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J. G. BACKUS
ION PRODUCING MECHANISM

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2 Sheets-Sheet 1

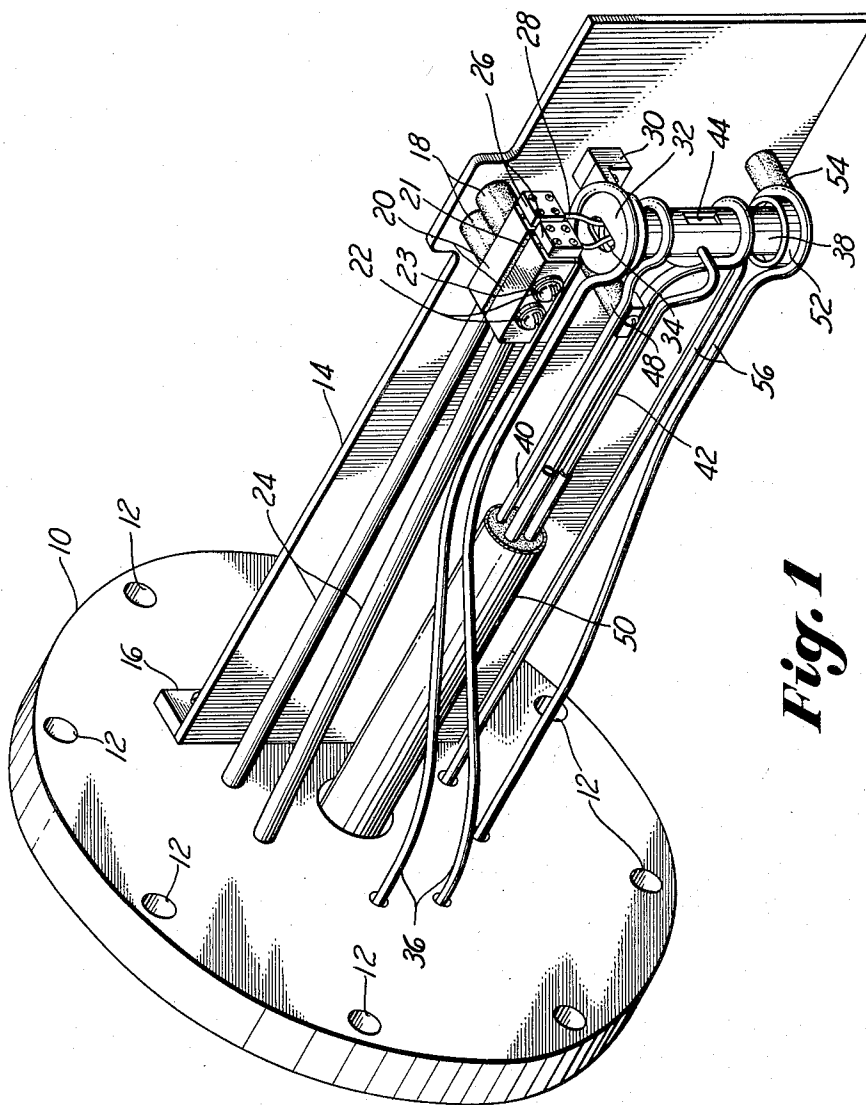


Fig. 1

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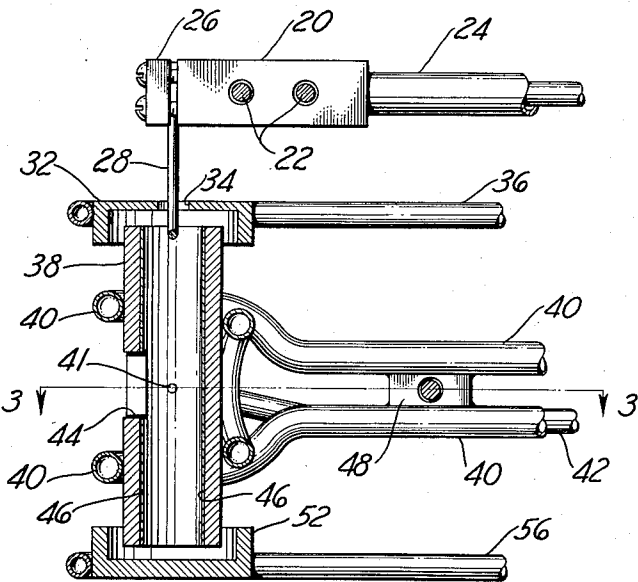


Fig. 2

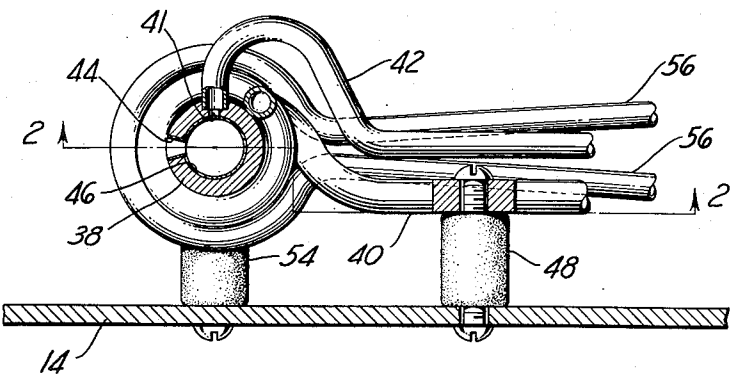


Fig. 3

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ION PRODUCING MECHANISM

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5 Claims. (Cl. 250—41.9)

My invention relates to apparatus useful in the art of separating polyisotopic materials into segregable masses wherein the distribution of the isotopes is radically altered from that in the naturally occurring substance. More particularly, my invention relates to calutrons and comprises an improved mechanism for producing ions.

The construction and theory of operation of a calutron has been fully disclosed and discussed in United States Patent No. 2,709,222, issued May 24, 1955, to Ernest O. Lawrence, and it would serve no useful purpose to repeat the discussion in this patent. However, it may be stated in passing that a calutron comprises an evacuated tank or vessel disposed between the poles of a powerful magnet and containing mechanism for vaporizing a polyisotopic material, ionizing the vapor, and projecting positive ions through the tank in the form of a beam or ribbon. The action of the magnetic field, in which the flux direction is normal to the path of the ion beam, is to bend the beam of ions and cause it to follow an arcuate path. The action of the magnetic field is more pronounced upon ions of lighter isotopes, and the result is that ions of lighter isotopes tend to concentrate along the inner periphery of the beam, whereas the ions of heavier isotopes congregate along the outer periphery thereof. The beam debouches into a collector or receiver containing pockets or compartments so disposed as to receive different portions of the beam and in which ions are neutralized. After the calutron has been operated for a suitable period it will be found that there have been produced at least two segregable masses in the receiver; one of the masses will be enriched with respect to at least one of the isotopes of the polyisotopic material originally vaporized, and the other mass will be correspondingly impoverished with respect to that isotope.

One difficulty encountered in the operation of the conventional calutron results from the presence therein of ions produced from the chemical elements with which the polyisotopic material is compounded as well as from various impurities in the charge material. The presence of what may be referred to as relatively heavy "stray ions" causes interference in the generation of the beam as well as making it more difficult to produce a stable beam. Furthermore, to be efficient, the various mechanisms in the calutron must be responsive to delicate control. The stray ions render it difficult to control the operation of the calutron accurately.

The most important object of my invention is to eliminate stray ions from the ion generating mechanism of a calutron.

Another object of the invention is to improve the efficiency of a calutron and to increase the sensitivity of the elements thereof to control.

An important feature of the invention resides in an arc chamber having a lining of the polyisotopic material to be treated in the calutron and the bombardment of the lining with positive ions of a light gas to induce sputtering and ionization of the lining.

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Another feature of the invention resides in the method of producing ions of a polyisotopic material which comprises bombarding a surface of a polyisotopic metal with positive ions of a light gas produced by an arc that passes close to the surface, and thereby causing the polyisotopic metal to be sputtered into the arc where it is in turn ionized.

These and other objects and features of my invention will be more readily understood and appreciated from the following detailed description of a preferred embodiment thereof selected for purposes of illustration and shown in the accompanying drawings, in which:

Figure 1 is a view in perspective of an ion producing mechanism constructed according to the invention,

Figure 2 is a view in cross section through the arc chamber of the ion producing mechanism shown in Fig. 1, taken along the line 2—2 of Fig. 3, and

Figure 3 is a view in cross section along the line 3—3 of Fig. 2.

As shown in Fig. 1, the ion producing mechanism of my invention is adapted to be carried by a heavy metal disk 10 provided adjacent its periphery with a series of holes 12 through which pass bolts (not shown) by means of which the disk may be secured to a wall of the calutron tank. In one sense the disk 10 may be considered as a door of the tank. A flat metal plate 14, substantially rectangular in configuration, is welded at one end to a relatively heavy bar 16 bolted to the inner face of the disk 10. The plate 14 with the bar 16 form a bracket or support extending inwardly (that is, into the interior of the calutron) and providing a support or mounting plate for the ion producing mechanism. Near the inner end of the plate 14 and close to its upper periphery there is provided a pair of insulated supports 18 on the outer ends of which are mounted a pair of metal clamp blocks 20 separated by an insulating sheet 21 of lavite or other suitable insulating material. The clamp blocks 20 are secured in place by means of a pair of screws 22 which engage tapped holes in the supports 18 and pass through sleeves 23 of insulating material. A pair of stiff insulated leads 24 pass through suitable apertures in the disk 10 and terminate in the clamp blocks 20. The inner end of each of the clamp blocks 20 is provided with a grooved plate 26 by means of which the legs of an electron emissive filament 28 are clamped in position and electrically connected to the leads 24. The filament 28 may be made of tungsten or other suitable material, is substantially U-shaped, and depends vertically from the clamp blocks 20 and the face plates 26.

A bracket 30 secured to the plate 14 supports a circular shield 32 which has a central slot 34 adapted to receive the filament 28. Surrounding the outer periphery of the shield 32 is a metal conduit 36 through which a cooling fluid may be forced in order to prevent the shield from overheating. The lower end of the filament 28 extends into the upper end of a hollow tubular member 38 disposed with its axis parallel to the direction of the magnetic flux and is gripped by a hollow metal tube 40. The tube 40 not only serves as a mount and support for the member 38 but is also adapted for use as a conduit for a cooling fluid. At its midpoint the tubular member 38 is provided with a relatively small aperture 41 in which is secured the end of a tube 42. A larger aperture in the form of a rectangular slot 44 is cut through the wall of the member 38 at 90° from the aperture 41. The interior of the member 38 is covered with a thin foil or lining 46 of the polyisotopic material to be ionized and treated in the calutron. For example, the lining may comprise copper or uranium.

The conduit 40 is supported adjacent the member 38 by means of an insulated bracket 48 secured to the face

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of the plate 14, and the tubes 40 and 42 are received in a supporting stem 50 which passes through the disk 10.

Disposed below the tubular member 38 is a cup-shaped metal anode 52 supported from the plate 14 by means of an insulated support 54 and encompassed by a tube 56 through which a cooling fluid may be passed to prevent overheating of the anode. The tube 56 also serves as an electrical lead to the anode, and the tube 40 also serves as an electrical lead for the member 38.

It has not been deemed necessary to show a circuit diagram. It is sufficient to note that there is provided a power supply to render the filamentary cathode 28 thermionically emissive, and a supply of arc current connected across the cathode 28 and the anode 52. The tube 38 is connected to the negative terminal of a high voltage supply, and the anode 52 is connected to the positive terminal of the high voltage supply.

In the operation of the device shown in the drawings, a light gas such as helium or argon is supplied to the tube 38 through the conduit 42, the operating pressure within the tube 38 being of the order of 10^{-3} mm. Hg. When the power circuits are closed, an arc discharge is generated, traveling from the filament 28 to the anode 52. The electrons leaving the filament 28 ionize the gas in the tube so that the tube 38 contains an arc plasma surrounded by a sheath. The term "plasma" may be defined as a region electrically neutral but containing a copious supply of ions. The sheath between the liner 46 and the plasma is not electrically neutral, there being a voltage drop from the surface of the plasma to the negative liner 46. Positive ions which reach the surface of the plasma adjacent the liner 46 are accelerated through the sheath by the voltage drop referred to. Thus the liner 46 is bombarded by positive ions. The impact of the positive ions upon the liner 46 causes the polyisotopic metal to sputter off, and the particles leaving the liner enter the plasma and themselves become ionized by the arc discharge through the tube 38.

A pair of accelerating electrodes (not shown) may be disposed outside the tube 38 adjacent the slot 44. The accelerating electrodes are rendered highly negative with respect to the tubular member 38, the voltage drop between the two being as high as 30 kv. The result is that positive ions of the polyisotopic metal are withdrawn through the slot 44 and accelerated by the accelerating electrodes to form a narrow ribbon or beam which traverses the calutron tank in the manner previously discussed.

In the conventional calutron a chemical compound of the polyisotopic material is generally employed as the charge material. For example, in the separation of the metal uranium it is customary to use uranium chlorides or fluorides which are vaporized and then ionized. Obviously there are present in the ion generating mechanism ions of the chloride or fluoride as well as uranium ions. However, by means of the present apparatus the only ions present in addition to ions of uranium are those of the light gas. It has been found that the ions of helium or argon are so much lighter than the uranium ions that no deleterious effect results from their presence in the apparatus.

Having now described and illustrated one embodiment

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of my invention what I claim as new and desire to secure by Letters Patent of the United States is:

1. An ion generator comprising walls defining a chamber having an exit opening through which ions may be withdrawn, a liner disposed on the walls of said chamber and containing the material to be ionized, means for producing an electric arc discharge through said chamber to form a plasma region within said chamber, and means for rendering said liner electrically negative with respect to said plasma.

2. Ion producing mechanism which comprises an electron emissive cathode, an anode, walls forming a chamber between said cathode and anode, means for conducting gas to said chamber, a liner disposed on the walls of said chamber and containing the material to be ionized, electric means connected to said cathode and anode for producing a plasma therebetween, and means for rendering said liner electrically negative with respect to said plasma.

3. Ion producing mechanism which comprises walls defining an open-ended tubular chamber, an electron-emissive cathode disposed adjacent one end of said chamber, an anode disposed adjacent the opposite end of said chamber, a lining of the material to be ionized disposed on the surface of said chamber, means for conducting gas to said chamber, means connected to said cathode and anode for producing a plasma therebetween, and means for rendering said lining electrically negative with respect to said plasma.

4. Ion producing mechanism which comprises walls defining an open-ended tubular chamber and having an exit opening therein, an electron-emissive cathode disposed adjacent one end of said chamber, an anode disposed adjacent the opposite end of said chamber, a lining of the material to be ionized disposed on the surface of said chamber, means for introducing a supply of gas to said chamber, means connected to said cathode and anode for producing a plasma therebetween, and means for rendering said lining electrically negative with respect to said plasma.

5. An ion-producing mechanism comprising walls defining an open-ended chamber having an exit opening therein, a lining of a material to be ionized disposed on the inner surface of said chamber, a shield having a central slot disposed adjacent one end of said chamber, an electron-emissive cathode disposed within said chamber through said slot, an anode disposed adjacent the other end of said chamber, means for producing an arc discharge between said cathode and anode, means for introducing a light gas to said arc thereby forming a plasma, and means for rendering said lining electrically negative with respect to said plasma.

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