

trode contact assembly 4355 is positioned so as to make proper contact to the cartridge electrodes. As cartridge tray 4320 retracts further into the reader, rollers 4342 ride in the extended flat portion of the track 4370, and mounting frame 4340 and cartridge tray 4320 remain in alignment and move at the same speed and direction, but allowing for positioning of specific assay locations, e.g., electrodes or array elements in the cartridge, under photodiode assembly 4330. Elevation and release of mounting frame 4340 during extension of the cartridge tray follows the reverse of the process described for retraction of the tray.

[0317] FIGS. 44(a)-(b) provide a top view of cartridge tray 4320 and illustrate features present on the tray to allow a user to reproducibly and accurately position and lock cartridge 4380 in place on cartridge tray 4320. FIG. 44a shows a cartridge that is partially inserted in the tray, similar to that shown in FIGS. 43(a) and 43(c). Cartridge 4380 has a skirt and preferably a narrow skirt along both sides of the cartridge that slides into slots along both sides of cartridge tray 4320. The back end of the cartridge is patterned to provide a visual and tactile cue to help the operator hold and orient the cartridge for proper insertion into the instrument. The skirt does not extend along the entire length of the cartridge but ends before this ergonomic zone. As cartridge 4380 is fully inserted into the tray, it also passes under cartridge latch 4420 and contacts pin 4424, which extends under latch 4420 causing the latch to pivot on its axis. This pivoting movement causes a second pin, pin 4426, to insert into notch 4382 on the side of cartridge 4380, releasably locking the cartridge into place, as shown in FIG. 44(b). Spring 4428 is initially stretched by the pivoting motion adding resistance to the rotating motion, and the stretching is reduced as the spring passes the axis of rotation and begins to aid in the rotation instead of resisting it. Pin 4426 is inserted in the notch, thus transferring the spring force to the cartridge and drawing the cartridge in until it meets a reference surface. The spring force maintains the cartridge the locked position and provides positive feedback to the user that the cartridge is correctly positioned. The user may pull the cartridge out of the tray by providing a pulling force sufficient to compensate for the spring force keeping the cartridge in the locked position.

[0318] Latch 4420 has tab 4422 that in the locked position shown in FIG. 44(b) covers optical sensor 4430 to enable cartridge reader 4300's electronics to check that the cartridge is correctly inserted. The tab may have a pin (as shown in the figure) that extends down toward the sensor to provide a stronger optical signal. The tray has additional optical sensors (as indicated in FIG. 37(b) and associated text) including sensors 4440 for use in controlling the movement of fluid slugs in the cartridge. Cartridge tray 4320 may also include integrated heaters (not shown) for maintaining the cartridge at set temperatures during processing. The vertical guides have lateral cutouts that allow the thin skirt region of the cartridge to be inserted but not the tall ergonomic zone. This ensures that the cartridge can be inserted in only one orientation into the instrument. Optionally, the cartridge tray is coated with a water resistant seal to prevent any fluid leakage from affecting the optical sensors and other electronics in cartridge tray 4320. The seal material (which may be a polymeric film) transmits infra-red light used by the optical sensor. Preferably, the seal does not transmit visible light. FIG. 44(a) also shows alignment guide 4326 and vertical guides 4328a and 4328b on each side of the tray, as described above. Optionally, as the cartridge is inserted into cartridge tray 4320, a cartridge

cap passes in close proximity to a surface of cartridge tray 4320, shown in FIGS. 44(a)-(b) as a surface of vertical guide 4328a, so as to prevent insertion of a cartridge that is not properly capped.

[0319] FIGS. 45(a)-(b) provide two views of components of photodiode assembly 4330 that are used to align photodiode 4510 with specific assay regions on cartridge 4380. Photodiode 4510 is mated to optical coupler 4516, a light guide used to maximize the efficiency of light collection while not requiring photodiode 4510 to be located directly adjacent to cartridge 4380. Most of the length of optical coupler 4516 is surrounded by cylindrical conductive shield 4514 to shield the photodiode from capacitive pickup. Photodiode 4510 is mounted in traveler block 4520, which can translate side-to-side or in a transverse direction along guide cylinders 4522 which are slidably mounted into photodiode assembly frame 4530. Traveler block 4520 is spring loaded such that traveler block 4520 latches at the two extreme side-to-side positions and a force sufficient to overcome the spring force must be applied to move the traveler from one side to the other. In one embodiment, this spring force is provided by latching levers 4534 mounted in photodiode assembly frame 4530. Pins on levers 4534 engage slots in assembly frame 4530 such that the side-to-side motion of the traveler block causes the latches to pivot and stretch spring 4538. Electrodes 4334 from the electrode array of cartridge 4380 are shown in the exploded view of FIG. 45(a) to show their positions relative to photodiode 4510.

[0320] Traveler block 4520 as shown in FIG. 45(b) illustrates photodiode positioning pins 4524, which extend downwardly from traveler block 4520 and couple the motion of mounting frame 4340 to the side-to-side motion of the traveler block. This coupled motion is shown schematically in FIGS. 46(a)-(g). When mounting frame 4340 is in the lowered position, as shown in FIGS. 43(d) and (e), movement of cartridge tray 4320 along its axis causes an inserted cartridge 4380 represented schematically by two linear arrays of electrodes 4334, and mounting frame 4340 to move or translate at the same speed. In FIGS. 46(a)-(g), traveler block 4520 is represented by a rectangular shape, and positioning pins 4524 are represented by two dark spots. In FIG. 46(a), traveler block 4520 is positioned in the leftmost position and movement or translation of cartridge tray 4320 aligns the photodiode or preferably optical coupler 4516 with any of the electrodes in the left flow cell. As the cartridge tray is moved toward the extended position shown in FIG. 46(b), traveler block 4520 remains in the left position until left positioning pin 4524 hits a slanted control surface defined in mounting frame 4340, driving traveler block 4520 to the right position, as shown in FIG. 46(c). Retraction of the tray can be used to align the photodiode or optical coupler 4516 with electrodes in the right flow cell. During this movement, right positioning pin 4524 contacts spring loaded pivot cam 4610, which is mounted on mounting frame 4340, causing pivot cam 4610 to pivot around pivot 4612, as shown in FIG. 46(d). The spring force provided by spring 4614 is selected to be low enough that the traveler block remains in the rightmost position, as shown in FIGS. 46(d) and 46(e). As shown in FIGS. 46(f) and 46(g), traveler block 4520 is shuttled back to the far left position by extending the tray until right positioning pin 4524 contacts a slanted control surface located on the bottom of pivot cam 4610 driving traveler block 4520 to the left position, as shown in FIG. 46(f). As shown, pivot cam 4610 is mounted such that it can pivot in response to a retracting tray