Instead of device **212**, pin reset can be performed as a separate function, for example by a roller or magnet that sweeps across the display area. Additionally, it may be desirable to shield the part of the line of Braille text being written from finger contact, by a protective cover over the section of the display that is being written (at actuator **49**) and that follows the position of the moving actuator or actuators. The cover should not prevent tactile access to pins **81** that have already been set and that are being held in place by retention device **99**. With such a cover in place, the actuators that set the pins need not work against finger pressure, permitting faster writing action, with lower powered actuators. Actuators **49** that set pins **81** need not be mounted directly on assembly **210**. Mechanical linkages to assembly **210** responsive to actuators **49** located at a fixed position could be conceived to drive a mechanical pin setting apparatus at assembly **210**.

Passive pin retention device **99** is configured to be as long as the entire line of Braille cells in the display. Thus the entire Braille display assembly in this case will be more than twice as long as the line of Braille displayed. If, however, the passive pin retention device is made of strips of flexible material, supported along the sides away from the pins and of sufficient flexibility to support large-radius curves along its length but sufficiently stiff to prevent lateral flexing (steel tape for example), then the strips may be guided along tracks, grooves and/or wheels to wrap around under the moving assembly and thus extend to at its end in the direction opposite the direction of actuator movement. This would allow a linear display to be built with a total length not much greater than the length of the line of Braille displayed. If the material forming the retention device were even thinner and more flexible, the retention device could be maintained, fed from and reloaded at a spring-loaded roller.

A linear display would display a line at a time, and the line would be scanned in from one end to the other, unlike the near-simultaneous update possible with the conventional linear displays that use a separate actuator for each dot. However, with fast actuators, the time to write an entire line would be relatively short. Given the savings achievable in cost of the linear device of this invention due to the greatly reduced number of actuators, the time delay is felt to be acceptable.

Any degree of friction in the display system of this invention increases the amount of energy required to operate the display and increases the potential for wear of parts. A certain amount of friction in the motion of the pins along their shafts may be desirable to prevent the pins from slipping out of position during text or other tactile display cycling (i.e., during the transition from actuator to retaining device, from retaining device to passive positioning device, and from passive positioning device to actuator), thus rendering the device less susceptible to outside influences of gravity and vibration. A certain amount of friction in the system can also reduce the risk of build-up of internal vibrations leading to excessive system noise, timing errors and damage.

With these factors in mind, production of the display should take into account both the friction and the wear resistance of the components. Some form of lubrication is desirable (for example, a dry powder lubricant such a graphite or, where stiffening of component movement is desired, various known greases). Friction may be introduced into the system in a controlled manner at the transition points in the display cycle by application of a soft, compressible material such as felt, for example.

Pin shafts with a circular cross-section may have a tendency to rotate in their openings as the wheel rotates. This will not affect readability of the display at the viewing 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).

Turning now to FIGS. **25** through **28**, embodiments of this invention configured to allow extensive actuation of pins no matter direction of travel of the cylinder (or relative direction of travel of actuators and pins in other embodiments) are shown. In these FIGURES, it should be understood that the illustration of the embodiments have been greatly simplified, but that all elements previously discussed (particularly with reference to FIG. **6**) can be and are applied in the embodiments discussed hereinbelow unless otherwise noted. In particular, the various actuator (at least in part) and pin embodiments discussed are understood to be applicable herein as are the various position retaining devices heretofore discussed. It is desirable, however, for at least some of the embodiments discussed below to eliminate the various passive default pin positioning devices heretofore discussed for reset of the pins.

A first embodiment of the apparatus and method utilizing bi-directional relative movement for implementation of a refreshable tactile display is illustrated by FIG. **25**, wherein passive reset of rows **121** of pins **81** in openings **93** as heretofore described (for ease of illustration, none are shown in FIG. **25** or **26**; refer to FIG. **6**) is accomplished with a two ramp default positioning device **212** (as discussed with respect to FIG. **23**). Device **212** is located between assembly **45** and a second set, or assembly, **250** of actuators much like assembly **45**, the two assemblies together comprising an actuator station **255**.

The arrow shows the direction of normal rotation of cylinder **27** for normal reading and advancement of the Braille text, with pins being set by actuator assembly **45**, assembly **250** being inactive. If the user wishes to re-read text that was displayed at reading, or display, area **39** on surface **33** but which has already passed from display area **39** (effectively reading backward), the direction of rotation of cylinder **27** is reversed by the user at user input **75** of controller **65**, and the second set of actuators **250** sets the pattern of Braille text as far back as the user wishes to read (assembly **45** remains inactive during this period) under the control of properly programmed control implementation **65**/driver **81** (FIG. **4**). Position retaining device **99** and default positioning device **212** operate as before and are accessible in either direction of cylinder rotation.

FIG. **26** shows another implementation of a bi-directionally rotatable cylinder for streaming Braille text in either forward or backward order at display area **39**, with only a single set, or assembly, **260** of actuators at station **262**. In this case actuators that can set or reset pins, regardless of the initial positions of the pins, by contacting and moving a pin in either direction in its opening. This design takes advantage of the fact that the user does not expect any text that has already been read to change, so with no automatic reset, all of the text that is at the bottom of the cylinder (outside of the reading area) is still readable if the direction of the rotation of the cylinder is reversed. The single set of