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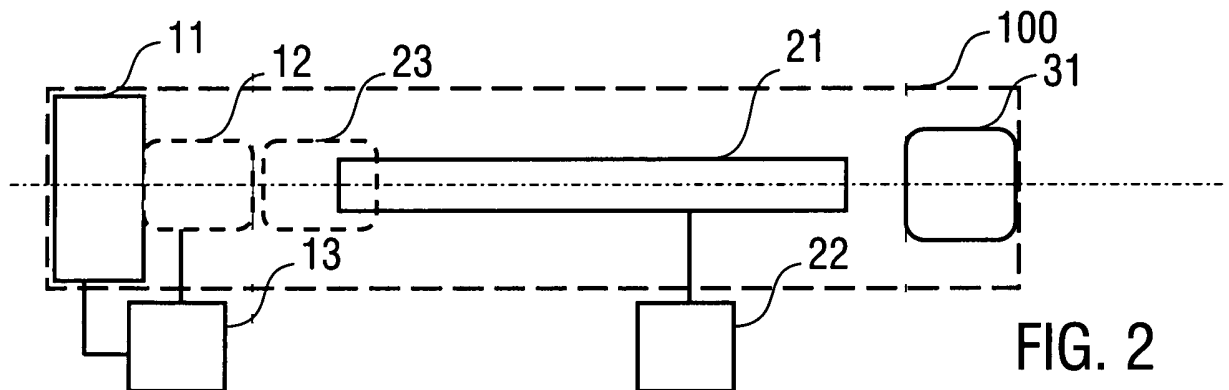
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**(54) Method and device for transferring ions in a mass spectrometer**

(57) A method for transferring ions, in particular in a mass spectrometer (100), comprises the step of moving the ions from a source device (10) having a first electric potential through a transfer section (20) having a second electric potential into an analysis device (30), wherein

the second electric potential is changed to a deceleration potential during the movement of the ions through the transfer section (20) and the deceleration potential has a different sign relative to the first electric potential. An ion guide (21) and a mass spectrometer (100), in particular for implementing this method are described.



## Description

**[0001]** The invention relates to a method for transferring ions, in particular in a mass spectrometer, wherein the ions are injected from a transfer section into an analysis device like e.g. an ICR cell. Furthermore, the present invention relates to an ion guide for guiding ions e.g. in a mass spectrometer, in particular for injecting ions into a trapping device of a mass spectrometer. Furthermore, the present invention relates to a mass spectrometer being equipped with the above ion guide and being adapted for implementing the above method for transferring ions.

**[0002]** Mass spectrometry is an analytical technique with high sensitivity and selectivity, which is generally known in particular in analytical chemistry and biochemistry. In most cases, molecules of a sample are brought into the gas-phase, ionised and subsequently analysed by determining the mass to charge ratio ( $m/z$ ). The ( $m/z$ )-ratio is determined in an analysis or trapping device, which is structured depending on the analysis method used in the particular case.

**[0003]** In Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR mass spectrometry), the analysis device is a so-called ICR cell. In the ICR cell, ions are trapped in two dimensions by a magnetic field and in a third dimension, which is parallel to the magnetic field lines, by an electric field created by trapping plates of the ICR cell. By measuring the cyclotron frequencies of the ions, their masses can be determined with high accuracy. This measurement occurs ideally under ultra-high vacuum conditions to avoid dephasing as a result of ion/gas collisions.

**[0004]** When ions are generated outside the magnetic field of the ICR cell, they need to traverse the region between low magnetic field and high magnetic field in the region of the ICR cell. For injecting the ions into the ICR cell, various techniques have been developed (see e.g. publication "Ion optics for Fourier transform ion cyclotron resonance mass spectrometry" by A. G. Marshall et al. in "Nuclear instruments methods and physics research A", vol. 363, 1995, p. 397-405). When the ions are injected with an ion optic, care must be taken that the ions are not reflected due to the so-called "magnetic mirror"-effect. To this end, the ion optic including e.g. a radio frequency (RF) multipole ion guide and/or electrostatic lenses is adapted for an acceleration of the ions toward the ICR cell. On the other hand, the kinetic energy of the ions accommodated in the ICR must be reduced for effectively trapping the ions in the ICR cell.

**[0005]** In order to trap ions in the ICR cell, the ions must have a kinetic energy that is lower than the trapping potential of the ICR cell plates. The kinetic energy is essentially determined by the velocity of the ions in direction parallel to the magnetic field lines. On the other hand, for an efficient transfer of ions through the "magnetic mirror", they must have a significant, e.g. many electron volt (eV) kinetic energy. As trapping of ions with high kinetic energy with a correspondingly high trapping potential is undesir-

able, techniques have been developed for decelerating ions when entering into or being in the ICR cell.

**[0006]** In the practice, the following deceleration techniques are used for reducing the kinetic energy of ions in the ICR cell.

**[0007]** Firstly, a deceleration can be caused by collisions of the ions with a gas that is been injected. This technique has the disadvantages of a reduced instrument performance due to collisions of ions and gas molecules, a reduced duty cycle due to evacuation periods after deceleration and a risk of undesired ion fragmentations. Furthermore, it is possible to apply an electric deceleration voltage to the ICR cell, creating a potential barrier which reduces the kinetic energy of ions during the injection from a transfer section into the ICR cell. A consequence of this technique is that when the transfer section is near ground potential, the excitation and detection plates of the ICR cell need to have an offset voltage, which is not desirable. Alternatively, a high potential can be applied to the transfer section, while the ICR cell is on low potential. This technique has a disadvantage in that the complete transfer section between the ion source and the ICR cell needs to be on an offset potential requiring a complicated shielding. Finally, it is a conventional deceleration technique to change the kinetic energy from a forward motion to a magnetron motion (spiral motion around the magnetic field lines). With this technique, there is a disadvantage in that complicated ion trajectories are generated which can complicate measurements.

**[0008]** The above problems occur not only with the injection of ions into ICR cells but rather generally with the transfer of charged particles into analysis devices accommodating the particles in a trapping field.

**[0009]** It is the object of the invention to provide an improved method for transferring ions, in particular in a mass spectrometer, wherein the disadvantages of the conventional techniques are avoided and wherein in particular the application of an offset potential in the analysis device and the provision of a complicated shielding of the transfer section are no longer required and any disadvantages due to gas collisions or magnetron trajectories are avoided. Furthermore, the object of the invention is to provide an improved ion guide avoiding the disadvantages of the conventional transfer systems. According to a further aspect, the object of the invention is to provide an improved mass spectrometer, in particular for FT-ICR mass spectrometry.

**[0010]** These objects are solved with a method for transferring ions, an ion guide and a mass spectrometer comprising the features of claims 1, 12 or 19. Advantageous embodiments of the invention are defined in the dependent claims.

**[0011]** According to a first basic aspect of the invention, a method for transferring ions in a transfer section, in particular in a mass spectrometer, includes the step of changing an electric potential in the transfer section while the ions are travelling within the transfer section. Ions are

provided, preferably accelerated e.g. from a source device having a first electric potential to the transfer section having a second electric potential. The second electric potential is changed to a deceleration potential for the ions after entering and before leaving the an electrically shielded component of the transfer section. The second electric potential is changed such that the ions, after leaving this component of the transfer section and while or before entering an analysis device, are subjected to a deceleration. The changing step comprises an adjustment of the deceleration potential e.g. by switching a bias voltage to a component included in the transfer section, in particular to an ion guide included in the transfer section.

**[0012]** The setting of the deceleration potential in the transfer section has an essential advantage in that the ions being e.g. accelerated from the source device into the transfer section are not subjected to a further acceleration as the ions are contained in the transfer section during changing the second electric potential thereof. When the deceleration potential is created in the component of the transfer section, the ions to be detected are not subjected to a field gradient. This important result of the invention means that the kinetic energy is kept constant even after the changing the second potential to the deceleration potential. As the result, the ions are moving towards a decelerating potential barrier at the analysis device while the application of an increased potential to the analysis device can be avoided. Accordingly, the application of an offset voltage in the analysis device like e.g. an ICR cell is not necessary, so that the operation of the analysis device and in particular the determination of the (m/z)-ratio are facilitated. On the other hand, a particular shielding of the complete transfer section is not necessary as the deceleration potential is applied during predetermined operation cycles to a component, e.g. an ion guide, of the transfer section only.

**[0013]** In the present specification, the terms "potential" or "electric potential" refer to the absolute value of the potential, while the potential can have a positive or negative sign depending on the particular application. The term "near ground potential" covers potentials having a slight difference, e.g. up to 3 V compared to zero or ground potential. Furthermore, the term "ion" refers to any particle, like a molecule or an aggregate of molecules carrying at least one electric charge. Ions can carry a negative or positive charge depending on the application. Accordingly, negative ions are accelerated with increasing potential having a positive sign, while positive ions are accelerated with increasing potential having a negative sign. The term "changing a potential" covers any type of setting, switching, modifying and/or adjusting the potential in the transfer section by applying a bias voltage. The bias voltage may comprise a DC voltage or an AC voltage, wherein the potential is changed by the DC voltage as such or by the rising component of the AC voltage. The term "transfer section" refers to the evacuated region between the source device and the analysis device,

wherein this region contains at least one electrically shielded component passed by the ions. This component (generally called: transfer device) comprises e.g. a multipole ion guide, a tube, a row of electrode rings or generally an elongated electrode arrangement surrounding the path of the ion. Furthermore, the transfer section may comprise e.g. ion optics.

**[0014]** As the result of changing the potential according to the invention, a change of sign occurs for the deceleration potential of the transfer device relative to the first electric potential in the source device. This change of sign has an essential advantage in that a low potential can be maintained in the analysis device while e.g. a requested acceleration from the source device towards the analysis device for passing the "magnetic mirror" can be provided.

**[0015]** The method of the invention represents a further essential advantage in that the deceleration potential can be applied with a simple time control. The only important aspect in setting the deceleration potential is that the transfer device is at the initial (second) potential when the ions enter the transfer device and that it is at the final deceleration potential when they are leaving the transfer device. As an example, the deceleration potential can be switched with a step-shaped or ramp-shaped time structure followed by a constant amplitude. It is not critical whether this switching step occurs at the begin or at the end of the ion motion through the transfer device. Furthermore, the method of the invention is not critical with regard to the further time structure of the deceleration potential. If a DC voltage is applied to the transfer section for generating the deceleration potential, this represents an advantage in that the energy reduction from the transfer section to the analysis device has a fixed quantity. Otherwise, an AC voltage can be applied for generating the deceleration potential.

**[0016]** According to a preferred embodiment of the invention, the second electric potential in the transfer section, i.e. the potential before the changing step, has an absolute value lower than the absolute value of the first electric potential in the source device providing the ions. This embodiment represents an advantage as the ions are accelerated into the transfer section. Furthermore, extended shielding measures at the transfer section can be avoided.

**[0017]** Preferably, the second electric potential is near zero i.e. the second electric potential is near or at ground potential so that any shielding of the transfer section can be avoided.

**[0018]** According to an embodiment of the invention, the deceleration potential is controlled such that the first electric potential of the source device and the deceleration potential have essentially equal absolute values but opposite signs. Preferably, ions are accelerated from the source device into the transfer section according to the potential difference from the first electric potential to the second electric potential, e.g. ground potential while the ions are decelerated with the same amount during the

injection from the transfer section to the analysis device so that the kinetic energy in the analysis device is near zero. Accordingly, the efficiency of trapping ions in the analysis device can be improved.

**[0019]** According to a particularly preferred embodiment of the invention, the deceleration potential is controlled such that the absolute value thereof is lower than the absolute value of the first electric potential. Advantageously, compared with the acceleration into the transfer section, the ions can be decelerated into the analysis device so that a residual kinetic energy remains, which is lower than a trapping potential of the analysis device. Accordingly, the efficiency of trapping ions in the analysis device can be improved even with ions having a certain energy distribution after creating the ion beam in the source device.

**[0020]** The difference of the absolute values of the first electric potential and the deceleration potential can be advantageously selected to be lower than the trapping potential of the analysis device. In terms of practical applications in mass spectrometry, the above difference is preferably lower than 5 V.

**[0021]** A further advantage of the invention is given by the fact, that there is no restriction in terms of the time structure of the guided ion beam. According to a first alternative, a pulsed ion beam can be directed into and moved in the transfer section. Guiding pulsed ion beams has a particular advantage in that changing the second electric potential to the deceleration potential can be synchronized with the arrival time of the pulsed ion beam in the transfer section. The term "pulsed ion beam" refers to a non-continuous ion beam formed by the series of single ions or packages of ions generated in dependence on the particular ion source type. Preferably, the changing step according to the invention is directly synchronized with a pulsed operation of a source device, like the pulsed operation of a MALDI ion source or a pulsed release of ions from an accumulator and storage device.

**[0022]** According to an alternative embodiment, a continuous ion beam can be transferred into and move in the transfer section. With this embodiment, particular parts of the continuous ion beam being present in the transfer section during the changing step can be analysed after injection into the analysis device. Other parts of the continuous ion beam which are not subjected to the switching step, are not trapped in the analysis device.

**[0023]** Preferably, the analysis device has a third electric potential with an absolute value lower than the absolute values of the first electric potential in the source device and the deceleration potential. Accordingly, the application of an offset voltage in the analysis device can be avoided. Particularly preferred is a third electric potential near or at ground potential.

**[0024]** According to a second general aspect of the invention, an ion guide is provided, being connected with a power supply device for applying a high-frequency (rf) ion guiding voltage to the ion guide, wherein the power supply device is adapted for temporarily applying a bias

voltage to the ion guide. To this end, the power supply device is connected in particular with a control device for superposing the high-frequency ion guiding voltage with a bias voltage providing the above deceleration potential. Depending on the structure of the power supply device, the control device can be implemented with a microprocessor for a software-based generation of the bias voltage in the power supply device or with a switch connecting a separate bias voltage source with a high-frequency source included in the power supply device.

**[0025]** The ion guide of the invention may be an ion guide as it is known per se e.g. from conventional mass spectrometers. The ion guide is combined with a bias voltage source which can be controlled in the time domain for implementing the above potential changing step of the invention. This combination represents an essential advantage in that conventional mass spectrometers can be simply adapted for implementing the invention.

**[0026]** According to a particularly preferred embodiment of the invention, the control device is operated in synchronisation with an operation of a source device for providing ions to be guided. With the pulsed operation of the source device, a reference time is provided on the basis of which the above deceleration potential can be applied with a predetermined time delay depending e.g. on the geometry of the transfer region, the acceleration potential difference between the ion source and the transfer section and the expected mass range of the ions. Alternatively, the control device is adapted for activating the above bias voltage source at predetermined operation periods only. The latter embodiment of the invention is preferred with the application of continuous ion beams.

**[0027]** Another important advantage of the invention is given in that there are no restrictions with regard to the structure of the ion guide. Preferably, the ion guide is a multipole ion guide which is known as such from prior art mass spectrometers. Alternatively, a simple tube-shaped ion guide can be used as the transfer section, which can be made from a massive or mesh-shaped metallic material.

**[0028]** If according to a further embodiment of the invention, the ion guide is combined with an ion optic, e.g. in a transfer section of a mass spectrometer, advantages with regard to the acceleration of ions into the ion guide can be obtained.

**[0029]** According to a third general aspect of the invention, a mass spectrometer, in particular an FT-ICR mass spectrometer is provided comprising the above ion guide of the invention as well as a source device for providing ions to be analysed and an analysis device for determining the above (m/z)-ratio.

**[0030]** Generally, the method of the invention can be applied with various types of mass spectrometers including an analysis device with a trapping field. The application with FT-ICR mass spectrometers is preferred as the magnetic fields of the ICR magnet stabilize the trajectories of the ions during the deceleration and injection from the transfer section into the ICR cell. If the invention is

applied with an analysis device without magnetic fields parallel to the straight trajectories of the ions, further ion optic components, like e.g. a ZOOM-optic can be used for shaping the trajectory during the injection into the analysis device.

**[0031]** Accordingly, the analysis device comprises preferably an ICR cell which cooperates in an advantageous manner with the trajectory formation in the transfer section. The source device preferably comprises an electro-spray source being combined with an accumulator and storage device or a MALDI source. These source devices have particular advantages as ion beams can be generated with a pulsed operation mode facilitating the synchronisation with the above switching of the deceleration potential of the invention.

**[0032]** If the source device comprises an accumulator and storage device, further advantages may arise in terms of a pulsed ion generation independent from the ion beam generation mechanism in the ion source.

**[0033]** Further advantages and details of the invention are described in the following with reference to the attached drawings.

Figures 1 and 2 show components of a mass spectrometer of the invention with a schematic illustration and with further details, respectively.

Figure 3 illustrates the switching of the deceleration potential according to the invention.

Figures 4 and 5 illustrate further details of power supply devices of the transfer section according to embodiments of the invention.

Figure 6 illustrates a mass spectrum obtained with the method of the invention.

**[0034]** Preferred embodiments of the invention are described with reference to an FT-ICR mass spectrometer 100, which is illustrated in Figs. 1 and 2. According to Fig. 1, the following three regions can be distinguished in the mass spectrometer 100. Firstly, ions to be analysed are provided by the source device 10. Subsequently, the ions are moved to a transfer section 20 for transferring them from the field conditions of ion beam generation to the trapping field in the analysis device 30. The analysis device 30 is provided e.g. with an ICR cell 31 and a magnet 32, e.g. superconducting magnet. The field lines of the magnetic field created by the magnet are illustrated with dotted lines. After injection into the analysis device 30, the (m/z)-ratio is measured.

**[0035]** According to Fig. 2, the source device 10 comprises an ion source 11, e.g. an electro-spray device or a MALDI source, which are known from conventional mass spectrometers. Ions created in the ion source 11

are collected in an accumulator and storage device 12. The accumulator and storage device 12 can comprise a multipole or ring storage region and an ion optic with e.g. lenses for collimating and shaping the ion beam and/or a deflection unit if necessary. The multipole storage region can comprise e.g. a 4-, 6- or 8-pole or higher-multipole storage device. The accumulator and storage device 12 is not a necessary feature of the invention. This component can be omitted in particular depending on the structure of the ion source 11. As an example, if the ion source 11 is a MALDI source, ions created in the MALDI source can be injected directly into the transfer section 20. Furthermore, the structure can be modified in that the ion optic is provided as a separate component, e.g. as component 23 in the transfer section 20.

**[0036]** The source device 10 contains a control device 13 for controlling the operation of the ion source 11 and (if necessary) the accumulation and storage device 12 as it is known from conventional mass spectrometers.

**[0037]** The transfer section 20 comprises the ion guide 21 connected with a power supply device 22. The ion guide 21 is e.g. a radio frequency ion guide comprising e.g. an octopole structure or a tube structure with a diameter of about 3 cm and a length of about 1 m. Ion guide 21 is made of e.g. stainless steel or other metallic and/or conducting material. According to another alternative, the ion guide may comprise a so-called wire guide for moving ions on a spirally shaped trajectory.

**[0038]** The analysis device 30 comprises the ICR cell 31 as it is known from conventional FT-ICR mass spectrometers (see e.g. the above publication of A. G. Marshall et al.). The ICR cell 31 includes in particular trapping electrodes having a static potential for trapping ions parallel to the magnetic field lines and excitation and detection electrodes for applying a radio frequency to the trapped ions and measuring the cyclotron frequency. A particular advantage of the invention consists in that these excitation and detection electrodes can be operated at or near ground potential. Optionally, the ICR cell can comprise an ion transfer optic for influencing the ion path from the ion guide 21 to the ICR cell 31.

**[0039]** The electric potentials in the mass spectrometer 100 are schematically shown in Fig. 3 illustrating absolute potential values (a.u., solid lines) and the kinetic energy of the ions (a.u., dotted lines). The following example refers to transferring positive ions. For transferring negative ions, potentials with opposite signs are provided.

**[0040]** In the source device 10, a first electric potential (a) with a positive value  $U_0$  (e.g. 30 V) is created, while the transfer section 20, in particular the ion guide 21 thereof is at a second potential (at or near ground potential, b). Positive ions created or released from the source device 10 at a first reference time, are accelerated into the transfer section 20. When the ions have entered the ion guide 21, the (second) potential of the ion guide 21 is pulsed to a voltage that is near the voltage of the source device 10, however with different sign (c). Accordingly,

when the potential of the source device 10 is positive, the voltage of the ion guide 21 will be pulsed to a corresponding negative value (e.g. - 27 V) for positive ions.

[0041] Finally, the ICR cell 31 has a third potential at or near ground potential (d). Accordingly, ions travelling through the ion guide 21 are decelerated at the transfer from the deceleration potential (c) to the third potential in the ICR cell 31.

[0042] According to the above electric potentials, the kinetic energy of the ions is changed as illustrated in Fig. 3. During the acceleration from the first potential (a) to the second potential (b), the kinetic energy is increased. During motion through the ion guide 21, the kinetic energy is unchanged. According to the invention, the kinetic energy is kept constant even after the switching of the second potential to the deceleration potential (c). At the transfer from the ion guide 21 to the ICR cell 31, the kinetic energy is reduced as requested due to the potential difference between the deceleration potential (c) and the potential in the ICR cell 31. Due to the above difference of the first potential (30 V) and the deceleration potential (- 27 V), the ions have a residual kinetic energy of about 3 eV in the ICR cell 31.

[0043] The time control of switching the deceleration potential comprises a synchronisation with the operation of the source device 10. With a predetermined time delay after the above reference time, the deceleration potential is set just during the motion of the ions in the ion guide 21. Advantageously, the travel time in the ion guide 21 is relatively long (about 10  $\mu$ s to 1000  $\mu$ s, e.g. 100  $\mu$ s) so that switching with a characteristic time of some  $\mu$ s is sufficient for reaching the stable deceleration potential before the ions are leaving the ion guide 21.

[0044] The deceleration potential is created on the ion guide 21, when the ions in the ion guide 21 have a predetermined distance from both ends thereof. Preferably, this distance is selected to be at least two inner diameters of the ion guide, so that the ions with an increased reliability are not subjected to a field gradient.

[0045] The synchronization can be omitted if a repeated, e.g. periodic change of the second potential to the deceleration potential is introduced. The periodic change can be implemented by using an AC bias voltage. The frequency of the AC bias voltage is selected such that ions during their travel time in the transfer section are subjected to one positive (or: negative) slope of the AC voltage. With the above travel time values and ion guide length, typical frequencies are selected in the kHz- to MHz-range.

[0046] Further details of the power supply device 22 are illustrated in Fig. 4. The power supply device 22 comprises the high-frequency source 22.1 and a bias voltage source 22.2, which can be connected with the ion guide 21 via a switch 22.3, e.g. a transistor. The switch 22.3 is controlled with a control device 40, which is operated in synchronisation with the control device 13 of the source device 10 (see Fig. 2). The bias voltage source 22.2 is adapted for generating a DC voltage of about +/- 20 to

30 V.

[0047] According to a modification of the power supply device 22, the bias voltage source can be contained in the high-frequency source with a direct control by the control device 40 as shown in Fig. 5.

[0048] Fig. 6 illustrates the results of test experiments with the following conditions. A Cytochrome C sample contained in an aqueous solution (49/49/2 parts in H<sub>2</sub>O/ Methanol/Acetic Acid, 50  $\mu$ M Cytochrome C per litre) with a flow rate of 0.06 mL/min has been ionised in an electrospray source. The ions are transferred to the ICR cell with the following electric potentials: source potential: 27 V, initial (second) potential of the ion guide 0 V, switched to the deceleration potential of the ion guide: -24 V, trapping potential in the ICR cell: 5 V. The upper part of Fig. 6 illustrates the detected ions and the corresponding (m/z)-ratios with the application of the deceleration potential according to the invention. The ions are detected with high efficiency. If the deceleration potential is omitted (bias voltage: 0 V), the lower part of Fig. 6 is obtained. The ions cannot be trapped in the ICR cell. The comparison of both results illustrate the excellent effect of the deceleration potential created in the transfer section during passage of the ions.

## Claims

1. Method for transferring ions, in particular in a mass spectrometer (100), comprising the step of:
  - moving the ions from a source device (10) having a first electric potential through a transfer section (20) having a second electric potential into an analysis device (30), **characterized by** the step of
  - changing the second electric potential to a deceleration potential during the movement of the ions through the transfer section (20), wherein the deceleration potential has a different sign relative to the first electric potential.
2. Method according to claim 1, wherein the second electric potential has an absolute value lower than the absolute value of the first electric potential.
3. Method according to claim 2, wherein the second electric potential is the ground potential.
4. Method according to at least one of the foregoing claims, wherein the first electric potential and the deceleration potential have equal absolute values.
5. Method according to at least one of the claims 1 to 3, wherein the deceleration potential has an absolute value which is lower than the absolute value of the first electric potential.

6. Method according to at least one of the foregoing claims, comprising the step of creating a pulsed ion beam comprising the ions directed into the transfer section (20). 5
7. Method according to claim 6, wherein the steps of creating the pulsed ion beam and changing the second electric potential are synchronized relative to each other. 10
8. Method according to claim 7, wherein the step of changing the second electric potential is synchronized with a pulsed operation of the source device (10). 15
9. Method according to at least one of the claims 1 to 5, comprising the step of creating a continuous ion beam comprising the ions directed into the transfer section (20). 20
10. Method according to at least one of the foregoing claims, wherein the analysis device (30) has a third electric potential with an absolute value lower than the absolute values of the first electric potential and the deceleration potential. 25
11. Method according to claim 10, wherein the third electric potential is the ground potential.
12. Ion guide (21), in particular for guiding ions in a mass spectrometer (100), comprising: 30
- a power supply device (22) being connected with the ion guide (21) and including a high-frequency source (22.1), 35
- characterized by**
- a control device (22.3, 40) for temporarily applying a bias voltage to the ion guide (21). 40
13. Ion guide according to claim 12, further comprising a bias voltage source (22.2) for generating the bias voltage, wherein the control device comprises a switch (22.3) for temporarily connecting the bias voltage source (22.2) with the ion guide (21). 45
14. Ion guide according to claim 12, wherein the high-frequency source (22.1) is adapted for generating the bias voltage and the control device is adapted for controlling the high-frequency source (22.1). 50
15. Ion guide according to claim 13 or 14, wherein the control device comprises a microprocessor (40) being adapted to control at least one of the high-frequency source (22.1), the bias voltage source (22.2) and the switch (22.3). 55
16. Ion guide according to at least one of the claims 12 to 15, wherein the control device is adapted to operate in synchronisation with a source device (10) or with predetermined operation periods.
17. Ion guide according to at least one of the claims 12 to 16, which is a multipole ion guide or a tube-shaped ion guide.
18. Ion guide according to claim 17, wherein the tube-shaped ion guide (21) is made of a massive material or a mesh-shaped tube.
19. Mass spectrometer (100), comprising:
- a source device (10) for providing ions to be investigated,
  - a transfer section (20) with an ion guide (21) according to at least one of the claims 12 to 18, and
  - an analysis device (30).
20. Mass spectrometer according to claim 19, wherein the analysis device (30) comprises an ICR cell (31).
21. Mass spectrometer according to claim 20 or 21, wherein the source device (10) comprises a MALDI source (11) or an electro-spray source (11).
22. Mass spectrometer according to claim 21, wherein the source device (10) comprises an accumulator and storage device (12) .

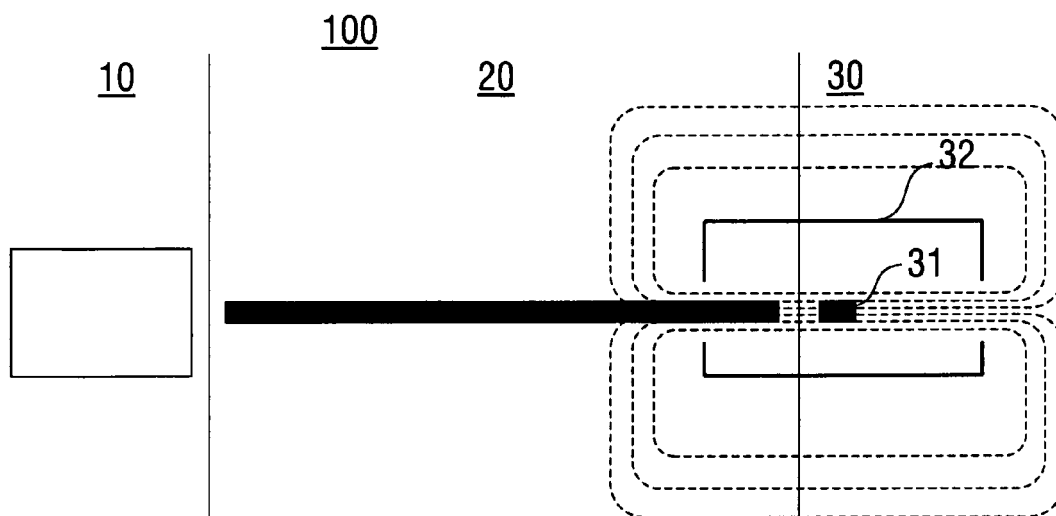


FIG. 1

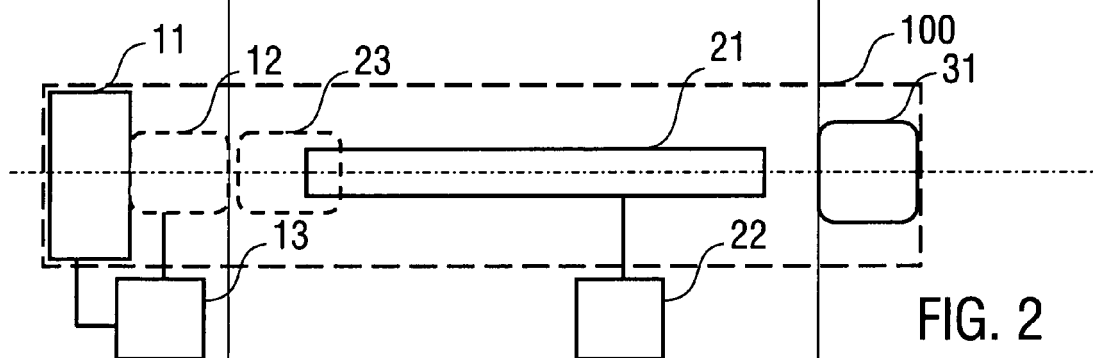


FIG. 2

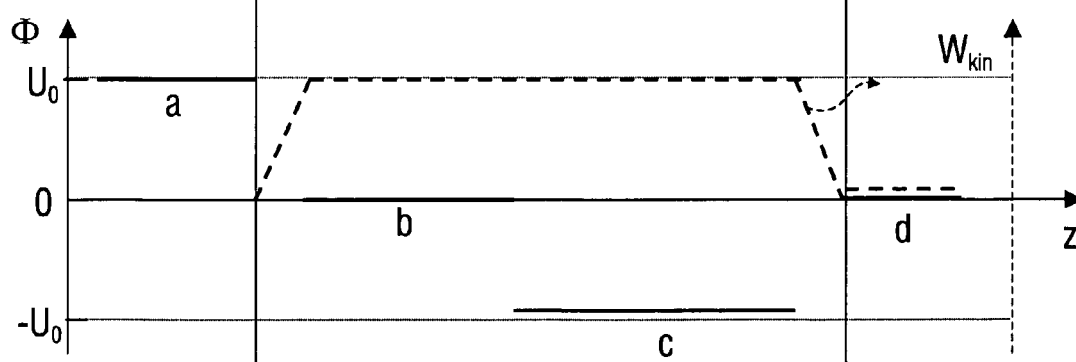


FIG. 3



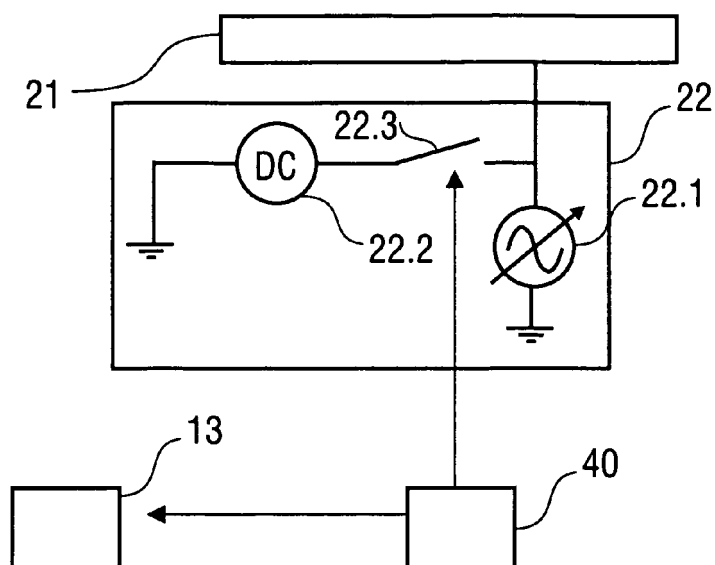


FIG. 4

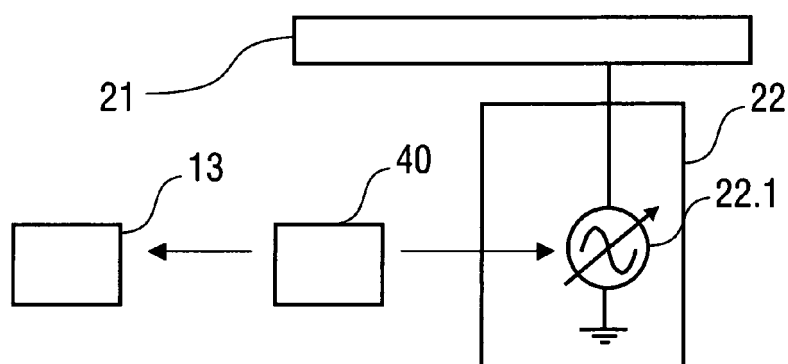


FIG. 5

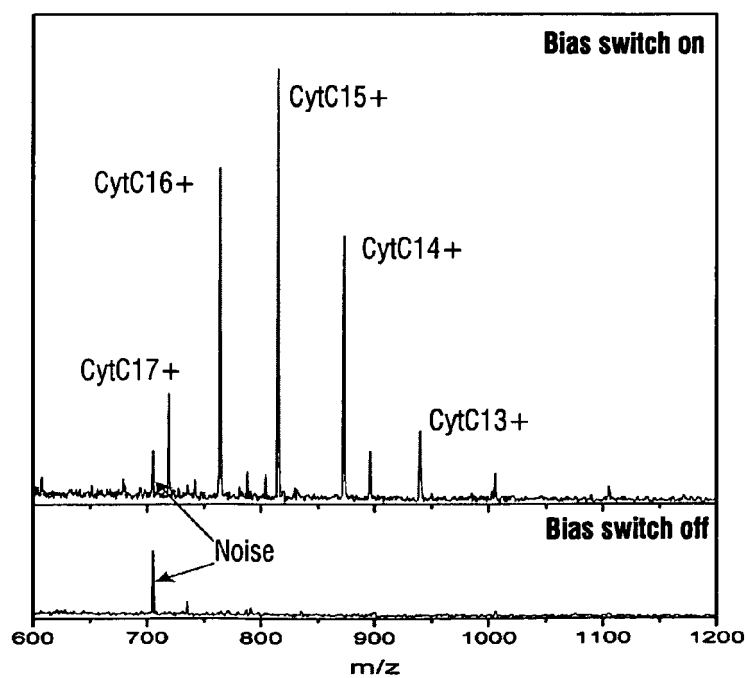


FIG. 6



European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 05 00 2148

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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A	* paragraphs [0005], [0016] * * figures 1-3 *		
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