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ION SOURCE FOR MASS SPECTROMETER

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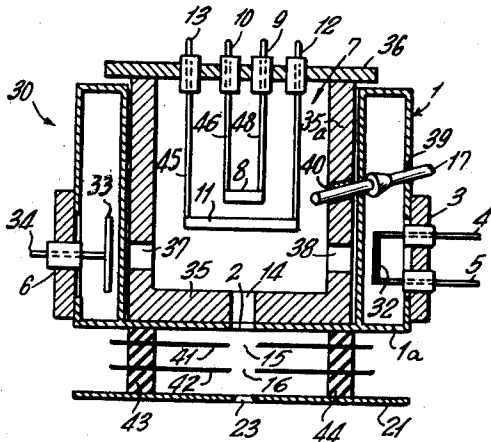


FIG. 1

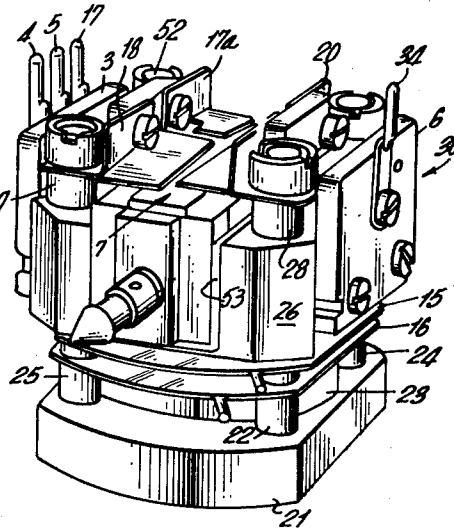


FIG. 2

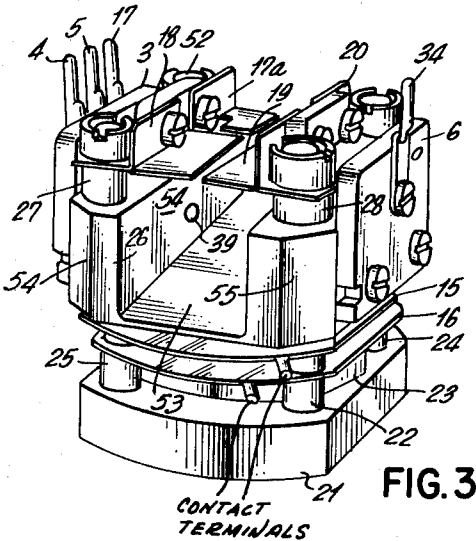
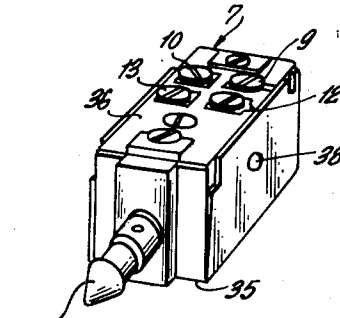


FIG. 3

CONTACT
TERMINALS



COUPLING
PIN

FIG. 4

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ION SOURCE FOR MASS SPECTROMETER

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The present invention relates to electrode systems used for the production of ions in vacuum devices, such as mass spectrometers.

In such electrode systems; the molecules of the gases and vapors, which enter the electrode system through an inlet, are ionized by electronic collision.

In another embodiment of such electrode systems, a solid sample is provided on a tungsten band and is evaporated, and the vapors formed by the sample are then ionized by thermal ionization on the surface of a second tungsten band, which has a temperature of about 2000° C., according to the Langmuir effect.

In accordance with the prior art, in order to be able to use a mass spectrometer both for electronic collision and thermal ionization, it is necessary to be able to interchange the ion sources. However, for this purpose, the evacuated zone of the mass spectrometer must be aired so that another ion source can be inserted. After the ion sources have been interchanged, vacuum pumps connected to the evacuated zone must be operated for several hours before a new measurement can be effected with the spectrometer. Furthermore, in the prior art devices, it is impossible to compare measurements between gaseous or liquid samples which are introduced through an inlet system.

In view of the foregoing, it is an object of the present invention to provide means aiming at and effectuating the obviation of the disadvantages of the prior art.

It is another object of the present invention to provide means affording a highly efficacious construction wherein two separate electrode systems are provided in a single source, and which electrode systems can be operated either separately or together.

It is another object of the present invention to provide means attaining two separate electrode systems in which one system is utilized to produce, from samples having a high vapor pressure, substantially equal energy ions, while the other system is utilized for the ionization of samples which have a very low vapor pressure.

It is a further object of the present invention to provide means assuring a highly economical, efficient and generally simplified ion producing electrode system for evacuated devices.

These and other objects of the invention will become further apparent from the following detailed description, reference being made to the accompanying drawings showing preferred embodiments of the invention.

In the drawings which illustrate the best mode presently contemplated for carrying out the invention:

FIG. 1 is a simplified and somewhat schematic cross section taken through an ion source pursuant to the present invention;

FIG. 2 is a perspective view of the ion source;

FIG. 3 is a view similar to FIG. 2 with the ionization chamber removed from the ion source; and

FIG. 4 is a perspective view of the ionization chamber.

Briefly described, the present invention provides a construction wherein a heated ionization strip and an evaporating strip or oven are provided for producing thermal ionization.

Referring now to the drawings in detail, FIG. 1, which is a somewhat schematic transverse sectional view of FIG. 2, illustrates an ion source 30 pursuant to the

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present invention. Said source is provided with a casing or housing 1. The strips are so disposed that, under otherwise unchanged field conditions in the ionization chamber, either electronic-collision-ionization or thermal ionization can be utilized. Care is taken, by suitable disposition of these parts and of additional electrodes, that electrons do not impinge on the ionization strip or band.

The ion source is so constructed that the ionization chamber and the heating strips or bands for thermal ionization are formed as a plug-in unit provided with an insulator so that the unit can be removed from the ion source and inserted into it without any tools.

The unit is constructed so that the heating strips or bands and the evaporator oven are completely shielded from the other parts of the ion source so that contamination of the ion source during the evaporation of the sample is prevented.

However, the interchangeable part of the ion source is so constructed that the interchange can be effected by means of an air lock provided for this purpose in the vacuum devices, such as a mass spectrometer.

Casing 1 includes a pair of hollow double-walled sides interconnected by a substantially flat bottom wall 1a formed with an outlet slit or aperture 2. The right side of casing 7, as viewed in FIG. 1, supports a cathode assembly 3 comprising a cathode 36 having terminal portions 4 and 5. Cathode 36 extends through the outer wall of the right side of casing 1, and the inner wall of the right side of casing 1 is formed with an aperture substantially centrally aligned with cathode 32 which latter is disposed in the hollow space between the inner and outer walls of the right side of casing 1.

The left side of casing 1 has mounted thereon an electron trap 6 including an anode 33 and a terminal portion 34. The outer wall of the left side of casing 1 is formed with an aperture for insertion of anode 33 into the space between the inner and outer walls of the left side, and the inner wall of the left side of casing 1 is formed with an aperture in alignment with the aperture in the outer wall. All four apertures in the walls forming the sides of casing 1 are aligned with each other. Cathode assembly 3 and electron trap 6 are so adjusted, relative to each other, that electrons normally issuing in a straight line from the surface of cathode portion 32 are accelerated in a direction toward anode 33 of electron trap 6.

The casing 1 mounts a removable ionization chamber 7 having upright walls 35a, a bottom 35 and a top closure 36, said bottom, walls and closure being formed of heat insulation material. The upright walls 35a have opposing openings 37 and 38 in alignment with the apertures in the walls of the sides of casing 1, and through which the electron beam can pass from cathode 32 to anode 33.

Sample gases can be introduced into the chamber 7 through an inlet tube 17 which extends through an opening 39 in the housing 1 of the ionization source and through an opening 40 in the casing 7 forming the ionization chamber. The electron beam formed between cathode 32 and anode 33 can be focused by any suitable geometric design of the ion source as well as by auxiliary means, such as magnetic fields.

The gases introduced through the inlet tube 17 are ionized by electronic collision in the electron beam and the ions thus formed pass through the opening 14 in the inner chamber 7, through aperture 2 in base 1a, and then pass through openings 41 and 42 formed in ionic lenses 15 and 16 mounted on insulators 43 and 44 on the outer housing 1, passing finally through slit 23 in the support base 21.

The electrode system constituted by cathode 32 and

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anode 33 produces substantially equal energy ions from samples having a high vapor pressure.

In addition to the electron collision electrode system 3, 6 the ion source 30 is provided also with an interchangeable thermal electrode system which can be used simultaneously with or independently of the electrode system 3, 6.

The thermal electrode system comprises a first pair of electrodes 45 and 46 which mount a heater strip or band 8 therebetween and a second pair of electrodes 47 and 48 which mount a heater strip or band 11 therebetween. It will be noted that the heater electrodes are mounted by cover 36 of the inner casing or chamber 7 and are provided with the respective contact screws or terminals 9, 10, 12 and 13. The heater strips are preferably formed of tungsten. It will be understood that the thermal ion system is used to produce ions from samples with a low vapor pressure.

It will be apparent that ionization can be effected by the separate use of the electronic system constituted by the cathode assembly 3 and the anode assembly 4, or by the thermal or evaporation system constituted by electrodes 45, 46, 47 and 48 and the associated heating strips 8 and 11, or by simultaneous operation of both systems.

The insulated chamber 7 shields the thermal strips 8 and 11 from the remainder of the ion source 30 so that contamination of the ion source during evaporation of a sample is eliminated.

The removable ion chamber 7 can be readily removed from the housing 1 when it is desired to replace the thermal ion source. To prevent the loss of the necessary vacuum in a vacuum device, such as a mass spectrometer, the spectrometer may be provided with a known air lock through which the removable ionization chamber can be removed and replaced without loss of vacuum.

The ion source 30, shown in FIG. 2 in a perspective view, consists of a U-shaped casing 26 (FIG. 3) corresponding to casing 1 of FIG. 1, which is secured on a base plate 21 by means of ceramic columns or supports 22, 24, 52 and 25, corresponding to columns 43 and 44 of FIG. 1. The base plate has a cutout 23, which is opposite the outlet slit 2 of FIG. 1 (not shown in FIGS. 2 and 3). On the outer side faces of the casing 26 are mounted the cathode assembly 3 and the electron trap or anode assembly 6. The ceramic supports or columns 22, 24, 52 and 25 carry at their upper end lead-in spring contacts 17, 18, 19 and 20, which bear against the contact screws 9, 10, 12 and 13 respectively, of the ionizing box or chamber 7 when the latter is inserted in the casing.

It will be noted from FIG. 4 that the ionization chamber 7 is a self-contained source which can be readily inserted, or removed, as a plug-in unit, in the space 53 between the opposing double wall arms 54 and 55 of the U-shaped casing 26. When the chamber 7 is inserted into the space 53, the spring contacts 17a, 18, 19 and 20 automatically effect electrical and mechanical contact with the terminals 10, 13, 12 and 9, respectively.

Distance or spacer rings 27 and 28 are provided to adjust the distance between the spring contacts and the

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screw terminals. Similar distance or spacer rings are used to adjust the mutual distance between the base plate and the two ionic lenses 15 and 16.

Various changes and modifications may be made without departing from the spirit and scope of the present invention and it is intended that such obvious changes and modifications be embraced by the annexed claims.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent, is:

1. An ion source, for a mass spectrometer, comprising, in combination, a casing formed with a pair of laterally spaced hollow sides, the walls of both sides being formed with first apertures all of which are laterally aligned, the inner walls of said sides defining a chamber receiving space therebetween, means forming a first electrode system for producing substantially equal energy ions from samples with a high vapor pressure, said first electrode system including a pair of electrode components each within a hollow side and aligned to direct an electron beam through said aligned first apertures across said space, an ionization chamber positionable within said space for cooperation with said first electrode system, said ionization chamber including side walls closely embraced by the inner walls of said casing sides, each of said side walls being formed with a second aperture and said second apertures being aligned with each other and with said first apertures, means in said ionization chamber forming a second electrode system for producing ions from samples with a substantially low vapor pressure, means for selectively energizing both of said systems whereby said systems can be operated either independently of each other or simultaneously to produce ions from samples with a high vapor pressure, from samples with a substantially low vapor pressure, or from mixtures of high vapor pressure samples and low vapor pressure samples, and means, including said ionization chamber, shielding said systems from each other.

2. An ion source as set forth in claim 1, the second electrode system being a thermal ionization system.

3. An ion source as set forth in claim 1, the first electrode system being an electronic-collision-ionization system.

4. An ion source as set forth in claim 1, said chamber being a casing of insulation material in which said second system is contained, and means providing for the removable insertion of said casing in plug-in fashion in said ion source.

5. An ion source, as claimed in claim 1, including electrode terminals projecting from said ionization chamber, and complementary resilient electrical contacts mounted on said casing and projecting into said chamber receiving space for engagement with the respective electrode terminals, whereby to establish an electrical connection to said second electrode system.

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