

United States Patent

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[54] ION BEAM SOURCES WITH TILTABLE FIRING ANGLE

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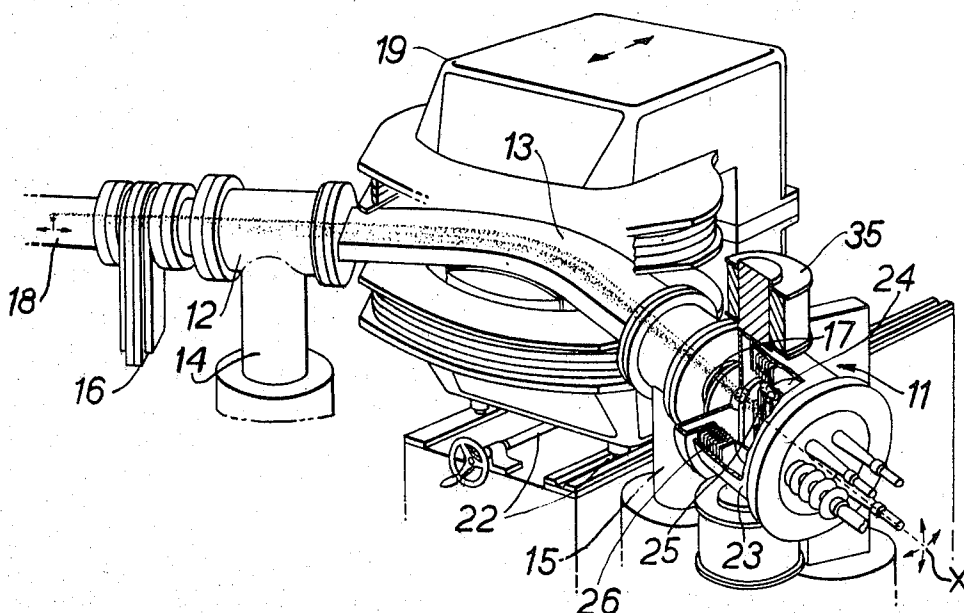
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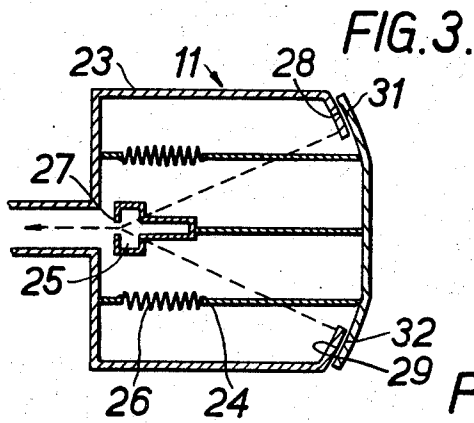
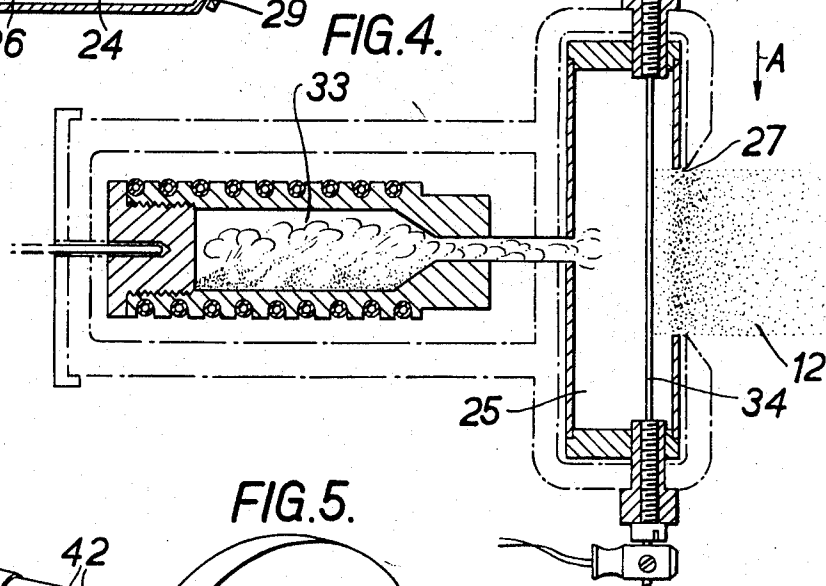
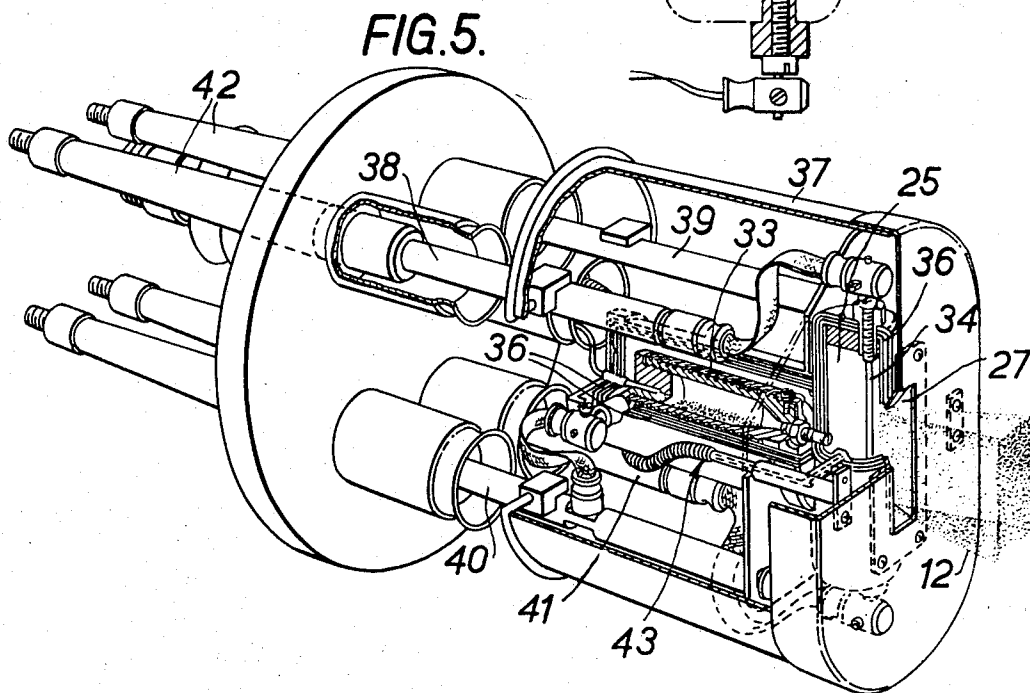
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[57] ABSTRACT

An ion source for an electromagnetic separator is tiltably mounted upon the ion beam passageway. Adjustment of the inclination to the passageway of the ion beam trajectory is thus provided.

4 Claims, 6 Drawing Figures





ION BEAM SOURCES WITH TILTABLE FIRING ANGLE

BACKGROUND OF THE INVENTION

The invention relates to ion beam sources, for example for separators.

In ion beam separators a beam containing ions of a plurality of isotopes is caused to pass through a strong magnetic field which extends substantially perpendicularly to the ion beam path. The magnetic field deflects the ions into a curved path, the magnitude of the deflection being dependent, inter alia, upon the mass of the ions. Thus ions of different isotopes may be separated into diverging beams and by appropriate geometrical arrangement of the components of the separator, ions of a selected isotope may be focussed upon a chosen target.

SUMMARY OF THE INVENTION

The invention provides an ion beam source comprising a vacuum tight enclosure, means for generating ions in the enclosure, means for ejecting the ions from the enclosure in a rectangular section beam from an extraction slit, attachment means for attaching the enclosure in vacuum tight communication with an enclosed beam passageway, which attachment means permits limited movement of the enclosure relative to the passageway for adjusting the relative inclination of the ejected ion beam to the passageway, and constraining means for constraining the enclosure, in its said limited movement, to follow a pivotal motion about either of two perpendicular intersecting axes, one of which is parallel with the said extraction slit and coincident with the origin or apparent origin of the ion beam.

Preferably the enclosure is attached to a beam passageway via a vacuum bellows. Conveniently, spherically machined relatively slidable surfaces provide the said constraint upon the adjusting movement of the enclosure. Alternatively, the enclosure may be mounted on gimbals for permitting the required limited movement.

BRIEF DESCRIPTION OF THE DRAWINGS

A specific construction of ion beam source embodying the invention will now be described by way of example and with reference to the accompanying drawings in which:

FIG. 1 is a diagrammatic perspective view of an electromagnetic separator to which the ion beam source is connected,

FIG. 2 is a diagrammatic plan view of the electromagnetic separator,

FIG. 3 is a diagrammatic representation of the ion source for illustrating the manner in which it is mounted on to the electromagnetic separator,

FIG. 4 is a diagrammatic sectional view of part of the ion source for illustrating the principle of its operation,

FIG. 5 is a diagrammatic perspective view of part of the ion source, partly cut away,

FIG. 6 is a diagrammatic perspective view of a part of an ion source, illustrating an alternate mounting arrangement to that shown in FIG. 3.

In this example, an ion beam source 11 provides a beam of ions 12 for an electromagnetic separator shown in FIGS. 1 and 2. As may be seen from FIG. 5 the beam is of rectangular section.

DESCRIPTION OF PREFERRED EMBODIMENT

The separator, which is described in British Patent Specification No. 6288/69, comprises a beam passageway 13 connected at 14 and 15 to a vacuum pumping system and via vacuum isolation valves 16, 17 to respectively the ion source 11 and a target (not shown) at 18. A magnetic field for bending the ion beam is provided by a large electromagnet 19 having pole pieces 21 disposed on each side of the passageway 13.

The provision, indicated at reference 22, for adjusting the position of the electromagnet 19 relative to the passageway 13 and the provision of adjustable pole tips in the pole pieces 21 is described in the abovementioned Patent Specification No. 6288/69.

The ion beam source 11 comprises an outer cylindrical walled vessel 23 and an inner cylindrical walled vessel 24. The arc chamber 25 and associated components for generating the ion beam are supported on and within the inner vessel 24. The outer vessel 23 is secured with a vacuum tight seal to the ion beam passageway 13.

As may best be seen from FIG. 3, the inner vessel 24 is attached to the outer vessel 23 by a vacuum bellows 26. This arrangement permits some movement of the whole ion source relative to the ion beam passageway 13 so that adjustment of the inclination of the ejected beam to the passageway 13 may be effected.

When making this adjustment, it is important that there is no lateral movement of the extraction slit 27. This is achieved by the provision of a spherically machined surface on the outer vessel 23, which surface is indicated at 28 and 29 in FIG. 3, and a co-operating spherically machined surface, indicated at 31 and 32, on a rim protruding from the inner vessel 24.

The centers of curvature of the spherically curved surfaces are arranged to coincide with the extraction slit 27 so that, when the inner vessel 24 is moved, the surface 31, 32 slides over the surface 28, 29 and constrains the movement to be pivotal about a notional pivot at the center of curvature. As may be seen from the arrows denoted X in FIG. 1, the pivotal motion is permitted about two perpendicular axes, one of which is parallel with the extraction slit 27 and is arranged to be coincident with the origin or apparent origin of the ion beam. An alternative mechanism for providing the required constraint upon the movement of the enclosure comprises gimbals, illustrated diagrammatically at 44 in FIG. 6.

The components of the ion source which are housed within the inner vessel 24 are shown in greater detail in FIGS. 4 and 5. FIG. 4 illustrates the essential components for describing the principle of operation and FIG. 5 illustrates the structural layout of the components.

As may best be seen from FIG. 4, the ion source operates upon the principle described in British Patent Specification No. 916703. The material which it is desired to ionize is introduced into the arc chamber 25 as a gas. For this purpose it may be necessary to heat the starting material and, for this, an oven 33 is provided behind the arc chamber 25. A filament 34 extends behind and along the length of the extraction slit 27. In operation, the filament is electrically heated and held at a negative potential relative to the walls of the arc chamber. The filament 34 emits electrons ther-

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mionically and the gas in the arc chamber is ionized by these electrons as they move, under the influence of the self-magnetic field generated by the current through the filament and a separately applied magnetic field in the direction indicated by arrow A (FIG. 4) from the filament 34 to the walls of the arc chamber. The ion beam is drawn out of the extraction slit by an extraction electrode (not shown).

The magnetic field indicated by the arrow A is produced by an electromagnet indicated at 35 in FIG. 1.

The principal purpose of this magnetic field is to increase the distance travelled by the electrons in the spiralling path which they follow from the filament 34 towards the arc chamber walls.

The ion source of this example has the property of so shaping the emergent ion beam that the beam appears to diverge from a virtual source of width significantly less than that of the actual extraction slit. This provides a corresponding improvement in the resolution of the separator.

In addition to the components shown in FIG. 4, FIG. 5 also shows heat shields 36 surrounding the arc chamber, a corona shield 37 surrounding the whole ion source, the various electrical input leads 38, 39, 40, 41 with their insulation 42 and a pipeline 43 for introducing a gaseous material direct into the arc chamber 25.

The invention is not restricted to the details of the

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foregoing examples.

I claim:

1. An ion beam source comprising a vacuum tight enclosure, means for generating ions in the enclosure, means for ejecting the ions from the enclosure in a rectangular section beam from an extraction slit, attachment means for attaching the enclosure in vacuum tight communication with an enclosed beam passageway so as to permit limited movement of the enclosure relative to the passageway and thereby provide for adjustment of the relative inclination of the ejected ion beam to the passageway, and constraining means for constraining the enclosure, in its said limited movement, to follow a pivotal motion about either of two perpendicular intersecting axes, one of which is parallel with the said extraction slit and coincident with the origin or apparent origin of the ion beam.

2. An ion beam source as claimed in claim 1, wherein the enclosure is attached to the beam passageway through a vacuum bellows.

3. An ion beam source as claimed in claim 1, wherein the said constraining means comprise spherically machined relatively slidable surfaces.

4. An ion beam source as claimed in claim 1, wherein the said constraining means comprise gimbals upon which the enclosure is mounted.

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