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APPARATUS FOR PRESENTING SOURCE PARTICLES TO A MASS SPECTROMETER

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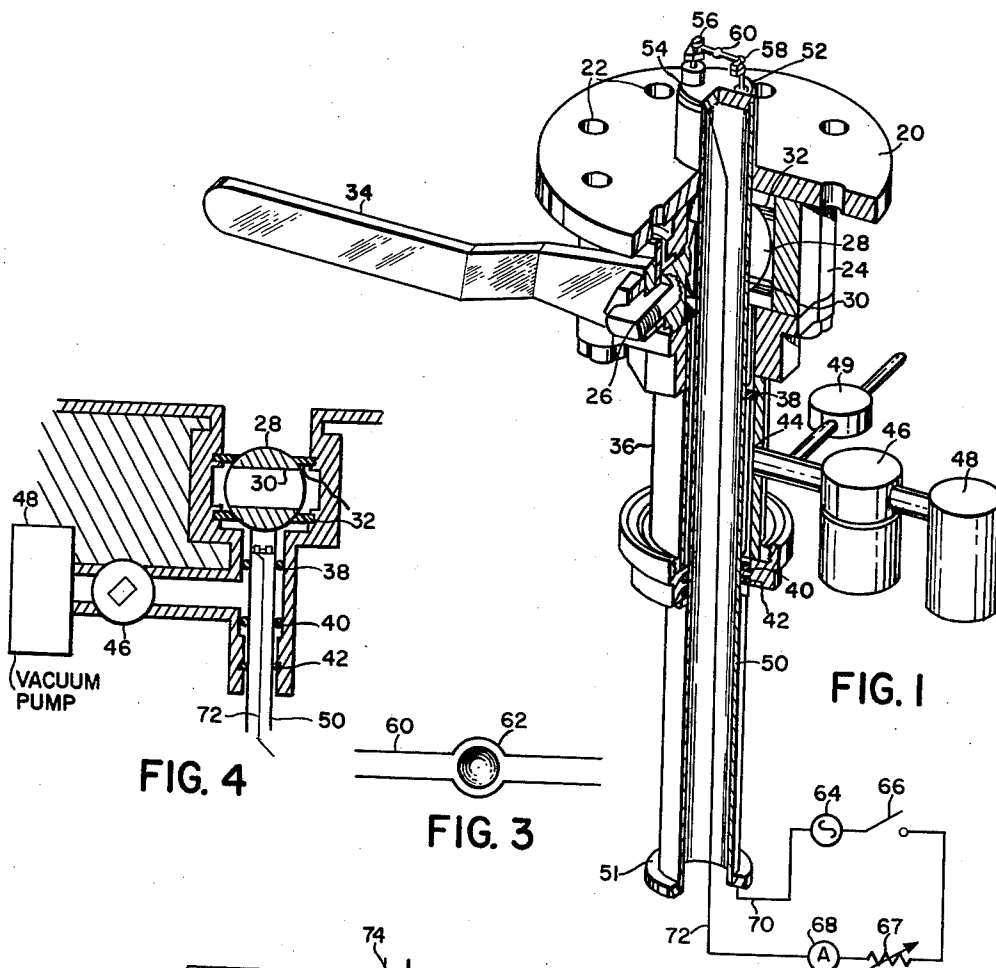


FIG. 1

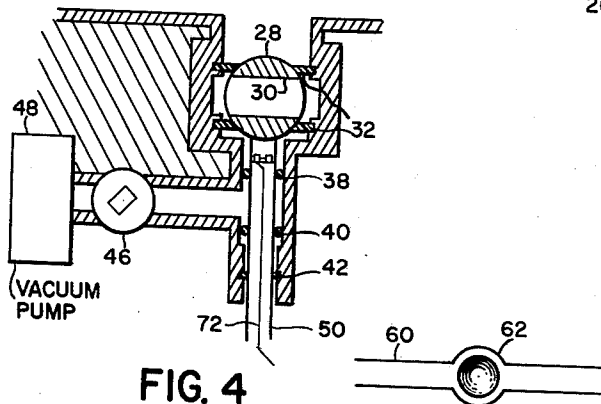


FIG. 2

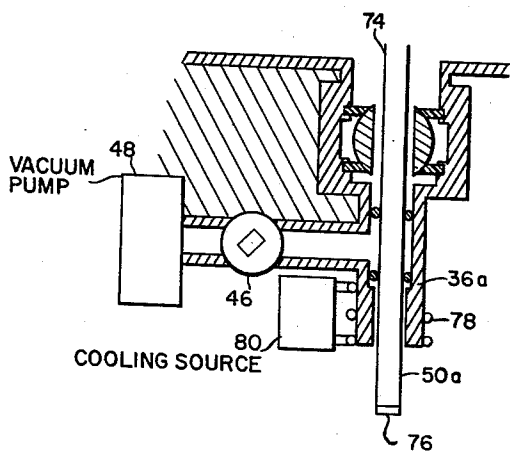


FIG. 3

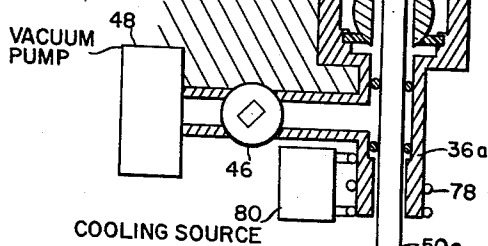


FIG. 4

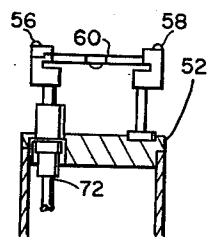


FIG. 5

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APPARATUS FOR PRESENTING SOURCE PARTICLES TO A MASS SPECTROMETER

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8 Claims. (Cl. 250-41.9)

This invention pertains to an apparatus for presenting the source particles to a mass spectrometer.

Objects of this invention include presenting in such apparatus: means for entering the vacuum of the mass spectrometer with a minimum of increase in pressure of said vacuum; means for providing rapid replacement of the source material; means for holding the source material which is of low thermal mass so that when the source material is heated, the thermal energy absorbed by the holder is a minimum; and accurate measurement of the source material temperature without the use of thermocouples.

A second embodiment of this invention provides: means for collimating the beam of source material particles so that there is a minimum deposition of these particles on mass spectrometer components; and also means for heating the source material to cause evaporation of source particles from a point outside of the mass spectrometer.

Both of the above embodiments incorporate a housing which can be sealed about a mass spectrometer opening, with a ball valve having a central opening being pivotable in the housing, and with a tube carrying the source material being slidable through the ball valve when it is in its open position. Before the ball valve is open and the tube is slid through, the area between the closed valve and the tube end is evacuated by a pump so that the vacuum of the mass spectrometer is not lost when the ball valve is opened.

In the first mentioned embodiment the tube carries at the end which is inserted into the mass spectrometer a thin filament on which is placed the source material. Electrical connections are made between the filament ends in order to heat the filament and the source material. By measuring the current in the filament circuit the temperature of the filament can be determined.

The second embodiment has a tube which carries the source material at the end which is remote from the mass spectrometer so that the source material can be heated outside of the mass spectrometer and the source particles have to travel the length of the tube before entering the mass spectrometer, thereby becoming collimated.

The objects provided by this invention will be better understood when preferred embodiments are described in connection with drawings in which:

FIGURE 1 is a partially cut away perspective view of a first preferred embodiment which is adapted for attachment to a mass spectrometer and is shown in its upper position in which position it would extend into the mass spectrometer;

FIGURE 2 is a section taken at 2-2 of FIGURE 1 showing the filament and filament clamps;

FIGURE 3 is an enlarged plan view of the filament;

FIGURE 4 is a schematic, partially sectioned view of the ball valve shown in FIGURE 1 in its closed position; and

FIGURE 5 is a partially sectioned schematic view of a second embodiment of this invention.

In FIGURE 1 is a first embodiment having a mounting plate 20 which has a plurality of holes 22 through which bolts connect plate 20 securely to the outer housing of a mass spectrometer, not shown, adjacent the ionizing area of the mass spectrometer. As an example of a mass spectrometer with which this invention may be used, Pat-

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ent No. 2,793,295 is cited although, of course, this invention may be used with other types. Depending from plate 20 is a cylindrical wall 24 which forms a housing for a high vacuum ball valve assembly which is commercially available. Wall 24 rotatably supports a shaft 26 which at one end is keyed to a ball 28 having a hole 30 formed centrally therein. Secured in wall 24 near the upper and lower portions of ball 28 and in sealing contact therewith are seals 32. Connected to the other end of shaft 26 is a handle 34 which is in the upper or open position and which, under proper conditions, may be moved to a lower or closed position as will be later described.

Tubular section 36 depends from the lower portion of wall 24 and has fixed at the upper portion thereof a Teflon positioning ring 38 and at the lower portion thereof a quad type O ring 40 and a plastic scraper ring 42. Placed intermediately of depending tube 36 is an opening 44 which is connected to a valve 46 for regulating the communication with a vacuum pump 48, which, preferably, is of sufficient force and speed to reduce the pressure in the housing 24 to a pressure below 10^{-3} torr (millimeters of mercury) at a speed greater than one liter per second. A second valve 49, when opened, admits ambient pressure to opening 44.

Reciprocable in housing 24 and tubular section 36 is a tubular probe 50 with a rim 51 at its lower end and a metallic head 52 (FIGURES 1 and 2) covering its upper end in which is mounted a ceramic post 54 which insulates clamp 56 from tube 50. Also mounted in head 52 is a second clamp 58 and held firmly by clamps 56 and 58 is a conductive filament 60, which may be of a material such as tantalum, and which has an enlarged center portion 62 for holding a sample of source material to be used in the mass spectrometer. A power generator 64 is in a circuit having a switch 66, a rheostat 67 and an ammeter 68 with a first lead 70 being connected to tubular probe wall 50 and a second lead 72 extending up through the center of probe 50 and being connected to clamp 56. By closing switch 66 and carefully controlling the current through adjustment of rheostat 67, the temperature of filament 60 can be accurately controlled so that the source material placed in center portion 62 of filament 60 can be evaporated as desired into the mass spectrometer. In order to change source material in center portion 62, tube 50 is moved downwardly until head 52 is below ball valve 28 and then ball valve 28 is closed by moving handle 34 in a downward direction. The position of the valve in the closed position is shown in FIGURE 4. At this point valve 49 is opened and air is then admitted to the system to facilitate further downward movement of probe 50. The movement of probe 50 is continued in a downward direction past positioning ring 38, O ring 40 and scraper 42 until it is free of tube 36. At this time clamps 56 and 58 may be loosened and a new filament 60 may be placed in the clamps which are then tightened. A new source material can be placed in the new filament 60 and the tube 50 inserted in the lower end of wall member 36 until the head 52 is just below opening 44. As the tube is inserted, scraper 42 cleans the tube. A plastic spacer (not shown) may be inserted between the lower portion of wall 36 and rim 51 of probe 50 to keep the probe in place at the proper distance. With the ball valve 28 in the closed position, the air admitting valve 49 is closed and valve 46 is opened so that pump 48 can evacuate the area between head 52 and ball valve 28. When this is accomplished, ball valve 28 may be opened by raising handle 34 to its upper position so that the opening 30 is aligned with probe 50 at which time the spacer is removed, and then probe 50 is drawn by the vacuum slowly past positioning ring 38, through hole 30, and into the mass spectrometer.

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If desired, a thermocouple may be connected to the filament 60 for more accurate temperature control. In addition, a Knudsen cell furnace may be used instead of filament 60 for more uniform temperature control providing better quantitative analysis.

In FIGURE 5 is shown a schematic of a second embodiment which differs from the first embodiment primarily in the construction of the probe assembly. In the embodiment of FIGURE 5, the probe 50A is of tubular construction with the upper end 74 being open and the lower end 76 being closed and holding the source material which is to be evaporated and analyzed in the mass spectrometer. In this embodiment the heat is applied at the lower end 76 of probe 50A as with a gas flame or the like and the evaporated particles then pass up through tube 50A and into the ionizing region of the mass spectrometer. This passage collimates the particle stream so that a well defined beam enters the mass spectrometer. Placed around tube 36A through which probe 50A passes, is cooling coil 78 which is connected to cooling source 80 which tends to cool the probe 50A to aid in condensation of the particles with random velocity which strike the sides of tube 50A. Also, the cooling prolongs the lives of the O rings and seals in the area of the heated probe.

Although this invention has been disclosed and illustrated with reference to particular applications, the principles involved are susceptible of numerous other applications which will be apparent to persons skilled in the art. The invention is, therefore, to be limited only as indicated by the scope of the appended claims.

Having thus described our invention, we claim:

1. A mass spectrometer source holder comprising a valve housing adapted for pneumatic sealing to a mass spectrometer, a shaft member extending from said housing, valve means being situated in said housing, tube means being reciprocable in said shaft member and movable to a first position into the mass spectrometer when said valve means is open, and movable to a second position away

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from said mass spectrometer to permit closing of said valve means and sealing of said mass spectrometer, seal means being between said shaft means and said tube means at a point farther from said mass spectrometer than said second position, evacuating means being connected to said shaft means at a point between said valve means and said seal means.

2. The apparatus of claim 1 with said valve means comprising a ball valve having a center opening through which said tube means is movable.

3. The apparatus of claim 1 with said shaft means and tube means being cylindrical.

4. The apparatus of claim 1 with a positioning member being between said shaft means and tube means a point between said mass spectrometer and said sealing means.

5. The apparatus of claim 1 with said tube means having a source holder at that end insertable into said mass spectrometer, means for heating said source holder, said holder having source material retaining means thereon.

6. The apparatus of claim 5 with said heating means comprising an electrical power source connected to each end of said holder, rheostat means to control the current and subsequent temperature of said holder, ammeter means to indicate the current through said holder.

7. The apparatus of claim 1 with an opening being formed at one end of said tube means, said opening communicating with a tube means portion extending exteriorly of said shaft means and mass spectrometer when said tube is in said first position, said tube means portion containing a source material, heating means to atomize said source material.

8. The apparatus of claim 7 with means to cool said tube means in an area adjacent said tube means portion and on the mass spectrometer side of said tube means portion to condense particles having random direction and to prolong source holder life.

No references cited.