during reading. A controlling mechanism (manual or automatic) sets array **67** in one of several positions depending on the function being performed by the display. An example would be a three-position locking mechanism. The sheet has holes **69** to allow the motion of the pins each defining a spring-like or clip-like structure **65** made out of the material of array **67** and associated with each of the holes **69**. The clips engage features (heads, ridges, or grooves) on pins **21**.

[**0053**] For the three-position design, sheet array **67** is positioned in an intermediate position during the pin setting process, so that clips **65** lightly engage pins **21**, and the pins that are set move frictionally past the clip arms **71** and are held temporarily thereby. After the pin setting process is completed, sheet array **67** is shifted laterally to a second position where the clips firmly hold the pins in place (i.e., the pins are locked in position) to resist finger pressure as the user reads the display. During reset of the display, the sheet may be shifted back to the intermediate position to lightly engage the pins, or to a third position where the clips are completely disengaged from the pins (the third position can be used if the display is always positioned so that gravity will hold the pins in the reset position until the writing process begins). Flexible clips offer the benefit of providing two functions (temporary retention and locking) in one layer of the display though two layers may still be desired (as shown in **FIG. 13**).

[**0054**] Pin locking is based on the application of a small amount of force (from a source other than the actuators that set the pins) to engage a mechanical interlock that holds the pins firmly in place and resists finger pressure while the user reads the display (such as clips **65** discussed above). Because of the close spacing of the pins and consequent small dimensions of the pin features, the actual travel distance of the interlock mechanism may be very small—less than the distance between pins. Mechanical stability can be provided by configuring the interlock mechanisms for all the pins onto a single sheet, which is incorporated in the stack that forms the pin matrix, and which is allowed to move laterally a sufficient distance to engage and disengage the interlock. Because thousands of pins may be engaged or disengaged simultaneously, the force to engage or disengage each pin must be relatively small. Because the distance for the interlock mechanism is small and relatively high precision of motion is required, it is desirable for the actuator that controls engagement and disengagement of the interlock to operate through a precision linkage in which a large motion of the actuator results in a small motion of the interlocks (not shown). This configuration also serves to amplify the force applied to the interlocks, and reduces the resistance the actuator must provide to disengagement of the interlocks during times the user is applying force to the pins while reading. A buckle mechanism would be an example of a linkage that provides considerable mechanical advantage when engaging, and considerable stability when fully engaged.

[**0055**] When the pins are being set during the writing process, there is a risk that a small number of pins will not be moved fully to the positions desired, and will remain in intermediate positions. Depending on the configuration of pin and interlock mechanism, a pin in an intermediate position could interfere with the proper operation of the interlock mechanism by requiring excessive force for interlock to occur, or by causing damage to pin or interlock mechanism. A small number of incorrectly set pins could potentially interfere with the ability of the locking mechanism to correctly lock the remainder of the pins. This can be avoided by shaping the pin and interlock features to minimize the likelihood of jamming, and by providing resilience in the interlocks or the drive mechanism to minimize the damage caused by jamming and to permit correct locking of pins that have been set to the correct positions.

[**0056**] Many possible interlock methods involve contact with pins **21** that is primarily on one side of the pin, because the motion of the locking mechanism causes the interlock to press against the pin on that side. If a larger contact area or more symmetric locking is desired, two interlock mechanisms (for example two sheets with attached or integrated interlock features) can be provided that move in opposite directions, so each pin is contacted by two locking mechanisms on opposite sides. This approach requires two locking layers **43** in the stack that makes up the pin holding matrix of layers.

[**0057**] Beside clip sheet array **67**, a layer **43** including sheet **75** having oversize round or ovoid holes **77** therein could be utilized for pin locking (see **FIG. 10**). Pins **21** pass through round or oval-shaped holes **77** of sheet **75** that are larger in diameter than shafts **27** of the pins. In the unlocked position, the pins can move in and out of the matrix (i.e., perpendicular to display surface **23**) without contacting edges **79** of holes **77**. When sheet **75** is shifted laterally to the locked position, edges **79** of the holes closely contact the pins, and ridges, grooves, or other features on the pins are prevented from moving through the holes in the sheet. Oval-shaped holes (with small radius of curvature matching pin shaft **27** radius) have an advantage over round holes, because when the pins are locked at this point, a larger fraction of the circumference of the pin is contacted by the locking mechanism than would be the case with oversize round holes.

[**0058**] **FIG. 11** shows yet another example of a pin locking mechanism that may be employed, wherein compressible material such as rubber is utilized. The use of a compressible material such as rubber as part of the locking mechanism is attractive because it minimizes the effects of jamming, and prevents locking problems with one pin from interfering with the locking of the other pins. The main concerns with this use of compressible material would be slippage and wear. For example, pressing a rubber sheet against the smooth shafts of the pins may permit the pins to slip, and if they slip they will contribute to the wear of the rubber material. To minimize the slippage that can result in wear, it is desirable in this embodiment to use jagged interlocking edges on pins **21** (ridges **33** may be thus shaped) in combination with interlocking edges **84** at locking sheet layer **85**, so that once the lock is fully engaged, the pins are prevented from sliding against the sheet. Dimensions should be selected so that if a pin is not correctly positioned, and the features on the pin and the locking sheet do not properly line up, then either the pin will move slightly (but not enough to cause significant wear) until the features line up correctly, or else the compressible material will compress to the extent that the pin is held in its then current position, and none of the display components suffers damage.

[**0059**] The compressible material can be a component of locking sheet layer **85**, though the overall structure of the