

[0237] One important embodiment of the present invention is that each bay is individually controlled and can be used to run any assay. For example, rather than have a user load a plurality of chips and then insert them sequentially into a bay, the present system allows the user to load a cartridge, scan and insert it into the instrument, start the assay and then load the next sample.

[0238] When an optional EPROM, EEPROM or RFID tag is contained within the cartridge, for example on the bottom substrate, which encodes the identification of the assay, the bays can optionally include an EPROM, EEPROM or RFID reader, such that the instrument reads the tag and loads the appropriate assay protocol for that particular assay. In some embodiments, some or all of the executable step program is stored on the EPROM and not on the bay processor.

[0239] This may also be accomplished using a barcode reader and barcode on the cartridge itself.

[0240] The bays optionally include a lighting indicator system as well that is associated with bay status. That is, the lighting indicator system will indicate any number of optional steps, including but not limited to, whether the bay is empty, the presence or absence of a cartridge, whether the cartridge assay is underway, assay complete, and a process error. The lighting system can be different colored lights and/or flashing lights and/or absence of light or any combination thereof (e.g. "error in processing" could be red, or no light; "ready to load cartridge" could be green, "assay underway" could be flashing green, etc.).

[0241] The bays optionally include one or more "off chip" heaters for reactions such as PCR amplification reactions, isothermal amplification reactions, enzymatic reactions (e.g. the generation of enzyme substrates that are redox active), etc. These thermal elements can be positioned in a variety of ways depending on the assay requirements. Several designs are shown in the figures, including the use of pogo pins to power the thermal element(s).

[0242] The bays optionally include Peltier heaters that serve all or part of the biochip, to heat and/or cool reactions, allow isothermal reactions, or allow all the bays to keep a constant temperature no matter their location within a bank.

[0243] The bays optionally include magnetic actuators, to allow the generation of magnetic fields on all or part of the biochip as needed, for example to collect and wash magnetic beads that have adhered nucleic acid target samples. This technology includes the use of the Boom patents, including U.S. Pat. No. 5,234,809, hereby incorporated by reference in its entirety for the use of particles for the purification and/or isolation of nucleic acids.

[0244] The bays include individually and optionally include components selected from the group consisting of thermal connections, spacing layers, framing layers, cartridge mechanisms, framing, fans, linear actuators, air flow systems, rotary dampers, spring loaded latches, lock-in mechanisms, etc., as depicted in the Figures. For example, cartridge mechanisms that lock a cartridge in during the assay and eject the cartridge when either an icon is pressed or an automatic ejection when the assay is done all can find use in the present invention.

[0245] The bays include electrical connections to power, monitor, and control various components, such as electrowetting and detection electrodes, heaters, thermometers, and motors, etc. Connections between the electrodes of the biochip and the corresponding electrodes in the bay can be typical "edge connector" configurations as well as pogo pin con-

nectors; see for example FIGS. 28 and 29. In preferred embodiments, it is the bottom bay of the bays that contain the electrical connections. See FIGS. 1A, 10 C and 73 of U.S. Pat. No. 7,172,897 and the accompanying discussion in the patent for "edge connectors" and "pogo pins" and the accompanying structure discussions for both the biochip and the bay, which document is incorporated by reference in its entirety for additional components and geometries as well as specifically including the material discussed above.

#### Top and Bottom Bays

[0246] "Top" and "bottom" in this sense means relative to ground. In general, as the samples and reagents are liquids, the LRM is at the top of the cartridge, and thus it is the top half of the bays that contain the mechanisms to activate the LRM.

[0247] The top bays contain the blister actuation mechanism to break open the blisters of the LRM and motivate liquid contents from them, as described above.

[0248] While one of the advantages of the present system is the lack of moving parts, in some optional embodiments valve systems are used, particularly passive "one way" valves within the LRM, such as "duck billed" one way valves. In some embodiments, active valves are utilized, and thus the bays (usually but not always the top bays) can optionally include valve actuation mechanism(s) to open and close valves as needed during the assay.

[0249] In some embodiments, for example when impeller mixing chambers are used, the bay (generally the top bay, although it could also be the bottom bay) comprises one or more mixing motor(s) to drive impeller(s) of the mixing chamber(s). The impellers can also be magnetically driven, removing the need to mechanically couple their movement. The rapidly rotating (thousands rpm) "impeller" is associated with a lysis "bead beating" chamber, (in contrast to the mixing chamber which usually employs a slowly rotating (about 100 rpm) "mixing paddle"). The mixing paddle will mechanically engage a gear located proximal to the cartridge that is driven by a bay mechanism. In contrast, the impeller is a self-contained miniaturized rotor that is located inside a lysis chamber in the LRM and turned on/off by electric current creating a magnetic field. For clarity, the mixing chamber will be located upstream of the lysis chamber.

[0250] In the embodiment where magnetic capture beads are used, the bay further comprises one or more magnetic actuators to facilitate the movement or sequestration of the magnetic beads. In general, due to the proximity of the LRM, these magnetic actuator(s) are found in the top bay, although they may also be found in the bottom bays, or both. Thus, for example, the cartridge may mix the sample with lysis buffer and then deliver the lysed sample to a location comprising the magnetic capture beads (held in place either physically or by a magnetic field). The beads and the sample are mixed in the presence of binding buffer, which can utilize physical agitation by oscillating the magnetic field and/or moving the beads from one location to another and back, as needed, optionally using more than one magnetic actuators in more than one location in the top bay. Thus one or more magnetic actuators are resident in the top bay.

[0251] The bays each optionally comprise a capture and latching mechanism to control both the positioning of the consumable (e.g. the loading of the cartridge in the correct orientation), the insertion of the cartridge into the bay sufficient to line up the LRM and the blister actuators, the electric connections, etc., as well as to prevent premature removal of