means a configuration that is equivalent on opposite sides of a dividing line, a plane, or about a center axis. The term symmetric also encompasses any rotation of an inner electrode geometry that becomes symmetric in the process of rotation. The cross section of a preselected inner electrode geometry is defined as the area of the largest circle that can be inscribed within that electrode geometry.

[0026] FIG. **4** is a schematic showing selected components in a preselected configuration that deliver dc-gradients and preselected waveforms to the ion funnel trap (IFT), which components are not limited. In the figure, a chain (series) of coupled resistors (e.g., R_1-R_5) spans the length of the IFT. Each electrode of the IFT is coupled to a separate resistor. To generate a voltage gradient across the resistor chain, two voltages, e.g., an entrance voltage (V_{enter}) and an exit voltage (V_{exit}) are applied at the entrance and exit points of the resistive divider. Entrance voltages (V_{enter}) and exit voltages (V_{exit}) applied to the resistor chain establish a preselected dc-gradient field used to drive ions through the IFT. By adjusting the difference between the entrance and exit voltages, the gradient that defines the electric field can be varied. The resistor chain couples to a power supply (not shown), e.g., a nine-channel power supply. Use of dc-gradient controls (FIG. **1***a*) permit adjustment and control of the dc-gradient within the trapping portion. In operation, a dc-gradient of, e.g., 4 V/cm in the IFT, can be controlled independently of a dc-gradient of, e.g., 20 V/cm, used in an electrodynamic ion funnel that may be coupled thereto. The electric field provided by a dc power supply to the IFT is preferably about 25 V/cm, except for the ion trapping portion, which is preferably held at ~1 V/cm. The IFT operates at a typical pressure of ~1 Torr and is characterized by a fast ion ejection time of <100 µs.

[0027] Ions are confined radially in the trapping portion of the IFT using preselected rf-fields. The rf-fields are established with capacitors (e.g., C_1-C_4) which are electrically coupled, e.g., as capacitor networks, to preselected electrodes. Effective potential used to trap ions in the trapping portion is generated by applying rf-potentials 180° out of phase with a pair of independent capacitor networks, one connected to even-numbered electrodes and another connected to odd-numbered electrodes. Each capacitor network links to a preselected rf-voltage source. Preferably, an rf-field generator is used to generate an rf-field at preselected rf-frequencies and amplitudes, which are not limited. For example, an rf-frequency of, e.g., 520 kHz and amplitude of 125 V_{p-p} can be used. In the trapping portion, an rf-frequency of, e.g., 600 kHz and amplitude of 55 V_{p-p} can be used. In another application, the 180° phase-shifted rf-fields are applied to adjacent ring electrodes at a peak-to-peak amplitude of, e.g., 70 V_{p-p} and a frequency of 600 kHz, which parameters again are not limited. Ions released from the trapping portion are directed toward a subsequent or adjacent stage (e.g., an IMS drift cell) using a preselected dc-gradient. Ion transmission through the IFT can be improved by superimposing a dc-field onto the rf-field applied to each electrode.

[0028] The IFT can operate in a continuous mode or a trapping mode of operation. The term "trapping mode" refers to the set of conditions by which ions are accumulated within the trapping portion of the IFT and is followed by release of ions to a subsequent ion analysis stage, e.g., IMS analysis stage. The term "continuous mode" refers to the set of conditions by which ions are transmitted with their associated ion current through the IFT without any interference from the electrostatic grids (i.e., entrance, trapping, and exit grids) within the trapping portion. The continuous mode is achieved by setting potential of the dc-only grids to values that equal those of the uniform dc-gradient in the coupled ion funnel. While operation of the IFT and ion funnel has been described in reference to preferred operating parameters, parameters are not limited thereto. All electrical configurations and parameters and stages as will be coupled to the IFT by those of skill in the art are within the scope of the invention.

[0029] FIG. **5** illustrates an exemplary instrument system and configuration that employs the ion funnel ion trap (IFT) **100** described previously herein. Here, a heated capillary **500** introduces ions to the ion trap through an electrodynamic ion funnel **105** coupled thereto. The IFT couples to an orthogonal acceleration (oa)-time-of-flight (TOF) mass spectrometer **550** (oa-TOF). Here the IFT interfaces to the oa-TOF through a collision quadrupole **505**, a selection quadrupole **510**, and various Einzel lenses **515** (that provide ion focusing prior to introduction of ions to the oa-TOF). The oa-TOF instrument **550** includes an ion pusher component **520**, a charge collector **525**, a reflectron component **530**, and a detector **535**. Coupled components are not limited. The ion trap can be coupled through use of terminal or conductance limit electrodes that enable control over the axial dc-gradient in the IFT. The instant instrument configuration has been characterized in both a trapping and a continuous mode. Performance of the oa-TOF in trapping mode exhibited an order of magnitude improvement in signal-to-noise (S/N) compared to that observed in the continuous mode (i.e., a continuous beam regime). In particular, intensities of analyte ions in the trapping mode exceeded those in the continuous mode by an order of magnitude. Improvement in (S/N) was due to an increase in sensitivity and reduction in the level of background noise. Background noise reduction is due to more efficient desolvation of ions during trapping. Capability of data-directed removal of low m/z chemical noise species prior to ion accumulation in the trap is important for increasing the linear dynamic range of any instrument configuration, which is enabled by segmenting the rf-field applied to the ion funnel.

[0030] FIG. **6** shows exemplary voltage profiles used to accumulate, store, and eject ions in the IFT for a given ion gating cycle. An IFT ion gating cycle typically consists of three distinct events: 1) injection and accumulation of ions, 2) ion storage, and 3) ion ejection. In a preferred configuration, the IFT is coupled with an electrodynamic ion funnel described previously (FIG. **1***b*). In the figure, voltage is plotted as a function of electrode number in the preferred instrument configuration. Exemplary voltage profiles are shown for a single ion gating cycle, described further in reference to FIG. **7** below. Ions are accumulated within the IFT by raising and lowering potentials on each of the entrance grid, trapping grid, and ejection grid surrounding the trapping portion in accordance with exemplary voltage profiles shown in the figure. In the illustrated gating cycle, ions are injected into the ion trapping portion by lowering potential of the entrance grid, e.g., from 80 V to 66 V. Ions introduced to the trapping portion are radially confined by an rf-potential (e.g., 61.5 V) applied to the trapping grid and a repelling potential (e.g., 68 V) applied to the exit grid. After a user-defined accumulation period, potential of the entrance grid is restored, e.g., to 80 V, and storage of ions begins in a storage phase. During both the accumulation and storage events, the exit grid is held to a potential of, e.g., 68 V. To eject ions, trapping and exit grids can be simultaneously ramped to 51 V and 49 V, respectively.