

June 9, 1959

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ION PRODUCING MECHANISM

2,890,339

Filed July 23, 1946

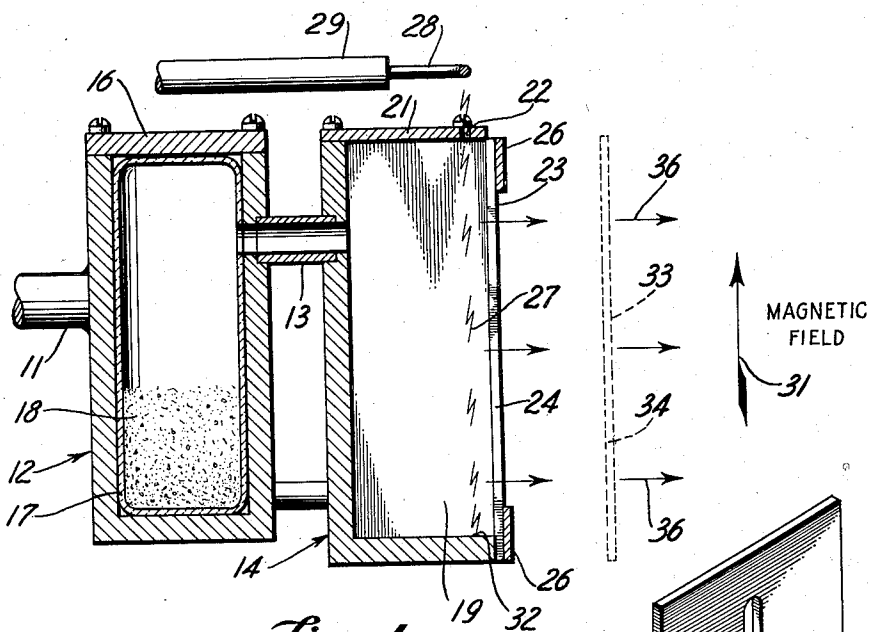


Fig. 1

Fig. 3

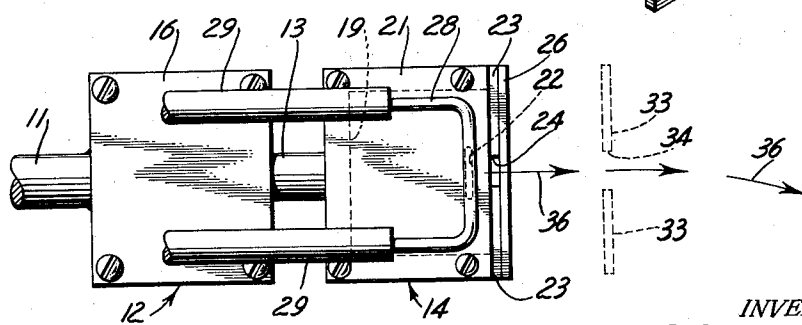


Fig. 2

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1

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ION PRODUCING MECHANISM

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Application July 23, 1946, Serial No. 685,644

4 Claims. (Cl. 250—41.9)

This invention relates to calutrons and more particularly to the shape of the ion exit of a calutron ion generator.

Calutrons are generally described in the "Atomic Energy for Military Purposes" by H. D. Smyth, and is described in greater detail in U.S. Patent No. 2,709,222, which issued to Ernest O. Lawrence, on May 24, 1955. They have been chiefly employed, and very successfully employed, in the separation of the isotopes of uranium for military energy purposes. In general, they embody a source unit wherein the polyisotopic material is ionized and the ions subjected to an intense electric field that projects them into a magnetic field. Thereafter, the ions travel in generally curved paths in the magnetic field, the ions of heavier mass describing a flatter curve than the ions of lighter mass. Collectors are disposed at appropriate points along the curved paths of travel, such as the 180° point. These collectors neutralize the ions and retain them, and thereafter the separated material is recovered from the collectors.

The present invention relates to the structure of the ion generator, the principal element of which is an arc discharge that takes place in a gas or vapor containing the desired element, e.g., uranium. The electric field acts on the plasma of this arc and withdraws ions from the plasma. The part of the arc plasma on which the electric field acts is defined by an ion exit slit, and it is the shape of this exit slit relative to the length of the arc that is concerned herein.

It has been discovered that the upper and lower ends of the arc of a calutron are not as uniform and stable as the intermediate portion of the arc. Accordingly, therefore, the present invention provides means for masking off these ends of the arc, allowing the accelerating electric field to withdraw ions only from the intermediate portion of the arc. This results in a much more uniform beam of ions that is considerably freer of "hash," flurries and other disturbances compared to the beam emanating from an unmasked arc.

It is therefore an object of the invention to provide a calutron ion generator with a structure that masks off the extreme portions of the arc of a calutron ion generator.

Other objects and advantages of the invention will be apparent from the following description and claims, taken together with the accompanying drawing in which:

Figure 1 is a sectional view through a reservoir, and arc block of an ion generator as taken along the magnetic field;

Fig. 2 is a top view of the ion generator mechanism of Fig. 1; and

Fig. 3 is an isometric view of a preferred form of arc slit plate made in accordance with the invention.

Referring to Fig. 1, a stem 11 supports a reservoir 12 communicating through a nipple 13 with an arc block 14. The reservoir 12 has a removable top cover 16, allowing the insertion of a charge bottle 17 into the reservoir. The charge bottle 17 may be filled with any desired salt 18 which is vaporizable to produce a gas,

2

For example, when the isotopes of uranium are separated, uranium tetrachloride in granular form is commonly used as charge material. Heaters (not shown) are then energized to vaporize the material, causing gas to flow through the nipple 13 into the arc block 14.

The arc block 15 is hollowed to define an arc chamber 19 open at the upper end and one side of arc block 14. The upper end of the arc chamber 19 is enclosed by a plate 21 having slot 22 formed therein for shaping the cross section of the electron stream. The open side of the arc block 14 is closed by two coplanar arc slit plates 23 that are spaced from each other to define an arc slit 24. The two ends of the arc slit 24 are masked by the transverse strips 26.

An arc is formed in the arc chamber 19 by an electron stream 27 emanating from a filament 28 supported by stems 29. The filament 28 is heated to electron emissivity by a conductive current passing therethrough and supplied by the stems 29. For this reason, the filament 28 is commonly made of tungsten, tantalum, or other high temperature metal. The filament 28 and the arc block 14 are placed in an appropriate electrical circuit, so that the arc block 14 is positive with respect to the filament causing the electric field to extend between the cover plate 21 and the filament 28 that emits electrons. A magnetic field 31 passes through the entire apparatus, and by referring to Fig. 2, it will be noted that the filament 28 is positioned directly over the electron stream defining slit 22. The magnetic field prevents the majority of the electrons from heating the plate 21, and instead causes them to pass through the slit 22, and thence into the arc chamber 19, wherein they are stopped by striking the bottom of the arc block 14 at the region 32. This bottom portion 32 of the arc block 14 is commonly referred to as the anode of the arc discharge because of the fact that the electrons impinge upon the structure at that point. It will be realized, however, that the entire arc block 14, including its cover plate 21, acts as an anode.

As discussed in the aforementioned application, the entire apparatus is placed in an evacuated vessel, and the magnetic field transverse the vessel. This vessel may be evacuated to a pressure such as 10^{-4} or 10^{-5} mm. Hg. Due to the fact, however, that gas is being produced from the charge material 18, the pressure within the arc chamber 19 is higher than the general vacuum pressure and may be of the order 10^{-3} mm. Hg. This pressure is sufficient to cause an arc discharge to take place in the arc chamber 19, but the gas pressure between the cover plate 21 and the filament 28 is sufficiently low so that the arc discharge does not ordinarily take place in this region. The arc extends, therefore, from the cover plate 21 to the bottom of the arc block 14.

When the arc discharge takes place, an arc plasma fills the whole region of the arc chamber 19 which contains a copious supply of positive ions and negative ions. If separation of the positive ions is desired, and these are usually the metallic ions, an appropriate negative electrical potential is imposed upon two coplanar plates 33 shown in dotted outline. These negative plates attract the positive ions causing the ions to be accelerated toward them and pass through an aperture 34 formed between the plates, and known as the accelerating slit. The ions, thus accelerated, form a beam 36 of ribbon-like configuration, and it is the ions of this beam that travel in the curved paths mentioned previously and along which collectors are disposed.

In the past, many of these ion beams 36 have been extremely irregular, fluctuating in intensity at a high frequency and are therefore known as "hashy" beams. Much of this irregularity of the ion beams has been due to the fact that the arc discharge is unstable and

3

irregular in its two ends, that is, the end near the cover plate 21 and the end near the anode 32. I have discovered, however, that if these two end-pieces are masked off, that the beam thereafter is much more stable. That is, ions are not withdrawn from the unstable region of the arc but only from the intermediate portion of the arc which is much more stable. Accordingly, I have provided the arc slit plates 23 with the transverse members 26 masking off the upper and lower ends of the slit 24, and found that this produced the desired result. A preferred form of my invention is shown in Fig. 3, wherein an arc slit 37 is milled in a single piece of sheet material 38 which is preferably formed of carbon or other material that is non-corrosive at high temperatures; e.g., in one form of calutron unit employing an arc about six inches long, a sheet of carbon about $\frac{1}{32}$ of an inch thick is employed, having the slit 37 milled therein. The sheet 38 may be secured to the open face of the arc block in any desired place such as by grooving the interior wall and sliding the sheet 38 into place.

There is no fixed rule on the extent of the masking of an arc, the extent of the instability at the ends depending upon a great many different factors, such as shape and design of the arc chamber, shape and design of the gas supplying apertures, the size of the electron stream and the voltage of the electron stream. In general, however, if the upper and lower $\frac{1}{10}$ of the arc is masked satisfactory beams will be produced for calutron purposes.

While I have described my invention relative to two general embodiments thereof, it is not limited to these embodiments, nor otherwise, except by the terms of the following claims.

What is claimed is:

1. A calutron ion generator comprising a hollowed arc block open on one side, means for creating an arc discharge within said hollowed block, means defining an

4

ion exit slit for the open side of said arc block, said slit being adjacent and parallel to said arc and extending over the length thereof in said arc block, and means masking each end of said slit for substantially one-tenth the length of said arc in said arc block whereby the maximum stable portion of said arc is exposed to said slit.

2. A calutron ion generator comprising a hollow arc block open on one side, means for establishing an arc discharge within the arc block, and a cover for the open side of the arc block defining an ion exit slit elongated along the direction of the arc, and having a length less than the length of the arc and opposite an intermediate portion only of the arc.

3. A calutron ion source comprising a hollowed arc block open on one side, means for establishing an arc therein that is unstable at its extreme ends and stable in an intermediate portion, and cover means for the open side of said arc block defining an ion exit slit extending parallel to said arc and coextensive only with the stable part of the arc.

4. A calutron ion charge comprising a hollow arc block open on one side, means for establishing an arc discharge therein, and a cover for the open side of the arc block formed of a single sheet of material having a slit formed therein, said slit being elongated in the direction of the arc and extending over substantially the middle eighty percent of the arc.

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