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CALUTRONS

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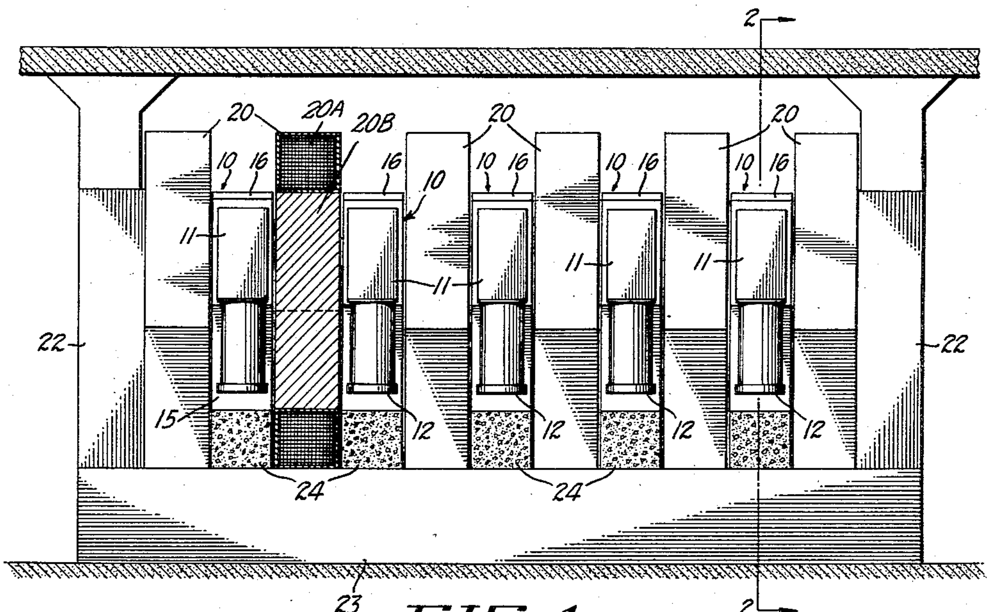

FIG_1_

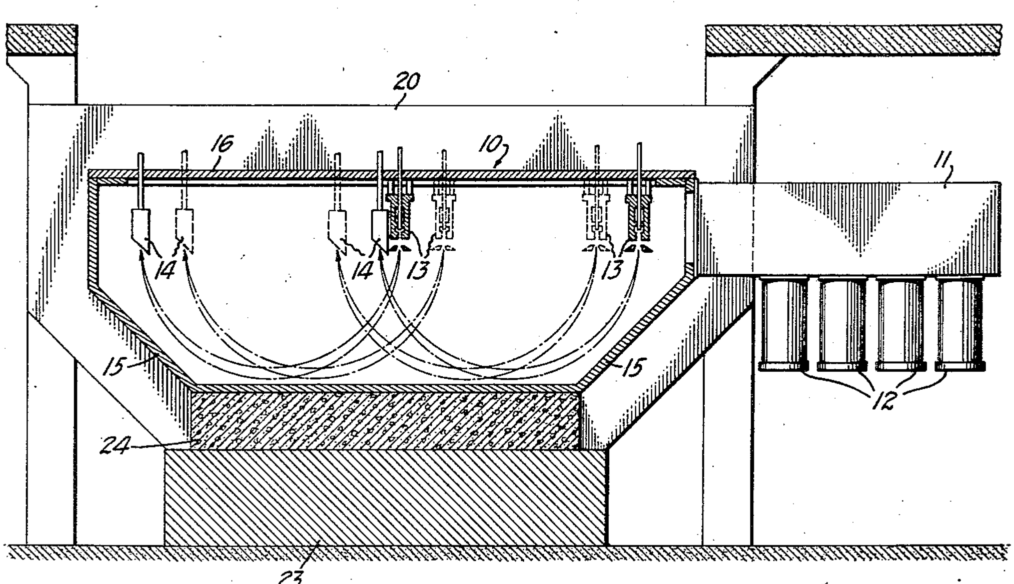

FIG_2_

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CALUTRONS

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The present invention relates to calutrons and more particularly to calutrons of the character disclosed in the United States Patents to Ernest O. Lawrence, No. 2,709,222, issued May 24, 1955, and No. 2,714,644, issued August 2, 1955.

At the outset it is noted that a "calutron" is a machine of the character of that disclosed in the above-mentioned Lawrence patents, and is employed to separate the constituent isotopes of an element and more particularly to increase the proportion of a selected isotope in an element containing several isotopes in order to produce the element enriched with the selected isotope. For example, the machine is especially useful in producing uranium enriched with U^{235}.

Such a calutron essentially comprises means for vaporizing a quantity of material containing an element that is to be enriched with a selected one of its several isotopes; means for subjecting the vapor to ionization, whereby at least a portion of the vapor is ionized causing ions of the several isotopes of the element to be produced; electrical means for segregating the ions from the un-ionized vapor and for accelerating the segregated ions to relatively high velocities; electromagnetic means for deflecting the ions along curved paths, the radii of curvature of the paths of the ions being proportional to the square roots of the masses of the ions, whereby the ions are concentrated in accordance with their masses; and means for de-ionizing and collecting the ions of the selected isotope thus concentrated, thereby to produce a deposit of the element enriched with the selected isotope.

It is an object of the present invention to increase the efficiency of a calutron arrangement by employing supporting structure for the calutron tanks as a return yoke for magnetic flux.

It is a further object of the present invention to provide a calutron including magnetic means in which mechanical support for the calutron tank is provided by the magnet.

It is a further object of the present invention to provide a calutron arrangement comprising an alternated series of tanks and magnets in combination with a magnetic yoke arranged to support the tanks and electromagnets.

Other objects not enumerated above will become apparent as the description proceeds, especially when taken in conjunction with the appended drawings in which Figure 1 is a side elevation of the described calutron arrangement and Fig. 2 is a section on the line 2—2 of Fig. 1.

Referring now to the drawings, the calutron arrangement illustrated comprises a series of tanks **10** each of which contains ion separating mechanism. The tanks **10** are conventionally formed of steel and are made to withstand atmospheric pressure when evacuated to pressure on the order of 10^{-4} or 10^{-5} mm. Hg. In order to evacuate the tanks **10** each is connected at its side to a laterally extending vacuum manifold **11** which in turn is connected to a plurality of diffusion pumps

12. The specific details of the evacuating mechanism forms no part of the present invention and it is sufficient to state that evacuation is carried out by a plurality of diffusion pumps in conjunction with a plurality of mechanical backing pumps.

The ion separating mechanism comprises a plurality of ion transmitters **13** and a plurality of receivers **14**. It will be noted that in the present illustrated embodiment it is contemplated that a substantial number of transmitters will be placed side by side, transmitting beams to a corresponding plurality of ion receivers. Since the operation of ion separating mechanism of this type is fully disclosed in the patents identified above, no elaboration of the same will be made herein.

In the illustrated embodiment, tank **10** is of substantial length and has its lower corners truncated as indicated at **15**. This truncation of the tank conserves space and it will be observed that the walls of the tank **10** are thus caused to lie closely adjacent to the outermost ion beams. The top wall **16** of the tank **10** is removably secured to the tank and will be provided with conventional sealing means (not shown). It will be observed that the several transmitters **13** and receivers **14** are supported directly by the removable top wall **16** and this permits removal of the top wall and the complete ion separating mechanism by simply elevating the top wall **16**, which may be done by a conventional overhead hoist.

I have illustrated a series of five tanks **10** which are spaced apart in a horizontal straight line, although it will be appreciated that the number of tanks thus provided may vary widely.

Magnetic structure is provided for establishing a substantially uniform magnetic field through each of the tanks **10** and this structure comprises a plurality of electromagnets **20**, there being an electromagnet positioned closely adjacent each side of each of the tanks. This arrangement provides a magnet between the individual tanks of an adjacent pair as well as an outer electromagnet at each end of the series. In other words, the arrangement comprises a series of alternated tanks and magnets, the end elements of the series being electromagnets.

The electromagnets each comprises a winding **20A** shaped to conform substantially to the transverse shape of the tank and having an inner opening substantially conforming to the transverse cross section of the tank. These windings are connected in such a direction that each tends to set up a magnetic field extending in the same direction through the series of tanks and magnets. Inside the windings there are provided core members **20B** whose cross sectional shape and area conform substantially to the cross sectional shape and area of the tanks **10**.

Adjacent to and preferably contacting the end electromagnet **20** I have provided vertical yoke portions **22** which extend downwardly substantially to the plane containing the undersides of the electromagnets **20**. I have further provided a horizontally extending yoke portion **23** which is in good flux conducting relationship to the vertical yoke portions **22** and whose upper surface lies substantially in the plane of the under surfaces of the electromagnets **20**.

The yoke portion **23** may thus be employed as a mechanical support both for the tanks **10** and the electromagnets **20**. As illustrated in Fig. 1 the electromagnets **20** may rest directly upon the upper surface of the yoke portion 23. I have illustrated the tanks **10**, however, as resting upon separate supports **24** which in turn rest upon the upper surface of the yoke portion **23**. The supports **24** may conveniently take the form of concrete blocks or the like. While the detailed structure of the yoke portion **23** is not illustrated, it will be appreciated that the essential consideration is that it shall contain sufficient material of a high magnetic permeability to provide a satisfactory path for the magnetic flux set up by the electromagnets **20**. Thus in practice the yoke portion **23** may be essentially a foundation element containing sufficient structural steel elements to carry the magnetic flux without approaching saturation.

It will be appreciated that the tank **10** illustrated is a very sizeable structure and may be on the order of twenty feet long and eight feet high. It will therefore be appreciated that the saving in iron effected by combining the function of a structural support and a return yoke in a single element is very material. Furthermore, the disclosed arrangement has the advantage that the return yoke is thus located in a position where it causes a minimum of interference with the calutron tank and specifically permits access to both the top and side walls thereof.

While I have illustrated a tank of a particular shape and further illustrated the ion separating mechanism as supported from a removable top closure plate it will be appreciated that the shape of the tank is of no particular significance in the present invention and that instead of the shape shown, the tank could well be rectangular, U-shaped, or circular as desired. It will further be appreciated that the ion separating mechanism disclosed is merely illustrative of the type of mechanism to be employed in the tank and that the precise structure and arrangement of the elements that make up this mechanism may be varied as desired. More generally, while I have illustrated a single preferred embodiment of my improved calutron arrangement it will be appreciated that this has been done merely to enable those skilled in the art to practice the invention the scope of which is indicated by the appended claims.

What is claimed is:

1. In a caluton comprising an evacuated tank provided with electromagnetic ion separating mechanism therein, means for establishing a magnetic field through said tank comprising a pair of magnet windings disposed one on each of opposite sides of said tank, and a return yoke for magnetic flux extending beneath and supporting said tank.

2. A calutron arrangement comprising a plurality of substantially fluid-tight tanks disposed parallel to one another and spaced-apart in an aligned array along a common center line, ion separating mechanism disposed in each of said tanks, a longitudinal member of ferromagnetic material disposed parallel to said center line for supporting said tanks, end members of ferromagnetic material magnetically joined to said longitudinal member at the ends thereof and perpendicular thereto, an electromagnet disposed between adjacent tanks and between end tanks and end members, each electromagnet comprising a winding substantially conformed to the perimeter of said tanks and surrounding a ferromagnetic core having substantially the same configuration as the parallel faces of said tanks, and electrical means connected to said windings for establishing magnetic fields through each of said tanks in the same direction with said end and longitudinal members providing a magnetic flux return path.

3. A calutron arrangement comprising a plurality of evacuated tanks, a plurality of electromagnets, each of said electromagnets comprising an electrical winding disposed about the perimeter of a ferromagnetic core having substantially the same configuration as said tanks, said tanks and said electromagnets being disposed alternately in a linear array having a common center line, the end elements of said linear array being electromagnets, a ferromagnetic structure having end members contiguous with the end elements of said linear array and an elongated member magnetically interconnecting said end members, and electrical means connected to said windings for establishing a magnetic flux through said linear array parallel to the center line thereof.

4. A calutron arrangement comprising a plurality of evacuated tanks, a plurality of electromagnets, each of said electromagnets comprising an electrical winding disposed about the perimeter of a ferromagnetic core having substantially the same configuration as said tanks, said tanks and said electromagnets being alternately disposed in a linear array having a common center line, the end elements of said linear array being electromagnets, electrical means connected to said windings for establishing a magnetic flux through said linear array parallel to the center line thereof, and magnetic yoke structure disposed about three sides of said linear array and having end members contiguous with the end elements of said linear array and an elongated member abutting said end members for supporting the elements of said linear array and providing a return path for said magnetic flux.

5. A calutron arrangement comprising a plurality of substantially fluid-tight tanks, means for evacuating said tanks, a plurality of electromagnets, each of said electromagnets comprising an electrical winding disposed about the perimeter of a magnetic core having substantially the same configuration as said tanks, said tanks and said electromagnets being alternately disposed in a linear array having a common center line, the end elements of said linear array being electromagnets, electrical means connected to said windings for establishing a magnetic flux through said linear array parallel to the center line thereof, a magnetic structure having end members contiguous with the end elements of said linear array and an elongated member magnetically interconnecting said end members, a plurality of transmitters respectively disposed in said tanks and arranged to transmit a plurality of ion beams therein transversely through said magnetic flux, and a plurality of receivers respectively disposed in said tanks to receive and collect desired portions of said ion beams.

6. A calutron arrangement comprising a plurality of substantially fluid-tight tanks disposed parallel to one another and spaced-apart in an aligned array along a common center line, ion separating mechanism disposed in each of said tanks, a longitudinal member of ferromagnetic material disposed adjacent said tank array and parallel to said center line, end members of ferromagnetic material magnetically joined to the outer ends of said longitudinal member and extended parallel to the end tanks of said array, a plurality of electromagnets, said electromagnets being disposed one between successive pairs of tanks and between each end member and adjacent tank, each of said electromagnets comprising at least a winding having substantially the same configuration as the parallel faces of said tanks, and electrical means connected to said windings for establishing magnetic fields through each of said tanks in the same direction parallel to the common center line thereof with said end and longitudinal members providing a magnetic flux return path.

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