

April 14, 1959

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2,882,410

ION SOURCE

Filed June 14, 1946

3 Sheets-Sheet 1

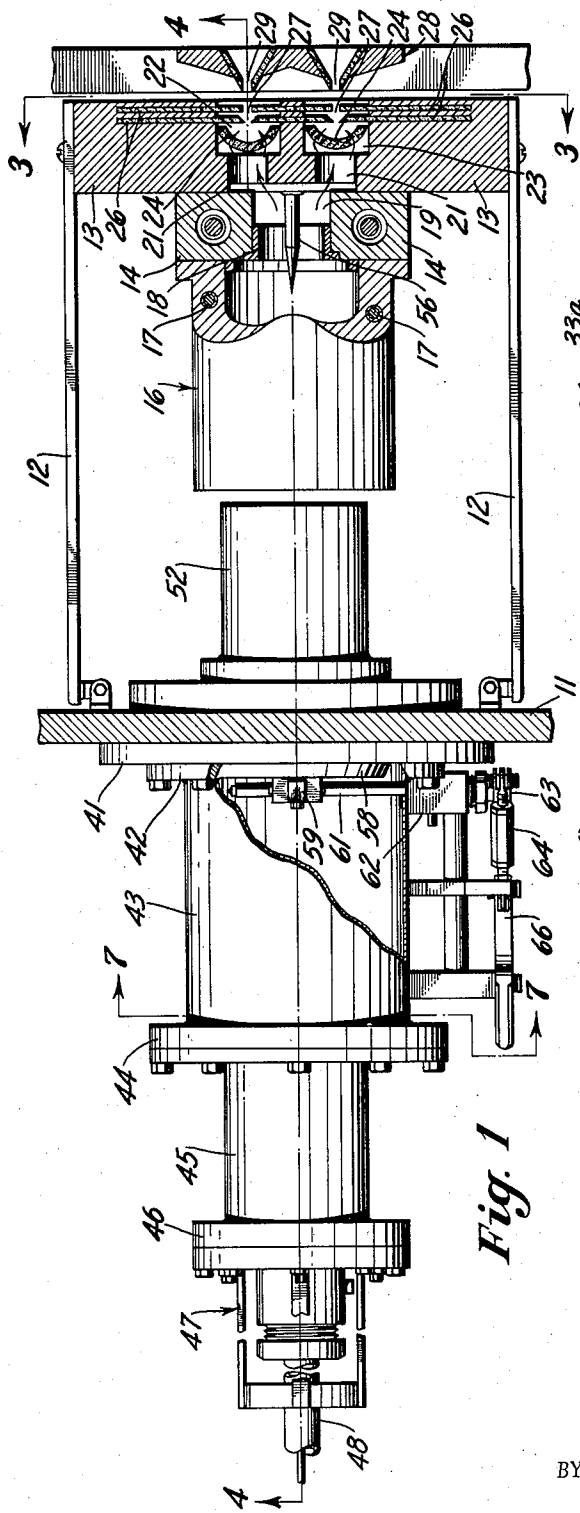


Fig. 1

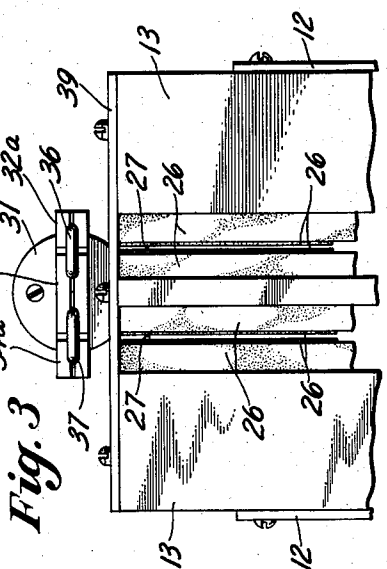


Fig. 3

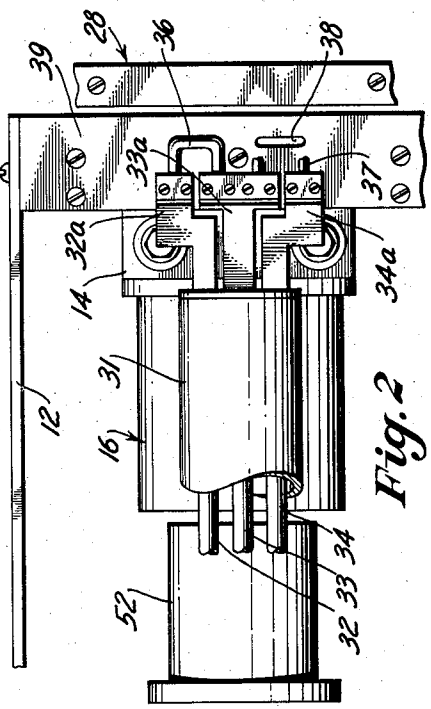


Fig. 2

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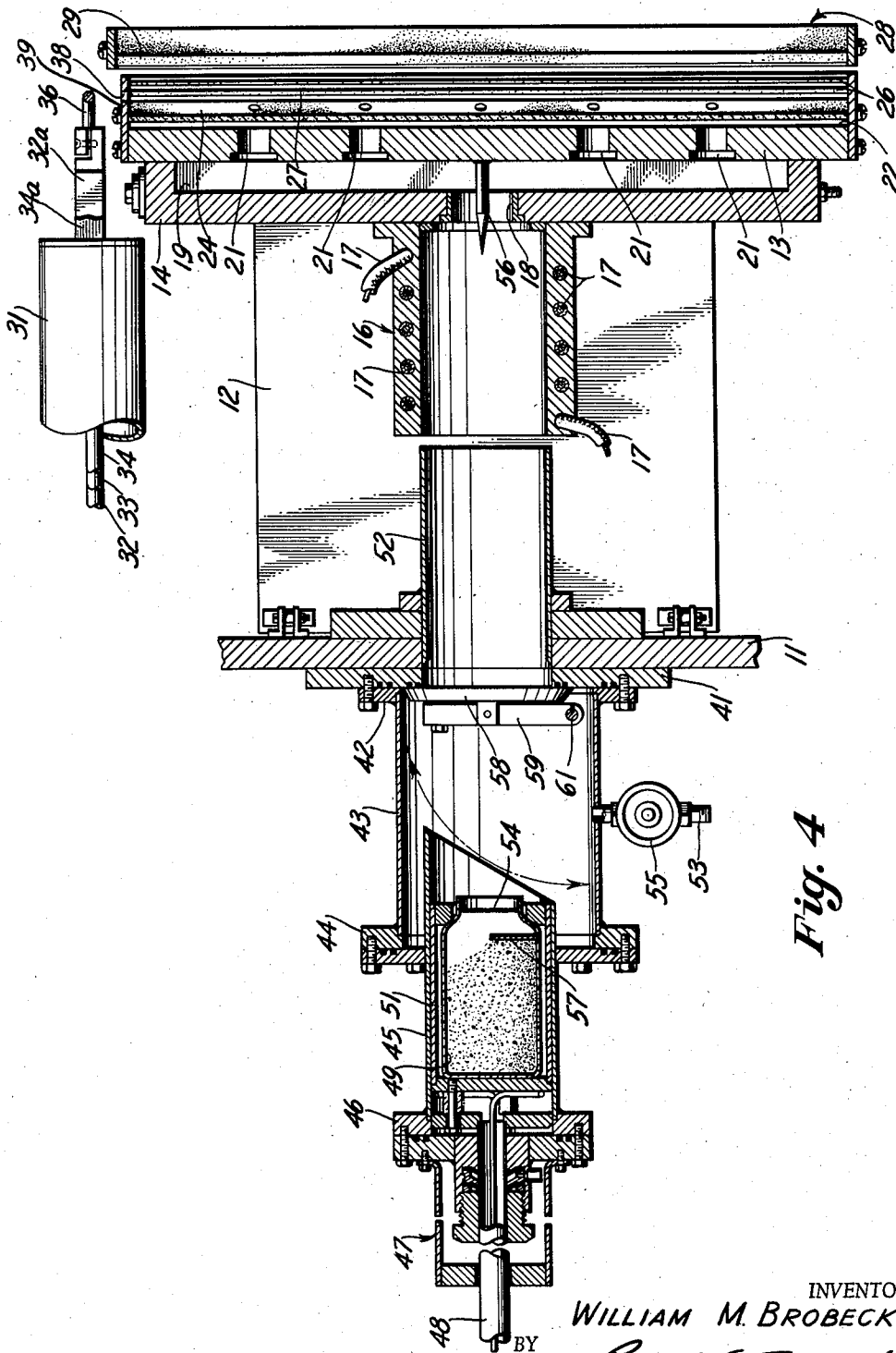


Fig. 4

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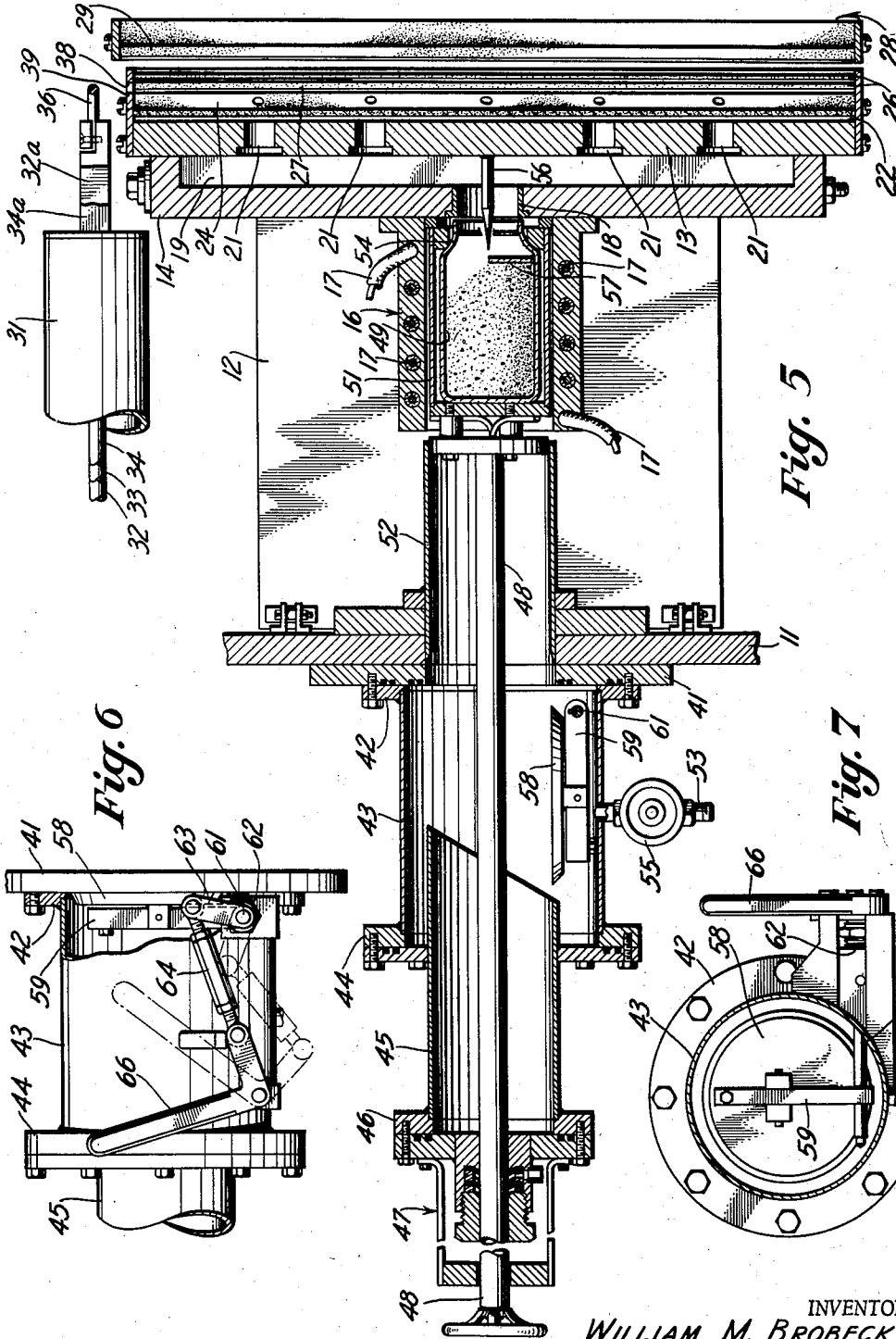
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3 Sheets-Sheet 3



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2,882,410

ION SOURCE

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4 Claims. (Cl. 250—41.9)

This invention relates to calutrons and more particularly to an arrangement therein whereby charge bottles in a calutron source unit may be replaced without admitting atmospheric air to the calutron vacuum chamber.

Calutrons are described in general in "Atomic Energy for Military Purposes" by H. D. Smyth, and are described in great detail in U.S. Patent No. 2,709,222, issued to Ernest O. Lawrence on May 24, 1955. Calutrons are commercial isotope separators, separating large quantities of material compared to laboratory instruments which separate only microscopic amounts of material. They have been principally used, and very successfully used, in separating the isotopes of uranium, the isotope U^{235} being separated from the isotope U^{238} . In general, the material to be separated in a calutron is placed in an ion source unit, and therein converted to ionic form, whereupon it is projected by electrical means into a magnetic field. Thereafter the ions travel in curved paths due to the magnetic forces, the heavier ions traveling in paths of greater radius than lighter ions. Ion collectors are placed across these paths at some convenient point, such as the 180° point of travel of the ions along their curved paths. The entire apparatus is evacuated so as to reduce the number of collisions that the ions encounter in traveling through the magnetic field to the collector.

The substance to be separated is usually vaporized and the vapor bombarded by an electron stream to ionize the particles. In the separation of uranium isotopes, uranium tetrachloride and uranium hexachloride have been used, which substances are solids at room temperature. The charge material is placed in a heater or furnace region whereupon a vapor is produced which is directed into an arc chamber, and an arc discharge takes place due to the electron bombardment of the vapor. Ions are formed in this discharge and removed from the arc chamber by a strong electric field, and projected into the magnetic field as just described. The charge substance is usually placed in separate containers and the container inserted in the calutron prior to operation. Inasmuch as heat transmission limitations and production techniques limit the size of this bottle, the charge is frequently consumed even though the calutron unit as a whole is still able to operate. The present invention, therefore, provides means for permitting the removal of an empty charge bottle and the insertion of a fresh charge bottle without letting the entire apparatus down to air. This feature is important when it is realized that pumping out time may consume from 12 to 24 hours for a calutron and the removal of parts otherwise necessary to add a new charge bottle involves considerable labor.

It is therefore an object of the invention to provide means for replacing the charge container of the calutron without letting the calutron tank go down to atmospheric pressure.

Another object of the invention is to provide vacuum lock apparatus for a calutron which permits the removal

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and replacement of charge bottles without letting the calutron down to atmospheric pressure.

Other objects and advantages of the invention will be apparent in the following description and claims considered together with the accompanying drawings forming a part thereof, in which:

Fig. 1 is a plan view partly in section of a calutron ion source unit,

Fig. 2 is a plan view of the arc chamber portion of the calutron source of Fig. 1 wherein that portion is in section,

Fig. 3 is a fragmentary elevational view taken along the line 3—3 of Fig. 1,

Fig. 4 is an elevation view in full section of the entire calutron ion source showing a charge bottle in the vacuum lock preparatory to insertion for operation, the section being taken along the line 4—4 of Fig. 1,

Fig. 5 is a sectional elevation view similar to Fig. 4 but showing the charge bottle in its operative position,

Fig. 6 is an elevation view of the valve operating mechanism of the vacuum lock, and

Fig. 7 is an elevation view in section of the valve mechanism taken along the line 7—7 of Fig. 1.

Referring to Fig. 1, there is shown a face plate 11 forming a part of the vacuum envelope in which the calutron portions operate, and secured thereto are two metal sheets 12, which support an arc block 13 on the inner end, that is the side of the face plate 11 that is subjected to vacuum. Secured to the arc block 13 is a heater block 14 and a reservoir housing 16 is attached to the heater block. In normal operation a charge bottle or container is placed in the housing 16 and its contents vaporized by heat from a heater 17 cast integrally with the housing 16. The vapor passes through an angular conduit 18 into an elongated vapor distributing chamber 19. From there it flows through drilled passages 21 into the arc chambers 22 and 23. The vapor then passes through semicircular baffles 24 disposed in the arc chambers and thereafter is subjected to bombardment by an electron stream in each arc chamber, whereupon an arc discharge is formed. Arc slit plates 26 form a restricted outlet 27 for each arc chamber. The ions formed in the arc discharge are withdrawn from the arc chambers 22 and 23 through the slits 27 by an electric field set up between the arc block 13 and an electrode structure 28 having two slits 29 through which the ions pass. The accelerating structure 28 is insulated from the entire vacuum tank, including the face plate 11, by insulators (not shown) and a suitable negative potential is applied thereto, such as 30 kv.

Referring now to Figs. 2, 3, and 4 there is shown the filament structure giving rise to the electron stream of the arc. A supporting stem 31 contains three leads 32, 33 and 34, which are insulated from each other and from the stem 31. These leads terminate in clamp blocks 32a, 33a and 34a respectively which clamp two filaments 36 and 37. The two outer leads 32 and 34 are at the same potential and several volts above the middle lead 33, so that current flows from the two outer leads through the filaments 36 and 37 into the center lead 33. The conductive current heats the filaments to emissivity. The three leads 32, 33 and 34 are several hundred volts negative with reference to the arc block 13, and electrons emitted from the filaments are attracted toward the arc block 13. The strong magnetic field, however, permeates the whole structure collimating the electrons so that they follow along the magnetic field, rather than along the electric field lines. The electrons, therefore, travel toward the arc block 13 and through apertures 38 formed in a strip 39, secured to the top of the arc block 13. These apertures trim the electron stream, passing only the most

desirable portion of the electron stream, thereby increasing the stability of the arc in the chambers 22 and 23.

Referring to Figs. 4, 5, 6 and 7 there is shown the vacuum lock structure and the retracting mechanism for the charge bottles, all in accordance with the invention. Secured to the outer or atmospheric side of the face plate 11 is an angular plate 41 to which is secured a second angular plate 42 to which is soldered, or otherwise secured, a tubular member 43, forming the principal part of the vacuum lock. A flange 44 on the outer end of the tube 43 forms a securing plate for a reduced tube 45, also having an outer flange 46. Secured to this outer flange 46 is a vacuum seal bushing assembly 47 having a slidable rod 48 passing therethrough. This entire mechanism acts as a vacuum lock for a charge bottle 49 which is transported therethrough to the reservoir 16. This transportation is performed by a slidable carriage assembly including a tube 51 secured by flanges to the slidable rod 48. A tubular guide 52 is secured to the inner side of the face plate 11 to aid in the movement of the charge bottle into the reservoir 16. A vacuum line 53 is connected to the tubular air lock member 43 and evacuates this chamber to the same pressure as that prevailing inside the face plate 11.

Fig. 5 shows the charge container or bottle 49 in its operating condition, a frangible seal 54 being broken by a fixed spike 56. The partition 57 in the charge bottle prevents the sliding of the material into the vapor conduit in the event that the entire seal 54 is broken. When it is desired to remove the charge bottle for any reason, such as consumption of the material, the rod 48 is manually pulled and since the charge bottle 49 is held by a carriage in the inner end thereof, the entire charge bottle is removed from the reservoir 16 into the tubular support 45 as shown in Fig. 4. When this operation is completed a vacuum valve 58 is manually closed, shutting off the vacuum lock from communication with the interior of the calutron unit which is on the right hand side of the face plate 11. When this is completed, a vacuum line 53 is closed by a valve 55 and the seal assembly 47 is removed from the flange 46. The charge bottle 49 is then completely freed from any mechanical connection with the entire source structure, permitting the charge bottle to be replaced by a fresh one. When it is desired to replace the charge bottle in the source structure the seal assembly 47 is secured to the flange 46 as shown in Fig. 4. The vacuum control valve 55 is then opened and after a suitable lapse of time the pressure is reduced inside the tubular member 43 to a pressure approximating that used in the main calutron tank. Valve 58 is then manually opened as shown in Fig. 5 and the rod 48 manually pushed until the charge bottle 49 assumes the position as shown in Fig. 5, the frangible seal 54 breaking upon the last part of the movement when it contacts the fixed spike 56.

The operating mechanism for the flap valve 58 is shown in Figs. 6 and 7. The valve 58 is pin-jointed to a lever arm 59 soldered to a shaft 61, which passes through a vacuum seal 62 and has a short lever 63 secured on its outer end. The lever 63 is connected by a link 64 to the short end of a pivoted L-shaped handle 66. The entire valve operating mechanism is shown in solid outline in Fig. 6 when the valve is in closed position, and in dotted outline for the open position of the valve 58. The pin-jointing of the valve 58 to the lever 59 permits a limited pivoted movement with respect to the lever so that the valve is free to strike the valve seat area squarely.

The operation of the entire apparatus can best be described with reference to all of the figures. The charge bottle 49 is in the position shown in Fig. 5 and heat is

applied by the heater 17, vaporizing the contents thereof, which in the case of uranium charge material may be uranium tetrachloride or uranium hexachloride. The vapor passes through the distributing chamber 19 and the passages 21 through the baffles 24 to the arc chambers where it is bombarded by electrons emanating from the filaments 36 and 37 and thereafter passes through the defining holes 38. The ions generated in the arc discharge are accelerated through the accelerating slits 29 by virtue of a negative potential applied to the entire accelerating structure 28. In due course the contents of the charge bottle 49 are consumed, and the charge bottle is removed by manually pulling on the rod 48 until the charge bottle is in the position shown in Fig. 4. Thereupon the flap valve 58 is manually closed and seal assembly 47 disconnected from the flange 46, allowing the charge bottle to be free of the source structure. A fresh charge bottle is inserted in the carriage mechanism 51 on the end of the rod 48, the seal assembly 47 reconnected and the air within the vacuum lock member 43 evacuated by means of the vacuum line 53. When a suitable pressure is reached, the flap valve 58 is opened and the charge bottle slid into position as indicated in Fig. 5.

Although the invention has been described with reference to a particular embodiment thereof, it is not limited to this embodiment or otherwise except by the terms of the following claims.

What is claimed is:

1. A calutron comprising a vacuum envelope, an ion source structure disposed therein and including a reservoir having an opening toward one wall of the vacuum envelope, a charge bottle adapted to be placed in the reservoir for furnishing a charge gas to the ion source unit, and means secured to the outside of the wall of the vacuum tank for withdrawing the charge bottle and replacing it in the reservoir without reducing the pressure in the vacuum tank.

2. A calutron comprising a vacuum tank, an ion source unit disposed therein having a reservoir open toward a wall of the vacuum tank, a charge bottle adapted to be placed in the reservoir, a vacuum lock secured to the outside of the tank wall and communicating with the interior of the tank, a valve for closing the vacuum lock from communication with the interior of the vacuum tank, means for evacuating the vacuum lock, and means for removing a wall of the vacuum lock for removal of the charge bottle after it is withdrawn into the vacuum lock.

3. A calutron comprising a vacuum tank, an ion source unit disposed therein having a reservoir open toward a wall of the tank and having a spike projected into the reservoir, a charge bottle adapted to be placed in the reservoir and adapted to be broken by the spike when it is placed in operating position, and means for withdrawing the charge bottle and replacing it without admitting the gas to the vacuum tank, whereby a sealed charge bottle may be inserted in a calutron source unit and may be automatically opened by the insertion operation.

4. A calutron comprising an arc block, into which a gas is adapted to flow, a baffle disposed in the arc block anterior to the electron stream, a distributing chamber member secured to the arc block in communication therewith through holes formed in the arc block, and a source of charge gas connected to the distributing member, whereby the gas fed to the arc is distributed first in the distributing chamber and second in the space between the baffles and the distributing chamber.

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