ions introduced each source. It is yet a further object of the present invention to provide a method and apparatus for introducing ions from multiple sources from a region at relatively high pressure to a region at relatively low pressure in a manner that allows the user to control the quantity of ions introduced from each source with a highly responsive electronic system. It is yet a further object of the present invention to provide a method and apparatus for introducing ions from multiple sources from a region at relatively high pressure to a region at relatively low pressure in a manner that allows the user to rapidly switch between each source of ions. It is a further object of the present invention to provide a method and apparatus for introducing analyte ions and calibrant ions generated from separate sources in a region at relatively high pressure to a region at relatively low pressure in a manner that allows the user to precisely control the amount of analyte ions and calibrant ions introduced at any given time, and to rapidly change the amount of analyte ions and calibrant ions introduced at any given time.

These and other objects of the present invention are accomplished by providing a multi-source ion funnel. The basic concept of an ion funnel was described in detail in U.S. Pat. No. 6,107,628, entitled "Method And Apparatus For Directing Ions And Other Charged Particles Generated At Near Atmospheric Pressures Into A Region Under Vacuum," the entire contents of which are hereby incorporated herein by this reference. Briefly, as described in U.S. Pat. No. 6,107,628, an ion funnel is a plurality of elements, each having progressively larger apertures wherein the apertures, form an ion funnel having an entry at the largest aperture and an exit at the smallest aperture. An RF voltage is applied to each of the elements such that the RF voltage applied to each element is out of phase with the RF voltage applied to the adjacent element(s). Typically, a mechanical means, such as a fan, a vacuum, or some combination thereof, is also provided to assist in directing charged particles through the ion funnel. Further, an electrical means, such as a DC potential gradient across the plurality of elements is also provided to assist in directing charged particles through the ion funnel. While elements and the apertures used in the ion funnel may be any shape, typically they are selected as circular.

It is important to note that the while the present invention utilizes the concept of the ion funnel taught in U.S. Pat. No. 6,107,628, it also expands and greatly extends the utility of those concepts, and does so in a manner that relieves the invention of many of the limitations of U.S. Pat. No. 6,107,628. Thus, while the description herein relies on the disclosure of U.S. Pat. No. 6,107,628 to teach the rudimentary concepts of an ion funnel, the present invention should in no way be viewed as limited by the disclosure of U.S. Pat. No. 6,107,628. For example, while U.S. Pat. No. 6,107,628 describes the elements as having progressively larger elements, for purposes of this disclosure, such is not necessarily required. Further, with respect to the "sets of primary elements" described in greater detail below, it is not necessary that these elements even consist of a series of elements having apertures. As an alternative, a multipole arrangement, as is commonly used to guide ions in mass spectrometer instruments, may also be utilized as the "sets of primary elements." The term "ion funnel" as used herein should therefore be understood to encompass sets of elements that may be of the same size, or which may be of increasing size, or which may be of varying size. When describing the sets of primary elements, the term "ion funnel" as used herein should further be understood to encompass multipole arrangements.

The present invention allows the introduction of ions from multiple sources by providing multiple ion funnels, termed herein as "sets of primary elements" one for each source of ions. These sets of primary elements in turn feed into another ion funnel, termed herein as a "secondary set of elements." In this manner, ions from multiple ion sources can be readily passed from a region of relatively high pressure at the entrance of the sets of primary elements, to a region of relatively low pressure at the exit of the set of secondary elements. As ions are passed from the primary set of elements to the secondary set of elements, they are combined into a single pathway. The combination of the primary sets of elements and the secondary set of elements is collectively referred to herein as a "multi-source ion funnel."

By way of illustrative example, and not meant to be limiting, the simplest form of a multi-source ion funnel is shown in FIG. **1**. As shown in the figure, the multi-source ion funnel **1** of this illustrative example has two sets of primary elements **2**. Ions pass through the apertures formed by these primary elements **2** and are in turn delivered to the entrance of a secondary set of elements **3**. Those skilled in the art will readily recognize that while this illustrative example shows only two sets of primary elements, it is possible to extend the concept to have any number of primary sets of elements. Also, as described above, the primary elements **2** may take the form of a multipole arrangement as shown in FIG. **2**. In either case, the present invention should in no way be limited to methods and apparatus having only two sets of primary elements.

The utility of the multi-source ion funnel is readily apparent when one considers the challenges confronting electrospray ionization mass spectrometry (ESI-MS). Ions generated by an electrospray are typically generated in a region external to the mass spectrometer at about ambient, or atmospheric, pressures. The ions are then passed into a region of relatively lower pressure within the interior of the instrument through a capillary. By positioning a multi-source ion funnel in the interior of the instrument and adjacent to at the entrance, the present invention allows multiple electrosprays to feed ions into multiple capillaries which are then combined into a single ion stream for detection and analysis downstream in the interior of the instrument.

A further advantage of the present invention is derived from the use of jet disturbers in one or several of the primary sets of elements. The use of a jet disturber in connection with an ion funnel was first described in U.S. patent application Ser. No. 09/860,721, filed May 18, 2001, and entitled "Ionization Source Utilizing A Jet Disturber In Combination With An Ion Funnel And Method Of Operation," the entire contents of which are hereby incorporated herein by this reference. As described in U.S. patent application Ser. No. 09/860,721, a "jet disturber" is simply a physical barrier placed inside the apertures of an ion funnel. Referring again to FIG. **1**, a jet disturber **4** is shown within the primary elements **2**. Typically, a jet disturber is provided as a metal disk. As described in U.S. patent application Ser. No. 09/860,721, the placement of a jet disturber in this manner will greatly enhance ion conductance.

As with the description of the ion funnel contained in U.S. Pat. No. 6,107,628, It is important to note that the while the present invention utilizes the concept of the jet disturber taught in U.S. patent application Ser. No. 09/860,721, it also expands and greatly extends the utility of those concepts, and does so in a manner that relieves the invention of many of the limitations of U.S. patent application Ser. No. 09/860,721. Thus, while the description herein relies on the disclo-