

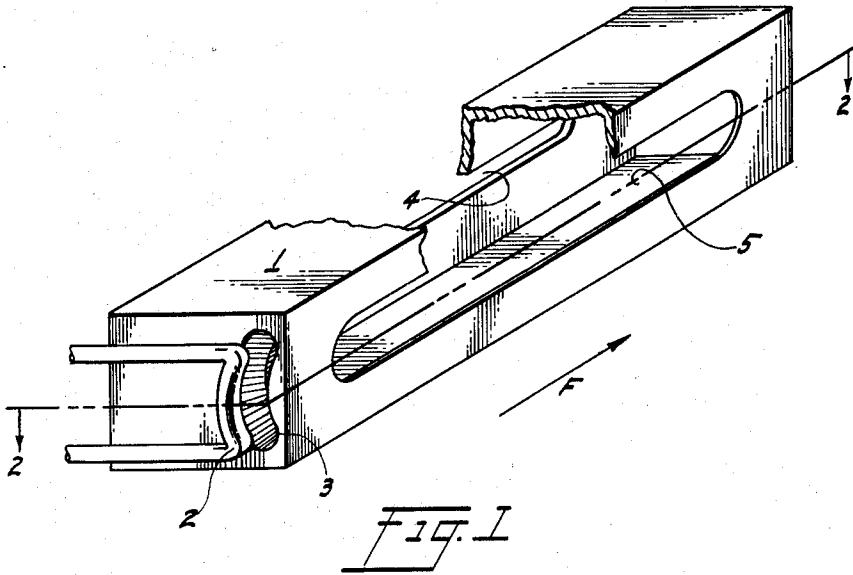
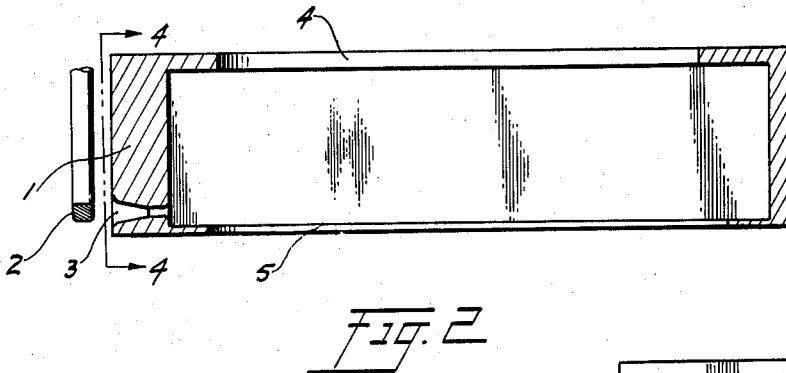
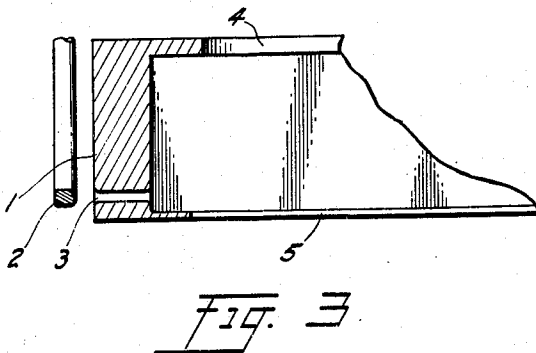
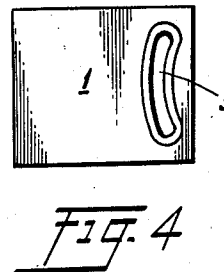
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TAPERED DEFINING SLOT

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TAPERED DEFINING SLOT

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5 Claims. (Cl. 250—41.9)

The present invention relates to improvements in ion sources of the type wherein a vapor of the material to be ionized is bombarded by electrons in a magnetic field to thereby strike an arc producing ionization. Ion sources of this type have been used extensively and with success in isotope separating apparatus of the electromagnetic type and my invention has found noteworthy application in this type of apparatus. It is not limited, however, to adaptation in this type of apparatus and as will be observed, the structural characteristics of the ion source itself may vary considerably without departing from the principle of the invention, the invention itself, as will presently appear, residing primarily in an improvement in the shape and formation of the slot or opening in the collimating slot member forming part of the ion source. The particular objective of the invention insofar as the shape and formation of the collimating slot is concerned, as will appear, is to reduce deterioration and prolong the life of the slot member during operation.

Ion sources of the type referred to above customarily involve a chamber which is usually elongated and into which vapor of the material to be ionized is admitted. Customarily, the chamber has an elongated exit opening with an ion accelerating electrode adjacent the opening, the chamber having a hot filamentary cathode at one end opposite a slot-like opening through which a beam of electrons is discharged from the cathode into the ionizing chamber. The cathode is at a negative potential relative to the ionizing chamber itself which serves as an anode, an arc being struck in the chamber during operation. In the past, it has been found desirable to make the slot of arcuate configuration.

The slot afore-mentioned serves to collimate the electrons entering the ionization chamber and to define the shape of the electron beam or in other words, it defines the cross section of the arc within the chamber.

In the normal operation of this type of ion source, it has been found that the cathode was subject to rapid deterioration due to movement of ions back from the ionization chamber through the slot, these ions bombarding the cathode. The effect is to remove material from the cathode with the ultimate result that the cathode cannot adequately carry the required current. This action is commonly referred to as sputtering. To overcome this effect, it has been discovered that the defining slot should be made deeper, that is, relatively thick in the direction of travel in the electron beam. With this formation, ions traveling in helical or spiral paths, through the slot back towards the cathode, strike the walls of the slot and are either stopped or deflected so as to prevent the rapid erosion and breakdown of the cathode.

Having succeeded in prolonging the life of the cathode in this manner, it became desirable to increase the velocity of electrons emitted from the cathode so that these electrons might bombard more neutral atoms in the ionization chamber before dropping below ionization potential. This would of course make for increased efficiency since

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it is desirable to produce as many positive ions as possible in the ionization chamber. This is particularly true in the electromagnetic type isotope separating apparatus since it is the positive ions that are withdrawn from the ionization chamber and acted upon by the system to separate the ions depending upon their mass-charge properties. It is possible to increase the velocity of emitted electrons by increasing the potential difference between the cathode and the anode. However, the result of doing so is that the edges of the defining slot nearest the cathode receive severe electron bombardment causing these edges to become extremely hot and to in fact vaporize and combine with ions and other material present producing a complex chemical compound within the defining slot and causing a resultant disturbance of the electron beam passing through the slot.

At the increased electron velocities, another disturbance presented itself in that a material tended to form on the anode side of the defining slot, often building up sufficiently to plug the slot and to enforce termination of operation. This effect apparently came about because with the deep slot, the anode side was not running hot enough to prevent condensation of vaporized material in that vicinity and the formation of complex compounds which would plug up the slot.

The objective of the present invention is accordingly to overcome the above described difficulties by so forming the defining slot, principally by forming it so as to have a substantial taper away from the cathode, so as to reduce the operating temperature of the slot member on the cathode side and to raise the operating temperature on the anode side. The tapering conformation causes the electron bombardment from the cathode to be dispersed over a greater area and at the same time to bring the principal concentration of heat from the electron bombardment nearer the anode side of the slot.

The foregoing describes in general terms the nature and objective of my invention. A preferred physical embodiment of my invention will be described in the ensuing detailed description from which further objectives and other advantages of the invention will become apparent.

In the drawings, Figure 1 is a perspective view of an ion chamber construction having incorporated therein the improved defining slot member or barrier member of my invention. Figure 2 is a cross section of the defining slot of the subject invention taken along the line 2—2 of Figure 1. Figure 3 is a cross sectional view of a previously known defining slot of the deep construction described above. Figure 4 is a view taken along line 4—4 of Figure 2.

Referring to Figure 1 of the drawings, the figure shows an ion source comprising a hollow rectilinear chamber 1, having a longitudinal inlet port 4 in the bottom thereof and an exit port 5 in the opposite side, that is, the top. As previously described, vapor of the material to be ionized is admitted through the opening 4 in any convenient manner and positive ions may be withdrawn by an electrode at negative potential positioned adjacent exit opening 5. In one end of the chamber 1 is the collimating or defining slot 3 which is shown in cross section in Figure 2. This slot is curved or arcuate, as is known to be a preferred shape in the prior art, and adjacent to the slot 3 is a cathode 2 positioned to emit a stream of electrons through the slot 3. The cathode 2 as shown has a transverse portion having curvature conforming to the curvature of the defining slot. A magnetic field is provided which is in a direction as indicated by the arrow and the letter F, and when the ion source is employed in an electromagnetic type isotope separator, the magnetic field will, of course, be the magnetic field of the isotope separator. The emitted electrons in general move only

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parallel to the magnetic field, and since the defining slot is smaller than the cathode and aligned with it in the field, the shape of the defining slot effectively defines the cross section of the arc or, that is, the bombarding electron stream.

As will be observed from Figure 2 showing the cross sectional shape of the defining slot 3, the electron bombardment from the cathode 2 is dispersed over a greater area by reason of the tapering conformation with the result as described above that the material of the member in which the slot is formed nearest the cathode does not operate at as high a temperature as otherwise. Also, the principal concentration of heat from electron bombardment, as can readily be observed, is brought nearer to the anode side of the slot with the result that this side operates at a higher temperature than otherwise. Thus, it is possible to operate with electrons being emitted at higher velocities and with higher resultant efficiency without rapid deterioration of the cathode side of the slot, as occurred in heretofore known devices, and without the difficulty of the anode side of the slot becoming plugged with material in the manner described above. The susceptibility of the slot to deterioration from electron bombardment when the taper is not provided, that is, when the slot shape is as shown in Figure 3, is readily apparent from observing this figure.

In practicing my invention in one specific form, the slot had a depth, that is, a thickness of $\frac{3}{4}$ inch. The slot was curved as shown in Figure 1, and it had a five degree taper extending approximately one-half the depth of the slot. The slot might, of course, be made with greater depth and the taper might be somewhat greater, that is, the slot opening could be made somewhat wider on the cathode side. It is to be observed, of course, that the objective of the invention is achieved by having the slot taper away from the cathode as shown in Figure 2 rather than having it of the same dimension throughout its depth as shown in Figure 3. The taper of course should be sufficient to achieve the objective of dispersing the electron bombardment over the surface rather than having it concentrated on edges nearest to the cathode and to bring the principal concentration of heat from the electron bombardment nearer the anode side. Operation of ionizing devices embodying my invention has demonstrated that longer periods of operation are made possible without terminations being necessitated and the efficiency of operation has been improved.

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The foregoing disclosure is illustrative of a preferred form of my invention and of a preferred manner of its adaptation. The invention is subject to some variation and modification as it may be practiced by those skilled in the art without departing from the principles thereof and accordingly it is intended to claim the invention as broadly as possible in view of the prior art.

I claim:

1. In an ion producing device, in combination, means forming a chamber, said chamber having an opening for admitting vapor of a material to be ionized therein, said chamber having therein a defining slot extending entirely through one wall thereof, an electron emissive element positioned adjacent said slot on the outside of said chamber, said element having a negative potential relative to the chamber and being positioned to emit electrons through the slot into the chamber, said slot being wider at the side facing said element than at the opposite side and having a tapering conformation diverging toward said element for the purposes described.

2. The structure of claim 1 wherein the taper extends substantially one-half the entire depth of the slot and is located on the side facing the said element.

3. The structure of claim 2 wherein the remaining half of the slot has a uniform configuration.

4. The structure of claim 1 wherein the taper is of the order of five degrees.

5. In an ion producing device, in combination, means forming a chamber, said chamber having an opening for admitting vapor of a material to be ionized therein, said chamber having therein a defining slot extending entirely through one wall thereof, means including an electron emissive element positioned on the outside of said chamber adjacent said slot for projecting electrons through the slot into the chamber, said slot being wider at the side facing said element than at the opposite side.

References Cited in the file of this patent

UNITED STATES PATENTS

2,373,151	Taylor	Apr. 10, 1945
2,387,786	Washburn	Oct. 30, 1945

OTHER REFERENCES

Tuве et al.: Physical Review, Aug. 1, 1935, vol. 48, pp. 241-245.

Lamar et al.: Physical Review, Dec. 1, 1935, vol. 48, pp. 886-892.