electromagnets **153** (at actuator shafts **149**) to control positioning across the three or four rows **121** of pins **81** (**FIG. 12**).

[**0092**] Many other actuator configurations may be conceived of without departing from the intended scope of this invention. For example, a sliding spring or Earth's gravity in a lateral shutter arrangement may be used to assist the motion of the pins. In the case of gravity assist, the orientation of the reader in use must be a constant. In the case of spring assist, the pins must be configured with a projection or similar physical feature part of the way along the shaft against which the spring may act. In either case, the actuators are used to operate sliding shutters that move perpendicular to the axes of the pins (i.e., perpendicular to the direction of motion of the pins), opening and closing apertures. When an aperture is closed, a pin moving past is unable to move along its opening and remains in the default position (either raised or lowered depending upon configuration). When an aperture is opened, the spring or gravity assist moves the pin to the non-default position. In either case, the pin is then held in its selected position by a passive position retention device as it moves across the reading aperture.

[**0093**] Another example is similar to the spring-assisted option above, except that the external force to assist or cause motion of pins along their axes is air pressure (i.e., an external source of pressurized air or a source for partial vacuum). A pressurized air source moving the pins to the raised (extended) position would provide the further benefit of cleaning the device and keeping the pin shafts clear of debris.

[**0094**] Other actuator examples utilizable with this invention include rotary actuators (utilizing linkages to convert rotary to linear motion), cam actuators (allowing pins to pass undisturbed on their flat side and rotatable to a position for moving pins relative to their sloped side) and hydraulic actuators. Rotary or cam actuators can be uni-directional or bi-directional in their rotation, should be able to start and stop rotation rapidly, and must be configured for precision positioning. Use of pneumatic or hydraulic actuators may actually provide additional benefits since the bulk of such devices can be physically located at a position other than directly adjacent to the pins. Factors such as compressibility and mass of the working fluid, elasticity of the conduits, and friction should be considered since each will have an effect upon the response time and maximum rate of operation of the apparatus.

[**0095**] Devices for default positioning of pins **81** after reading are shown in **FIGS. 13 through 15**. Again, for ease of illustration, **FIG. 13** and FIGURES following show a linear implementation of the default positioning and position retaining systems (a curved implementation for use at a segment of wheel **27** would employ the same structure and principles). The collection of pins **81** mounted through openings (or apertures) **93** in a block of material forming the readable surface **33**, are capable of movement back and forth through the block in their respective openings (in FIGURES and **14**, pins **81** that are moved to the right are considered raised, because tips **84** of pins **81** extend beyond reading surface **33** of the block and are thus felt as bumps, or dots, at the surface). The block segment shown in **FIGS. 13 and 14** is moving in the direction illustrated by the arrow with respect to a non-moving retaining wall **161** (for example, surface **163** of structure **97** in **FIG. 6**) to which the positioning devices are attached and that limits the extent to which pins **81** can be retracted. As they approach the default positioning devices, pins **81** may be in either the raised or lowered positions.

[**0096**] **FIG. 13** shows default positioning device **165** including ramp structure **167** affixed at the non-moving portion (i.e., structure **97**). As wheel **27** moves past ramp **167**, pins **81** that were in the lowered position are forced into the raised position. Pins that are already in the raised position are unaffected. The result is that all of the pins are forced into the raised position (extended from the surface) as they pass ramp **167**, and are kept in that position by extending the end of the ramp along the direction of travel as is needed until acted upon by an actuator (external as in **FIG. 2** or magnetic as in **FIG. 10**, for example). Note that in a Braille display, the passive system that positions and holds pins in the raised position and the length of the pins must be sufficiently tightly controlled to meet the dimensional specifications for a raised Braille dot.

[**0097**] In **FIG. 14 a** different type of device (**101** as used in **FIG. 6**) is shown. Passive ramp structure **169** is used to force all of the pins to the lowered position (retracted from surface **33**). Since pin shafts **83** must be able to pass unhindered through ramp structure **169**, ramp structure **169** includes plural ramp elements **171** defining slots **173** between element **171** (as shown in **FIG. 15** for only three rows **121** of pins **81**, it being understood that a similar ramp structure for four rows of pins could be provided). Slots **173** are wide enough to allow passage of pin shafts **183**, but narrow enough to allow ramp engagement of pin heads **85**. Pins **81** in the lowered (retracted) position can be recessed well below the surface of the block of material, so pin configuration is not as critical for proper Braille reading as would be true for positioning of raised pins. Ramp elements **171** include a leading edge **175** at surface **104** of the block to engage pins **81** in slots **173** (thus the necessity for pin heads with rounded edges to assure smooth engagement). As wheel **27** passes ramp **169**, pins **81** are borne away from the surface **104** by their heads **85**.

[**0098**] **FIGS. 16 and 17** illustrate use of passive device **99** to retain pins **81** in raised or lowered position for user reading, in whichever position they are in when they encounter device **99**. Leading edge **179** of device **99** is rounded or pointed or both to minimize the risk that a partially extended pin could jam the device (and thus the entire system). If a pin **81** is in the raised (extended) position, retaining device **99** maintains the pin thereat at top face **181** of head **85**, resisting external forces such as gravity, vibration, and finger pressure to retain the dots in a readable position with end **84** protruding from surface **33**. If a pin **81** is in the lowered position, the retaining device holds the pin in place by underface **183** of head **85** and shaft **83** of the pin passes through slot **185** formed by retainer elements **187** of retaining device **99** (**FIG. 17**, only one retaining slot **185** being shown for one of the three or four rows **121** of pins **81**, it being understood that side by side elements **187** forming sufficient such slots **185** for all rows **121** would be provided).

[**0099**] Retaining device **99** serves multiple purposes. It separates pins **81** into distinct raised or lowered positions,