Nov. 22, 1960 J. BISHOP 2,961,538

MASS-SPECTROMETERS

Filed March 10, 1959 3 Sheets-Sheet 1

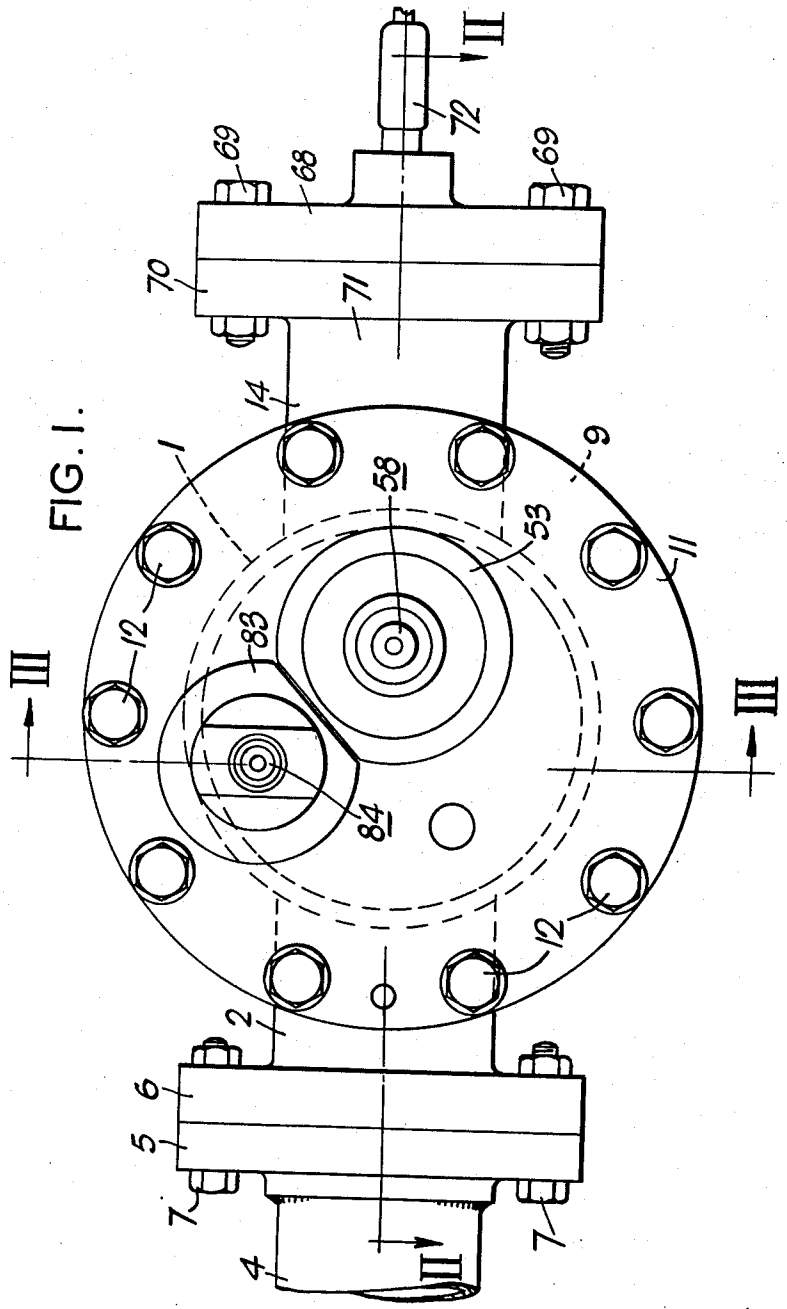


FIG. 1.

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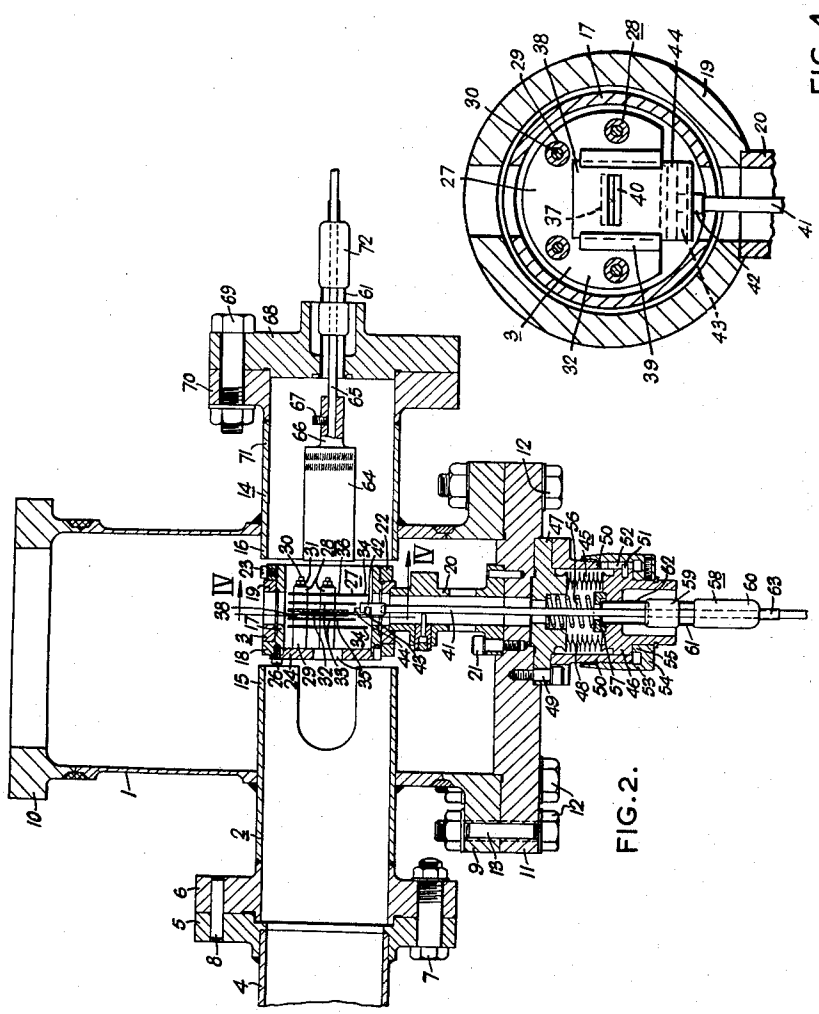


FIG. 2.

FIG. 4.

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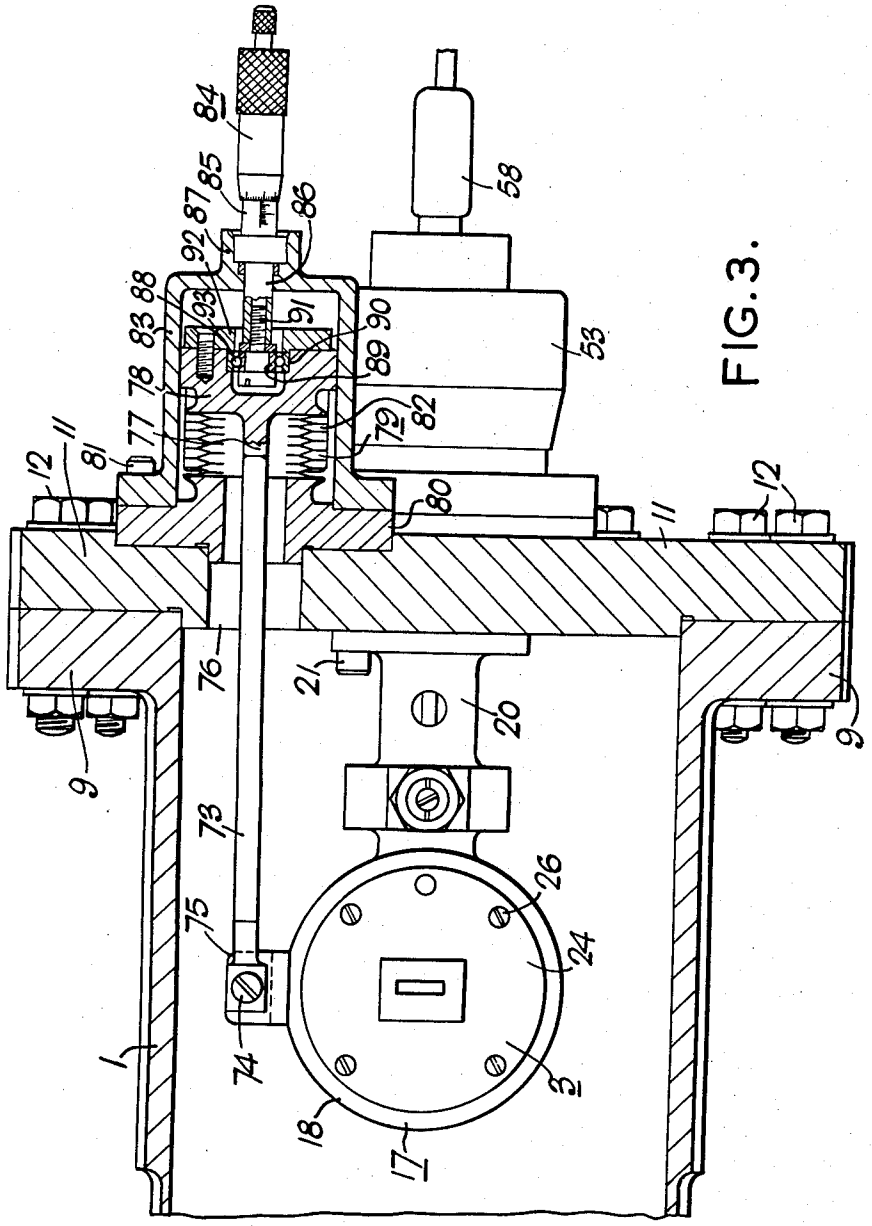


FIG. 3.

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MASS-SPECTROMETERS

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6 Claims. (Cl. 250—41.9)

This invention relates to collector heads for mass spectrometers.

In the analysis of the isotopic concentrations of materials using a mass spectrometer it is customary to generate the ion beam such that the beam is of nominal rectangular cross-section by using an ion source having accelerating electrodes with rectangular slots which are carefully aligned by the use of dowels. The ion beam in passage through an analyser tube in the mass spectrometer is bent under the influence of a transverse magnetic field so that the beam is stratified into separate beams of differing mass number. In the case of a beam containing ions of two isotopes the beam is split into first and second ion beams which are passed into a collector head in which the first ion beam is collected by a first collector electrode. and the second ion beam passes through a slot in the first collector electrode and is collected by a second collector electrode behind the first collector electrode.

The slot in the first collector electrode is usually of rectangular cross-section corresponding in shape and dimensions with the second ion beam. In order to obtain good resolution this slot is carefully aligned with the second ion beam and generally this is done during manufacture by accurately dowelling the ion source and the collector head with respect to the analyser tube. However in passing through the mass spectrometer the ion beams are subjected to aberrations, become distorted and twisted so that the resolution is impaired. It is an object of the invention to provide means compensating in part the effects of such aberrations.

According to the invention a collector head for a mass spectrometer comprises a first collector electrode for a first ion beam, the first collector electrode having a slot allowing passage of a second ion beam on to a second collector electrode, and is characterised in that the first collector electrode is rotatable in a plane transverse to the ion beams by an adjuster external to the collector head.

One embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:

Fig. 1 is an end elevation.

Fig. 2 is a sectional plan along the line II—II in Fig. 1.

Fig. 3 is a sectional elevation along the line III—III in Fig. 1.

Fig. 4 is a detail of the section along the line IV—IV in Fig. 2.

In the drawings there is shown a mass spectrometer collector head comprising a cylindrical chamber 1 fitted with an ion beam inlet tube 2 and containing an electrode structure 3. The collector head connects with the analyser tube 4 of a mass spectrometer through the beam inlet tube 2, the analyser tube 4 and the beam inlet tube 2 being fitted with flanges 5 and 6 which are clamped and located in gas tight connection by bolts 7 and dowels 8. The chamber 1 has flanged ends 9 and 10. The chamber 1 is connected to an evacuating system (not shown) at

the flanged end 10 and is closed at the flanged end 9 by a circular cover plate 11 clamped by nuts and bolts 12, additional location being provided by a dowel 13. The beam inlet tube 2 which passes through the wall of the chamber 1 is located diametrically opposite to a tube 14 which also passes through the wall of the chamber 1. The tubes 2 and 14 terminate inside the chamber 1 and the electrode structure 3 is located between the inner adjacent ends 15 and 16 of the tubes 2 and 14. The electrode structure 3 comprises a rotatably mounted tubular sleeve 17 having an external end flange 18 and mounted in a bearing bush 19 which is welded to a tubular pillar 20. The pillar 20 is secured to the cover plate 11 by bolts 21 and the sleeve 17 is retained in the bearing bush 18 by a locating ring 22 fitted with clamping screws 23. A circular plate 24 is fitted to the flanged end of the sleeve 17 by bolts 26. The plate 24 supports an array of five parallel electrodes 27 by means of composite ceramic pillars 28 so that the electrodes 27 are insulated from each other and from the plate 24. The pillars 28, of which there are four, comprise short ceramic spacer tubes 29 threaded on rods 30 projecting from the plate 24. The rods 30 pass through the electrodes 27 which are clamped between the spacer tubes 29 by nuts 31 screwed on the rods 30. The electrodes 27 are of three types, viz: a central collector electrode 32 located between two secondary electron suppressor rings 33 and two guard rings 34. The plate 24 and the secondary electron suppressor rings 22 have central rectangular apertures 35 while the guard rings 34 have central circular apertures 36. The collector electrode 32 has a centrally placed rectangular slot 37 as shown in Fig. 4.

A slide 38 movable in guides 39 brazed to the collector electrode 32 has a rectangular slot 40 corresponding to the slot 37 in the collector electrode 32 so that the effective area of the slot 37 may be varied by moving the slide 38. The slide 38 is movable under the action of a push rod 41 which after passing through the plate 11, extends through the tubular pillar 20 and is coupled with the slide 38 by a hook 42 on the rod 41 which engages with a groove 43 in a thickened part 44 of the slide 38. The push rod 41 is sealed in passage through the plate 11 by a bellows type seal 45 which accommodates reciprocating movement of the push rod 41. The seal 45 comprises movable and fixed bellows flanges 46 and 47 joined by a collapsible metal bellows 48. The bellows flange 47 is secured to the plate 11 by bolts 49 and the movable bellows flange 46 is slidable in a flanged tube 50 carried on the fixed bellows flange 47. Rotation of the bellows flange 46 in the tube 50 is prevented by a pin 51 carried by the flange 46 and engaging with an internal keyway 52 in the tube 50. The tube 50 is externally threaded to fit a knurled adjusting nut 53 having an internal flange 54 with a lip 55 adapted to thrust against and thereby move the bellows flange 46 on rotation of the nut 53 in a clockwise sense. The bellows flanges 46 and 47 are spring loaded apart by a compression spring 56 which bears against the movable bellows flange 46 through a thrust washer 57. The push rod 41 is sealed and electrically insulated in passage through the movable bellows flange 46 by a glass to metal seal 58. The seal 58 comprises two separate cylindrical glass sections 59 and 60 which are joined by a short metal guard tube 61. The seal 58 is brazed at a metal tube 62 to the movable bellows flange 46 and at a metal tube 63 to the push rod 41.

A second collector electrode 64 of tubular form is located coaxially inside the tube 14 adjacent to the electrode structure 3. The electrode 64 is fixed to a rod 65 by means of a tubular bush 66 fitted with a locking screw 67. The tube 14 is closed by a circular cover plate 68 which is clamped by nuts and bolts 69 to a flange 70 welded to the external end 71 of the tube 14. The

rod 65 is sealed and insulated in passage through the cover plate 68 by a glass to metal seal 72 identical to the seal 58.

Referring to Fig. 3 rotation of the electrode structure 3 is effected from outside the collector head by means of a push rod 73. A pivot pin 74 couples the push rod 73 with a lug 75 formed integrally with the flange 18 on the rotatable sleeve 17. The push rod 73 passes out of the collector head through a hole 76 in the cover plate 11 and is welded in connection with a stem 77 integral with a movab'e bellows flange 78 forming part of a bellows type seal 79. A fixed bellows flange 80 attached to the cover plate 11 by bolts 81 is joined with the movable bellows flange 78 by a collapsible metal bellows 82. The movable bellows flange 78 is slidable in a flanged tubular thimble 83 attached by the bolts 81 to the fixed bellows flange 80. A micrometer head 84 having a body 85 and a stem 86 is supported by the thimble 83. The thimble 83 has an end bush 87 which accommodates one end of the body 85 of the micrometer head 84. The stem 86 of the micrometer head 84 passes through the bush 87 and is coupled with the movable bellows flange 78 by a ball race 88 comprising inner and outer members 89 and 90. The movable bellows flange 78 is drilled to accommodate the outer member 90 of the ball race 88 while the inner member 89 of the ball race 88 is fitted with a pin 91 which is screwed into the stem 86 of the micrometer head. The outer member 90 of the ball race 88 is retained in the movable bellows flange 78 by an annular plate 92 fixed by bolts 93.

In use of the collector head in conjunction with a mass spectrometer two separate isotope beams of nominal rectangular cross section and containing ions of different mass number are passed from the mass sepectrometer analyser tube 4 into the collector head. It is arranged that one of the beams impinges on the collector electrode 32 and the other passes through the slot 37 in the collector electrode 32 and is trapped by the tubular collector electrode 64. The beam to be collected by the tubular electrode 64 is aligned axially with the slot 37 by adjustment of the magnetic field in the mass spectrometer. In order to accommodate for twisting of the ion beam the slot 37 is adjusted angularly with respect to the beam by means of the micrometer head 84 which operates the push rod 73 to rotate the sleeve 17 and hence the electrode structure 3. In order to accommodate for any distortion in the width or shape of the beam the width of the slot 37 is adjusted by moving the slide 38. The slide 38 is moved by rotating the knurled nut 53 to move the push rod 41 with flexure of the bellows seal 45. The hook 42 and the groove 43 engagement between the rod 41 and the slide 38 accommodates rotational movement of the electrode structure 3.

The guard rings 34 are provided in the electrode structure 3 to prevent leakage of D.C. currents onto the collector electrode 32 while the secondary electron suppressor rings 33 are held at a negative potential with respect to the collector electrode 32 and act to suppress electrons emitted by the collector electrode 32 due to the ionic bombardment thereof. The guard tube 61 of the metal to glass seal 58 is connected to a feed back line from a vibrating reed electrometer which provided a measurement of the ion current of the collector electrode 32 by measuring the potential drop across a high resistance through which the push rod 41 is connected to earth. The connection of the guard tube 61 with the electrometer feed back reduces leakage currents across the glass of the glass to metal seal 58. The guard tube 61 in the glass to metal seal 72 is similarly connected to the feed back line of a vibrating reed electrometer measuring the ion current of the collector electrode 64.

I claim:

1. A collector head for a mass spectrometer comprising a first collector electrode for a first ion beam, the first collector electrode having a slot allowing passage of a second ion beam on to a second collector electrode, characterised in that the first collector electrode is rotatable in a plane transverse to the ion beams by an adjuster external to the collector head.

2. A collector head as claimed in claim 1, characterised in that said first collector electrode is mounted in a rotatable sleeve and said adjuster comprises a rod for rotating the sleeve, the rod being coupled to the sleeve and sealed in passage through the collector head by a bellows.

3. A collector head as claimed in claim 1, characterised in that a movable slotted mask is provided for adjusting the width of the first collector electrode slot, the slotted mask being movable by a second adjuster external to the collector head.

4. A collector head as claimed in claim 2, characterised in that a movable slotted mask is provided for adjusting the width of the first collector electrode slot, the slotted mask being movable by a second adjuster external to the collector head.

5. A collector head as claimed in claim 3, characterised in that said slotted mask is movably mounted on said first collector electrode and said second adjuster comprises a rod coupled to the slotted mask and sealed in passage through the collector head by a bellows, the coupling between the slotted mask and the rod accommodating rotational movement of said first collector electrode.

6. A collector head as claimed in claim 4, characterised in that said slotted mask is movably mounted on said first collector electrode and said second adjuster comprises a rod coupled to the slotted mask and sealed in passage through the collector head by a bellows, the coupling between the slotted mask and the rod accommodating rotational movement of said first collector electrode.

No references cited.