United States Patent [19]

Gutow, Jr.

[11] **3,742,275**

[45] **June 26, 1973**

[54] **ION SOURCE HAVING IMPROVED ION BEAM ALIGNMENT AND FOCUS STRUCTURE**

[75] Inventor: **Russell S. Gutow, Jr.**, Mountain View, Calif.

[73] Assignee: **Varian Associates**, Palo Alto, Calif.

[22] Filed: **Mar. 4, 1971**

[21] Appl. No.: **121,114**

[52] **U.S. Cl.** ..... **313/63**, 250/41.9 SE, 313/86, 313/230

[51] **Int. Cl.** **H05j 27/00**

[58] **Field of Search** ..... 313/63, 86, 86 KM, 313/230; 250/41.9 SA, 41.9 SB, 41.9 SR, 41.9 SE

[56] **References Cited**

UNITED STATES PATENTS

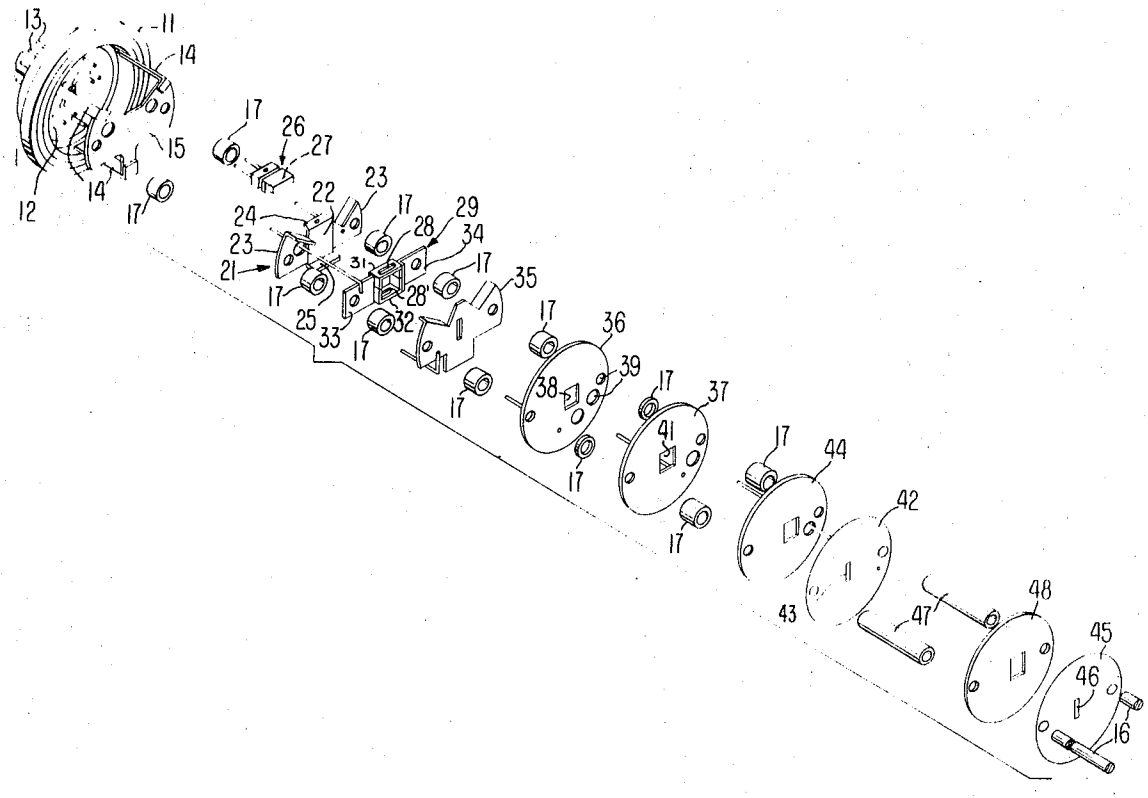
3,602,752	8/1971	Shriner	313/63
3,354,335	11/1967	Corpew	313/86 X
3,373,305	3/1968	Collins et al.	313/230

Primary Examiner—Roy Lake
Assistant Examiner—James B. Mullins
Attorney—Stanley Z. Cole and Vincent W. Cleary

[57] **ABSTRACT**

An ion source comprising a plurality of components arranged along the ion beam path including a source body, repeller and extractor electrodes, a lens structure including an alignment electrode and a focus electrode, and an aperture plate. Certain of the components are made from common parts including the alignment and focus electrodes, each of which is formed by a metallic disk having a rectangular aperture centrally disposed therein but located slightly off axial center. The two electrodes are mounted along the beam path so that the two apertures are off-set in mutually opposite directions. Only a portion of the aperture of each electrode is aligned along the beam axis through which the beam passes for alignment and focussing.

2 Claims, 3 Drawing Figures



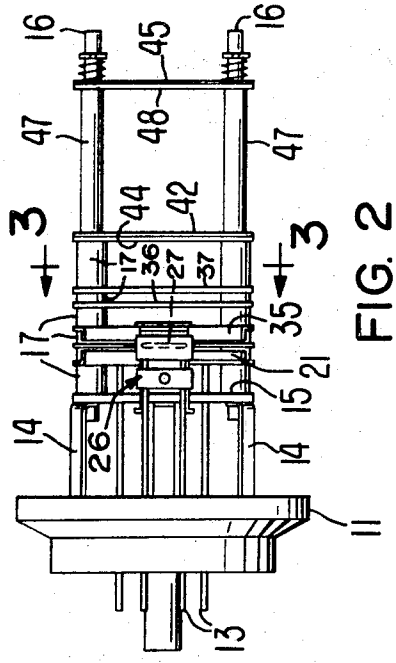


FIG. 2

FIG. 1

FIG. 3

INVENTOR.
RUSSELL S. GUTOW JR.
BY
ATTORNEY

ION SOURCE HAVING IMPROVED ION BEAM ALIGNMENT AND FOCUS STRUCTURE

BACKGROUND OF THE INVENTION

In present day mass spectrometers the gas under anaylsis is bombarded in an ion source region with a beam of electrons to produce positive ions. These ions are then separated according to their individual masses by momentum or velocity selection systems to determine the relative abundance of ions of selected mass numbers.

Although instruments of this type are of considerable interest to colleges and universities in the education of science students, the instruments have become increasingly expensive with time due, in part, to the expensive components and hand labor that go into the manufacture and assembly of mass spectrometers. The end price of such instruments is beyond the means of many such institutions.

One very important component in the mass spectrometer is the ion source where the ions are formed by electron bombardment and accelerated and focused into a beam for delivery to the ion selection stage of the spectrometer. Such sources are generally manufactured from machined parts with close tolerances, and are assembled with a relatively large amount of hand labor. The resultant cost of the ion source contributes substantially to the overall cost of the system.

To provide a mass spectrometer system that is within the means of educational institutions, it is necessary to substantially reduce the manufacturing and assembly cost of the components of the system, including the ion source, without appreciable reduction in overall performance.

BRIEF SUMMARY OF THE PRESENT INVENTION

The present invention provides an ion source for a mass spectrometer, or other system which may utilize such a source, which is relatively inexpensive compared with existing ion sources.

The principle parts which go into the construction of the source are manufactured by die stampings and certain rather critical slots are formed in electrodes by photoetching techniques, relatively inexpensive manufacturing techniques compared to machining processes.

The parts are designed so that certain elements may be assembled by spot welding identical sub-elements together. Other identical parts are used for different functioning components of the source. This reduces the number of manufactured parts needed to be assembled together to form the complete source. For example. one die stamped disk with appropriate openings therein serves to form or aid in forming four of the spaced-apart electrodes along the ion beam path. Another die stamped part is used to form an extractor electrode and also a repeller electrode by slight alternation in the configuration of the part.

A novel alignment-focus structure or lense is formed by two of the similar electrodes, each electrode being formed by a metallic disk having a rectangular aperture centrally disposed therein. The rectangular aperture is located slightly off center of the disk axis, and the two electrodes are positioned so that their apertures are offset in mutually opposite directions. Thus only a portion of the aperture of each electrode is aligned along the axis of the beam passing centrally therethru. By proper adjustment of the voltage between these electrodes, the ion beam may be properly aligned and focused along the desired ion beam path.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded perspective view of the novel ion source structure.

FIG. 2 is a longitudinal view of the assembled ion source.

FIG. 3 is a cross-section view of the ion source showing the alignment-focus lens taken along section line 3—3 in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The ion source of the present invention comprises a header assembly adapted to be affixed in the outer end of a tubular shaped evacuated chamber along which the ion beam is to be directed to an ion selection stage in well-known manner. The header includes an annular flange member **11** having a ceramic header **12** sealed therein, a plurality of electrical connector leads **13** extending through the header **12** for forming electrical connections with the various elements within the evacuated source. Three support legs **14** are affixed to the flange member and form a tripod for mounting a metallic support plate **15** upon which the remainder of the ion source elements are mounted by means of the two ceramic support rods **16.** The various elements are axially aligned along the structure between the two rods **16** and are spaced-apart by means of hollow cylindrical ceramic spacers **17** of suitable length.

The elements of the ion source positioned along the structure comprise a metallic repeller electrode **21** as of stainless steel including a central wall portion **22,** two side support wings **23,** a top lip portion **24** extending back toward the support plate **15,** and a bottom lip portion **25** extending in the opposite direction. The top lip serves to support the filament sub-assembly **26** including the filament wire **27** which extends over an opening **28** in the top wall of the ion source body **29.**

The source body comprises a four-sided box with open ends front and back, the box being formed by two similar U-shaped members **31** and **32** with their pairs of legs extending inwardly toward each other and being spot welded to two similar L-shaped support members **33** and **34.** Openings **28** and **28'** in the top and bottom walls, respectively, of the box allow an electron beam to pass from the filament **27** through the source body and out to be collected on the lower lip portion **25** of the repeller electrode **21** extending under the source body. Since the lower lip **25** is at a positive voltage with respect to the source body, secondary electrons will be collected thereon.

An extractor electrode **35** similar in configuration to the repeller electrode **21** is positioned in front of the source body, this electrode differing in configuration from the repeller only in that a beam aperture slot is located in the center thereof. The top lip portion is bent forward slightly to reduce the electrical field gradient produced btween the repeller and extractor electrodes.

A lens system comprising an alignment electrode **36** and a focusing electrode **37** is positioned in front of and spaced from said extractor electrode **35.** The alignment electrode **36** comprises a stainless steel die stamped disk having a rectangular aperture **38** centrally disposed therein and a plurality of openings **39** near the

periphery thereof, the latter openings serving to mount the disk on the support rods and to pass the electrical leads from following electrodes back to the base. The rectangular opening **38** is positioned slightly off center so that more of the aperture lies on one side of the axis of the disk than on the other.

The focus electrode **37**, which is spaced-apart slightly from and insulated from the alignment electrode **36** by the tubular ceramic spacers **17**, is identical in configuration and is interchangeable with the alignment electrode **36.** However, in assembly, the focus electrode **37** is turned around so that the larger portion of the central aperture **41** lies on the side of the beam axis opposite to that of the alignment electrode aperture. The two apertures **38** and **41** form a narrower aperture for the ion beam where their two aperature portions overlap along the central axis.

A stainless steel aperture slip plate **42** is positioned up stream of said focus electrode **37**, said plate being very thin and being provided with a 3 mil wide slot formed centrally therein by well-known photoetching techniques. Since the disk **42** must be very thin to promote a well defined, close tolerance slot by photoetching, it is not a rigid member, and therefore it is welded to a backing plate **44** for support. This backing plate **44** is the same part used for the alignment and focus electrodes, resulting in an inexpensive yet very adequate aperture slit structure.

An aperture stop member **45**, similar to the aperture slit disk except for a 30 mil photoetched slot **46** in the center, is positioned as the final electrode along the assembly, this aperture stop **45** being spaced from and electrically coupled to said aperture slit disk **42** by a pair of tubular stainless steel spacers **47.** Again, because of the thinness of the disk **45**, the aperture stop disk is spot welded to a backing plate **48** identical in structure to the other disks **36, 37** and **44.**

In operation, an electron beam from the heated filament **27** is focused by a magnetic field means (not shown) down through opening **28** and through the source box and opening **28'** to the collector **25.** Collisions with the gas molecules in the source box produce ions, the positive ions being repelled by a slight positive voltage on the repeller electrode **21** and attracted by a slight negative voltage on the extractor electrode **35** and directed through the aperture in the extractor.

The ion beam enters the lens system comprising the alignment and focus electrodes **36** and **37**, the alignment electrode being about 25 volts negative relative to the extractor electrode and the focus electrode being about 25 volts more negative than the alignment electrode. Although individually the two apertures **38** and **41** are relatively wide, together they form a substantially narrower width central aperture at their overlapping axial region through which the ions pass, the ions being focused into a narrow beam onto the 3 mil slit **43** in the aperture slit plate **42.**

After passing through the aperture slit **43**, the ions have a tendency to diverge, and the 30 mil wide slot **46** serves to shave the edges of the beam so as to provide a well defined beam output to the selection stage of the system. The aperture stop plate and aperture slit plate are tied together electrically to allow the ion current collected thereon to be measured and used as an indication of the gas pressure.

The alignment and focus electrodes are mutually insulated and the voltage of the alignment electrode may be varied about some mid-value to swing the ion beam and center it through the aperture slit **43.**

This novel ion source structure provides a source which utilizes inexpensive parts easily assembled with completely adequate performance for low cost mass spectrometer or the like.

What is claimed is:

1. An ion source comprising a source body adapted to enclose a gas sample, means including an electrical filament for producing an electron beam within said source body to produce positive ions from said gas sample, means for extracting a beam of ions from said source including an extractor electrode having an aperture, an alignment electrode and focus electrode mutually spaced-apart and spaced in front of said extracting means, each of said latter electrodes having a slot therein, the slot in said alignment electrode being off-center relative to said ion beam in one direction and the slot in said focus electrode being off-center relative to said ion beam in the opposite direction, a portion of each of said slots being aligned with said ion beam in mutually spatial overlap, and an aperture means including an aperture slit positioned in front of said alignment-focus electrode pair, said alignment-focus electrode pair operating to align the ion beam passing from said extractor electrode aperture and to focus said ion beam onto said aperture slit in said aperture means wherein said alignment electrode comprises a flat metallic member and wherein said alignment electrode slot is rectangular, and wherein said focus electrode comprises a second flat metallic member essentially identical to said alignment electrode facing in the opposite direction to said alignment electrode such that each said slot is off-set from the axis in the opposite direction and wherein said aperture means comprises a first thin metallic member having a narrow slit in the center thereof, and a support member on which said first thin metallic member having a narrow slit in the center thereof, and a support member on which said first thin metallic member is mounted, said support member comprising a third flat metallic member essentially identical to said alignment electrode.

2. An ion source as claimed in claim **1** wherein said aperture means further comprises a second thin metallic member having a narrow slit in the center thereof and spaced from said first thin metallic member along said beam path, and a further support member on which said second thin member is mounted comprising a fourth flat metallic member essentially identical to said alignment electrode.

* * * * *