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E. J. LOFGREN  
CALUTRON ION SOURCE  
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*Fig. 1.*

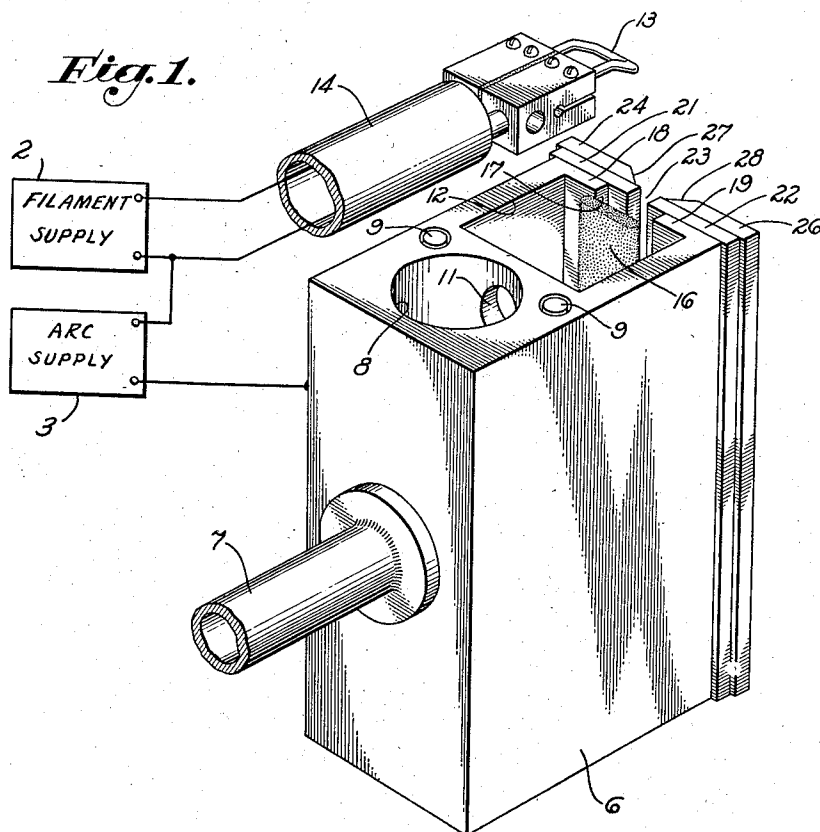
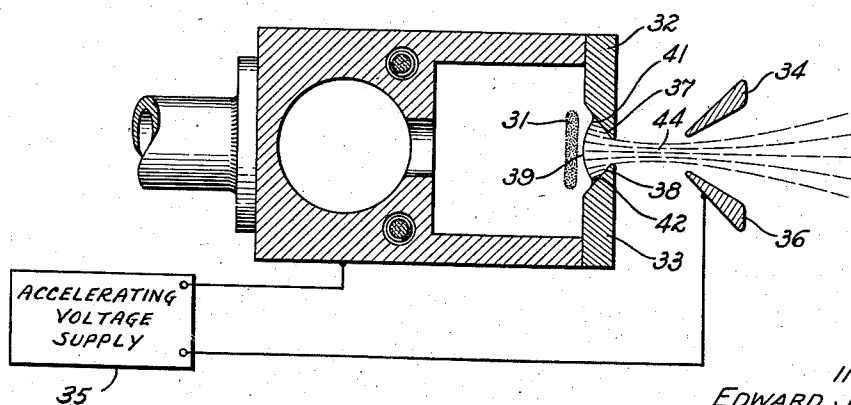


*Fig. 2.*



INVENTOR  
EDWARD J. LOFGREN  
BY *Robert A. Lander*  
ATTORNEY.

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## CALUTRON ION SOURCE

Edward J. Lofgren, Berkeley, Calif., assignor to the United States of America as represented by the United States Atomic Energy Commission

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5 Claims. (Cl. 250—41.9)

This invention relates to means for producing ions from an ionizable material and especially to ionizing means employing an electric arc as an ionizing agent. Devices of this character are particularly disclosed and explained in U. S. Patent No. 2,709,222, issued to Ernest O. Lawrence, on May 24, 1955, and in which Figures 3 to 5 of the drawings and the accompanying description especially characterize a structure to which the present disclosure is most applicable.

In devices of this nature the practice is to pass a stream of vapor or gas to be ionized to or into the vicinity of an electric arc. The arc is customarily of columnar form struck between a filamentary cathode and an anode spaced apart in the direction of a magnetic field in which the entire structure functions. Ions are produced by collisions of the gas or vapor molecules with particles occurring in the arc and are removed from the arc or its vicinity under the urgency of an electric accelerating field. This field is established between the arc mechanism and one or more, usually two, accelerating electrodes spaced from the arc mechanism in the general direction of propagation of an ion beam constituted by the withdrawn ions.

The operation of an ion source of the described kind is accompanied by the production of large quantities of heat. The resulting high temperatures have deleterious effects upon the materials of the arc mechanism and shorten the life of the arc structure to a uneconomic extent. Also the various particles generated by the operation of the arc bombard or sputter upon the adjacent mechanical surfaces and cause deterioration and erosion of an undesirable sort and quantity. In addition the ion stream flowing from the arc block tends to erode and vary the shape of the surfaces of the aperture or orifice through which the ions emerge. Since these surfaces are effective to establish the contour of the electric field existing in the vicinity and since the contour of such field is instrumental in controlling the particular shape and focus of the ion beams, imperfect and improper action of the mechanism occurs after only a short initial operation.

It is therefore an object of the invention to provide means for withstanding the ravages of the quantities of heat, erosion and deterioration concomitant with the operation of an ion source of the calutron type.

An additional object of the invention is to provide means for insuring a protracted operation of the ionizing mechanism without substantial interference with the trajectory or pattern of the ion beam.

An additional object of the invention is in general to improve arc ionizing mechanisms.

A still further object of the invention is to improve calutrons in general.

Other objects of the invention together with the foregoing are attained by the embodiments of the invention disclosed in the accompanying description and drawings in the latter of which:

Figure 1 is a diagrammatic showing of the ion source

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portion of a calutron, the showing being in isometric perspective with portions of the structure being omitted for clarity.

Fig. 2 is a section on a horizontal plane of an ion source mechanism for a calutron in diagrammatic form.

Since the general construction of a calutron and the detailed arrangement of the portions constituting the environment of the present inventive embodiment are well disclosed in the identified patent to Lawrence and play no immediate part in the present invention, reference is herein had only to a diagrammatic showing for simplicity in understanding and clarity of disclosure. It is understood that the entire mechanism operates in a magnetic field, is supplied with electricity in various appropriate circuits, and is, except for the parts referred to specifically herein, like the structure shown in the Lawrence patent.

There is provided an ion source mechanism incorporating a source block 6 preferably fabricated of metal having a good thermal conductivity such as copper and mechanically supported upon a mounting stem 7 also serving as an electrical conductor. The source block 6 is formed with a normally covered charge cavity 8 within which material to be ionized is placed. Customarily, the material is in a separate container or charge bottle containing granular material that evolves gas or vapor when heated.

To produce the desired effect the charge block 6 is provided with a plurality of heaters 9 effective to increase the charge temperature to the gasifying or vaporizing point. Gas so evolved flows from the charge chamber 8 through a passage 11 into a normally covered gas distribution and arc chamber 12 likewise constituted by a cavity in the arc block 6. To strike an appropriate arc there is arranged above the arc block 6 a filamentary cathode 13 disposed in the end of a cathode stem 14 carrying appropriate electrical leads and maintained, by means of a filament supply 2 and an arc supply 3, at the proper potential with respect to the arc block 6 that the block also serves as an arc anode. The position of the arc in the block is shown approximately by the stippled area 16 in Fig. 1.

Ions formed adjacent the arc are withdrawn from the arc block 6 through an opening 17 leading from the arc chamber 12 to the exterior of the block and being formed and defined by the facing edges of the forward coplanar walls 18 and 19 of the arc block. The margins of the opening 17 are further defined by a pair of coplanar plates 21 and 22 defining a somewhat narrower slot 23 and preferably fabricated of a metal having a higher resistance to temperature effects than the copper of the block 6 and thus being preferably made of molybdenum. The plates 21 and 22 are held in intimate contact with the walls 18 and 19 in order to facilitate thermal transfer from the plates to the block. Additionally, the further margins of the opening are defined by a supplementary pair of plates 24 and 26, respectively, having their facing edges 27 and 28 beveled to define a dihedral angle. The plates 24 and 26 are preferably formed of a metal such as copper having a high heat absorptive and transmitting property and are maintained in intimate thermal contact with the plates 21 and 22.

By the provision of this arrangement the narrowest portion 23 of the arc slit is defined by resistant plates 21 and 22. These plates are maintained at a feasible temperature by the ability of the adjacent plates, for example, 19 and 26 to carry away rapidly the heat imposed upon the intermediate plate 22. This laminated construction has been found in practice to increase the length of the arc slit very materially, and to resist erosion so that the original surfaces defining the arc slit are not interfered with by operation for a protracted period.

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Some of the attributes of the arrangement of Fig. 1 are attained in the modified embodiment disclosed in Fig. 2 wherein for the most part the structure is identical except that the arc shown by the stippled portion 31 is related to a pair of arc slit defining plates 32 and 33 in such a fashion that many of the ions withdrawn by accelerating electrodes 34 and 36, suitably supplied by accelerating voltage supply 35, do not directly impinge upon the plates 32 and 33.

This is effectuated by providing the plates with bevelled faces 37 and 38 respectively defining a dihedral angle that converges in the direction of efflux of the ions. Thus the contour of the arc plasma, represented by the heavy line 39, is in part behind the arc slit plates 32 and 33 and the portions 41 and 42 of the plasma that principally tend to release ions away from the central portion 44 of the ion stream are well masked from the electric field established by the arc slit plates 32 and 33 and the accelerating electrodes 34 and 36. In this fashion most of the ions leaving the vicinity of the arc 31 pass through the arc slit between the adjacent edges of the plates 32 and 33 without impinging thereon. As a result, the arc slits are not excessively eroded and are maintained in satisfactory operating condition for a substantial time.

In both modifications of the invention disclosed herein there is afforded a mechanism effective to improve in general the operation of an ion producing mechanism and calutrons in general.

What is claimed is:

1. In an ion source for a calutron, the combination comprising an arc chamber having an exit opening, means for establishing an electric arc in said chamber along the length of said opening, a pair of molybdenum plates in thermal contact with the walls of said chamber and disposed on opposite sides of said opening to form the margins thereof, and a pair of copper blocks in thermally conducting contact with said plates to form subsequent diverging margins of said opening.

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2. In an ion source for a calutron, the combination comprising an arc chamber having an exit opening, means for establishing an electric arc in said chamber along the length of said opening, a pair of high melting point plates in thermal contact with the walls of said chamber and disposed on opposite sides of said opening to form the margins thereof, and a pair of highly heat-conducting blocks in thermal contact with said plates to form subsequent diverging margins of said opening.

3. In an ion source for a calutron, the combination comprising an arc chamber having an exit opening, means for establishing an electric arc in said chamber along the length of said opening, and multi-layer devices mounted on the walls of said chamber and forming the margins of said opening, an exposed one of said layers being made up of a metal of high thermal conductivity and an inner one of said layers being made up of a metal having a high resistance to ion bombardment.

4. In an ion source for a calutron, the combination comprising an arc chamber having an exit opening, means for establishing an electric arc in said chamber along the length of said opening and laminated members in thermal contact with said ion source member and defining the facing edges of said opening, said members having different thermal conductivities and different resistances to heat.

5. In an ion source for a calutron, the combination comprising an arc chamber having an exit opening, means for establishing an electric arc in said chamber along the length of said opening and means including laminated plates defining the edges of said opening, the plates in the narrowest part of said opening having relatively the highest resistance to thermal deterioration.

#### References Cited in the file of this patent

"The Production and Focusing of Intense Positive Ion Beams," by Tuve et al., Physical Review, volume 48, August 1, 1935, pages 241-256.