[0083] As shown in **FIG. 8, a** first embodiment of an actuator **49** of the solenoid type for active selective positioning of pins **81** in an endless row **121** of pins from a lowered (retracted from reading surface **33**) default position (utilizing the device shown in **FIG. 14**, for example) to a raised (extended from reading surface **33**) position is illustrated. For ease of illustration, the FIGURES that follow will show a segment of the apparatus of this invention as being linear, the curved implementation required for use at wheel **27** employing the same features and principals. The FIGURES are thus numbered accordingly.

[0084] If actuator shaft **51** is retracted when a particular pin **81** passes the actuator location at station **47**, that pin will remain in the lowered position. If actuator shaft **51** is extended when a particular pin **81** passes actuator **49**, then that pin will be moved to the raised position with end **84** protruding forming a dot at surface **33**. Passive retention device **99** (discussed below) is placed immediately adjacent to actuator **49** so that pins **81** are retained in whichever position achieved after passage by actuator **49** as pins **81** pass by reading aperture **39**.

[0085] Element **137** at the end of actuator shaft **51** that contacts selected pins heads **85** is preferably sloped (**FIG. 8**) relative to the direction of pin travel or rounded (at **139** of **FIG. 9**) so that if actuator shaft **51** is extended slightly before the pin arrives, the pin can slide (up the slope or around the curved surface) to the raised position, thereby simplifying the timing issues for control of actuator **49**. If adjacent pins **81** are both to be moved to the raised position, actuator shaft **51** can safely remain extended during the interval between arrival of the two pins, and both pins **81** will be moved relative to the face of the actuator element **137**.

[0086] If it is desirable that actuator shaft **51** be retracted in between arrivals of adjacent pins **81** that are to be raised (for example, so that much of the raising operation will be implemented by actuator element **137** pushing pins **81** into position, or if required by the geometry of pins **81** and/or wheel **27**), then actuator **49** must be able to cycle at a rate of arrival of pins **81**. If the actuator can remain in position between the arrival of pins to be raised, then the actuator need only be able to cycle at half the fate of pin arrival for such activity. This implementation choice, and the maximum cycling frequency of actuators **49** ultimately determine the maximum rate at which pins **81** can be processed, and therefore the maximum rate at which Braille text can be displayed. The type of actuator, the driving voltage, the characteristics of any actuator return spring where necessary in a particular embodiment of the actuator, the mass of the pins and of any linkages, and the friction of the system all affect the maximum functional rate of operation of the actuators.

[0087] Element **137** (or alternatives thereto discussed hereinafter) at the end of actuator shaft **51** is designed so that it will not extend far enough toward wheel surface **104** to hook or catch on a pin **81** while in the process of retracting. If the actuator is late retracting or late extending, this may result in a pin that is only partially extended. Overall cooperation of the design of the passive retention devices and timing and geometry of the actuator minimizes the risk of this occurrence and errors or device jamming caused thereby.

[0088] One option to further minimize such risk is to place a small wheel **139** on the end of actuator shaft **51**, mounted on an axis **141** for rotation (in the direction of pin travel), as shown in **FIG. 9**. When actuator shaft **51** is extended, pins **81** contact the small wheel **139** and cause it to rotate. This particular construction maneuvers pins **81** thus contacted into the raised position while reducing lateral forces on the pins. The small wheel **139** must be large enough to shift pins **81** by the desired amount and to have a sufficiently shallow angle of initial contact with pin heads **85**, yet small enough to avoid interference with adjacent pins. This, in turn, depends in part on the relationship among pin spacing, pin head diameter, and the distance the pins must travel.

[0089] The solenoid type actuators shown in **FIGS. 8 and 9** are designed to be both extendible and retractable on command, for example utilizing a unidirectional solenoid with spring mounted return motion. An active bi-directional solenoid could also be utilized. The distance of travel of actuator shaft **51**, and thus element **137** at the shaft end, is controlled, for example, by stops or other such means to insure conformance to the geometry requirements of the display apparatus **91**.

[0090] Alternative actuator designs and implementations are described hereinafter and some are illustrated in **FIGS. 10 through 12**. Instead of using solenoid type actuators, electromagnetic actuators **145** could be utilized as shown in **FIG. 10**. The default position of pins **81** would be the raised position (retracted, utilizing the device shown in **FIG. 14**, for example) and pins **81** would be made of magnetically responsive metal (in other embodiments, the material utilized for the pins is of little consequence so long as they are robust). A bank of electromagnets **145** (the number and arrangement thereof being the same as heretofore discussed) mounted in the nonrotating assembly **95** at station **47** of rotating wheel **27** are selectively activated to cause selected pins **81** to move to the lowered (extended) position. Pins **81** thus function as an element of the actuator in such case. The configuration and strength of electromagnets **145** and the geometry and assembly must be chosen to prevent one electromagnet from shifting unintended pins **81** in the same or adjacent rows **121**. Avoiding inappropriate shifting of pins may be assisted by slightly staggering the switching area and electromagnet placement along the path of motion for the different adjacent rows **121**, with pins **81** only able to shift in one row at each position (pins in other rows held by a passive retention device **99**, for example).

[0091] Use of permanent magnets can assist in achieving the goals of maintenance of small actuator size and quick actuator response. Again pin material and geometry are chosen so that pins **81** will not be inappropriately shifted by the electromagnets. Permanent magnets may be incorporated in pin heads **85** and/or shafts **83**, with electromagnetic coils at the various activation positions. Alternatively, permanent magnets **147** may be incorporated in actuator shafts **149** operating against fixed electromagnets **145** in an actuator body (electromagnetic polarity switching controlling movement of the shaft) as shown in **FIG. 11** (exactly the opposite arrangement, as well as combinations thereof, could as well be utilized). Moreover, one large permanent magnet **151** as a fixed component of an actuator could be utilized in conjunction with three (or four) adjacent movable