG. **27** for ease of illustration) are configured with arms **267** and **269** each having a contact tip **271** and **272**, respectively, thereat. Actuators **266** are positioned so that contact tips **271** and **272** are located to provide the ability for the actuator to push either head **85** (by contact tip **271** at inner cylindrical surface **104**) or pin tip **84** (by contact tip **272** at cylindrical outer surface **33**) of each pin **81**, causing pin **81** to be extended or retracted in opening **93**, regardless of the initial position of the pin. Bi-directional mechanical drivers **275** for extending and retracting shafts **265** can be used. Alternatively, in some embodiments, a single-directional driver with high speed return mechanism, such as a spring, could be utilized. FIG. **28** illustrates a portion of assembly **260** of actuators **266** showing one construction of shaft arms **269** thereof (arms **267** would be similarly constructed) providing offset constructs **276** at the end of some of the shaft arms (in advance of contact tips **271** and **272**) in assembly **260** so that all pins **81** across rows **121** of pins in the Braille cells can be controlled.

It should be appreciated, as made evident in FIGS. **27** and **28**, that drivers **275** of individual actuators **266** in assembly **260** are not, as heretofore taught, positioned inside cylinder **27** (as illustrated in FIG. **4**). Instead, the drivers must be positioned so that actuator shafts **265** move adjacent to one circumferential edge **277** (either inside or outside) of cylinder **27**, thus allowing arms **267** and **269** access at either side of pins **81**, one arm above surface **33** and one arm below surface **104** of cylinder **27**. Moreover, while actuator assemblies **250** and **45** in combination with default positioning device **212** are illustrated in FIG. **25**, device **212** could be eliminated from this embodiment by providing dual directional actuator assemblies **260** in place of assemblies **250** and **45**.

Use of either embodiment having dual directional actuators as taught herein (using either a single actuator assembly or a pair of actuator assemblies) preferably employs static actuators in an actuator assembly at least equal in number to the rows of openings through the cylinder, with pins in the rows thereby being selectively contactable by different ones of the actuators in an assembly during cylinder rotation in either forward or reverse direction so that the tips of the pins are selectively positioned relative to the surface of the cylinder in the display area. In this way Braille text is selectively streamed across the display area in either forward or backward order depending upon direction of cylinder rotation.

The use of a bi-directional actuation mechanism as described herein can also be used with the linear or multiline display device of this invention (as shown in FIG. **23**). Use of bi-directional actuation would eliminate the need for a separate pin reset device (**212** in FIG. **23**), and allow the write head assembly (**210** in FIG. **23**) to operate in both directions. For example, an actuator assembly **260** discussed above could write one line of Braille on a left to right sweep across the line of the display, then write the next line on the return (right to left) sweep. Such an implementation of the device shown in FIG. **23** would require a modification of the pin retention device **99** to provide a pin retention device that could track the actuators at assembly **210** from both the right and left and that could be released independent of the motion of the write head assembly.

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 or cylinder 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 caused 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 display assembly having an outer surface, said surface having a plurality of openings therethrough with said openings arranged at said surface in rows;

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; and

actuating means maintained at a station adjacent to said surface of said display assembly for moving said pins, said pins selectively contactable by said actuating means to move said pins in said openings so that said first ends of said pins are selectively raised from or not raised from said surface, at least one of said actuating means and said display assembly being movable relative to the other of said actuating means and said display assembly in either of two directions, said actuating means capable of causing controlled pin movement in said openings while relative movement occurs in either of said two directions.

2. The Braille reader of claim **1** wherein said actuating means includes at least a first actuator assembly having actuators at least equal in number to number of said rows of said openings, each said actuator including a driver, a shaft selectively extendible and retractable by said driver and first and second contact tips at said shaft, said contact tips of each said actuator in said actuator assembly positioned relative to said pins in a said row so that said first contact tip can