connection to the ion tunnel section. The PEEK supports are held in the correct orientation by two stainless steel plates attached to the PEEK supports using screws and located correctly using dowels. These plates are electrically isolated and have a voltage applied to them.

Gas for collisionally cooling ions without substantially fragmenting ions may be supplied to the ion tunnel ion trap **1** via a 4.5 mm ID tube.

The electrical connections shown in FIG. **1** are such that a substantially regular stepped axial accelerating DC electric field is provided along the length of the ion tunnel ion trap **1** using two programmable DC power supplies DC**1** and DC**2** and a resistor potential divider network of 1 MΩ resistors. An AC or RF voltage supply provides phase (RF+) and anti-phase (RF−) voltages at a frequency of preferably 1.75 MHz and is coupled to the ion tunnel sections **4**a,**4**b,**4**c via capacitors which are preferably identical in value (100 pF). According to other embodiments the frequency may be in the range of 0.1–3.0 MHz. Four 10 pH inductors are provided in the DC supply rails to reduce any RF feedback onto the DC supplies. A regular stepped axial DC voltage gradient is provided if all the resistors are of the same value. Similarly, the same AC or RF voltage is supplied to all the electrodes if all the capacitors are the same value. FIG. **4** shows how, in one embodiment, the axial DC potential varies across a 10 cm central portion of the ion tunnel ion trap **1**. The inter-segment voltage step in this particular embodiment is −1V. However, according to more preferred embodiments lower voltage steps of e.g. approximately −0.2V may be used. FIG. **5** shows a potential energy surface across several ion tunnel segments **4**b at a central portion of the ion tunnel ion trap **1**. As can be seen, the potential energy profile is such that ions will cascade from one ion tunnel segment to the next.

As will now be described in relation to FIG. **1**, the ion tunnel ion trap **1** traps, accumulates or otherwise confines ions within the ion tunnel ion trap **1**. In the embodiment shown in FIG. **1**, the DC voltage applied to the final ion tunnel segment **4**c (i.e. that closest and adjacent to the exit aperture **3**) is independently controllable and can in one mode of operation be maintained at a relatively high DC blocking or trapping potential (DC**3**) which is more positive for positively charged ions (and vice versa for negatively charged ions) than the preceding ion tunnel segment(s) **4**b. Other embodiments are also contemplated wherein other ion tunnel segments **4**a,**4**b may alternatively and/or additionally be maintained at a relatively high trapping potential. When the final ion tunnel segment **4**c is being used to trap ions within the ion tunnel ion trap **1**, an AC or RF voltage may or may not be applied to the final ion tunnel segment **4**c.

The DC voltage supplied to the plates forming the entrance and exit apertures **2**,**3** is also preferably independently controllable and preferably no AC or RF voltage is supplied to these plates. Embodiments are also contemplated wherein a relatively high DC trapping potential may be applied to the plates forming entrance and/or exit aperture **2**,**3** in addition to or instead of a trapping potential being supplied to one or more ion tunnel segments such as at least the final ion tunnel segment **4**c.

In order to release ions from confinement within the ion tunnel ion trap **1**, the DC trapping potential applied to e.g. the final ion tunnel segment **4**c or to the plate forming the exit aperture **3** is preferably momentarily dropped or varied, preferably in a pulsed manner. In one embodiment the DC voltage may be dropped to approximately the same DC voltage as is being applied to neighbouring ion tunnel segment(s) **4**b. Embodiments are also contemplated wherein the voltage may be dropped below that of neighbouring ion tunnel segment(s) so as to help accelerate ions out of the ion tunnel ion trap **1**. In another embodiment a V-shaped trapping potential may be applied which is then changed to a linear profile having a negative gradient in order to cause ions to be accelerated out of the ion tunnel ion trap **1**. The voltage on the plate forming the exit aperture **3** can also be set to a DC potential such as to cause ions to be accelerated out of the ion tunnel ion trap **1**.

Other less preferred embodiments are contemplated wherein no axial DC voltage difference or gradient is applied or maintained along the length of the ion tunnel ion trap **1**. FIG. **6**, for example, shows how the DC potential may vary along a portion of the length of the ion tunnel ion trap **1** when no axial DC field is applied and the ion tunnel ion trap **1** is acting in a trapping or accumulation mode. In this figure, 0 mm corresponds to the midpoint of the gap between the fourteenth **4**b and fifteenth (and final) **4**c ion tunnel segments. In this particular example, the blocking potential was set to +5V (for positive ions) and was applied to the last (fifteenth) ion tunnel segment **4**c only. The preceding fourteen ion tunnel segments **4**a,**4**b had a potential of −1V applied thereto. The plate forming the entrance aperture **2** was maintained at 0V DC and the plate forming the exit aperture **3** was maintained at −1V.

More complex modes of operation are contemplated wherein two or more trapping potentials may be used to isolate one or more section(s) of the ion tunnel ion trap **1**. For example, FIG. **7**(a) shows a portion of the axial DC potential profile for an ion tunnel ion trap **1** according to one embodiment operated in a "fill" mode of operation, FIG. **7**(b) shows a corresponding "closed" mode of operation, and FIG. **7**(c) shows a corresponding "empty" mode of operation. By sequencing the potentials, the ion tunnel ion trap **1** may be opened, closed and then emptied in a short defined pulse. In the example shown in the figures, 0 mm corresponds to the midpoint of the gap between the tenth and eleventh ion tunnel segments **4**b. The first nine segments **4**a,**4**b are held at −1V, the tenth and fifteenth segments **4**b act as potential barriers and ions are trapped within the eleventh, twelfth, thirteenth and fourteenth segments **4**b. The trap segments are held at a higher DC potential (+5V) than the other segments **4**b. When closed the potential barriers are held at +5V and when open they are held at −1V or −5V. This arrangement allows ions to be continuously accumulated and stored, even during the period when some ions are being released for subsequent mass analysis, since ions are free to continually enter the first nine segments **4**a,**4**b. A relatively long upstream length of the ion tunnel ion trap **1** may be used for trapping and storing ions and a relatively short downstream length may be used to hold and then release ions. By using a relatively short downstream length, the pulse width of the packet of ions released from the ion tunnel ion trap **1** may be constrained. In other embodiments multiple isolated storage regions may be provided.

Although the present invention has been described with reference to preferred embodiments, it will be understood by those skilled in the art that various changes in form and detail may be made without departing from the scope of the invention as set forth in the accompanying claims.

What is claimed is:

1. A mass spectrometer comprising:

an ion tunnel ion trap comprising a plurality of electrodes having apertures through which ions are transmitted in use; and

a time of flight mass analyser downstream of said ion tunnel ion trap, said Time of Flight analyser including