Also there will be a force arising from the pressure tensor produced by the ions (and electrons) moving in the magnetic field (*3*). These forces make the ions avoid the side walls and precipitate upon the slats. They cause the ions to take on at the slats a velocity distribution entirely similar to the velocities of a gas which has expanded adiabatically.

But if the ions are made up of two isotopes, the displacements of the two isotopes will be different for these two forces; the ligher isotope will be brought towards the negative end of the receiving slats, and the heavier isotope will be brought toward the positive end of the receiving slats (*2*).

The relative enrichment of the material found on the two extreme positioned slats will vary approximately as the square of the distance from the arc, and should be enough to give practically pure isotopes in one operation even for uranium.

I have made a rough calculation of the total cost of using the magneto-ionic separator per gram of $U^{235}$. The cost of the magnet and equipment such as we used was about $150,000. Energizing the magnet at a cost of $0.01 per kilowatt hours would cost about $15,000 per year. For the arc current we have used, 100 amperes, 10 amperes of positive ions, or 6000 grams per year of $U^{235}$ would be obtained. The cost of power for the arc is less than $1.00 per gram of $U^{235}$ and the labor cost per magnet should be about $12,000 per year. These assumptions give $\$1.00 + \$7.00/x$ as the cost per magnet per gram $U^{235}$ with arc current of 100 $x$ amp. Thus, for a 100-amp arc the cost per gram $U^{235}$ should be about $8.00, while for a 1000-amp arc a unit cost of less than $2.00 per gram may be possible. This is to be compared with the value in the AEC 1956 price list of $17.07 per gram of $U^{235}$, ninety per cent enriched.

The ionic centrifuge has been tested repeatedly for 13 years and gave uniformly negative results in isotope separation. The magneto-ionic expander has been given a preliminary test at a low potential difference between the side walls of only seven volts. Tests at a higher voltage, a few hundred volts, should be made, or the flaw in the above discussion should be exposed.

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# Foil Depression Factors for Indium Disk Detectors[1]

Foil detectors have been used for some time as instruments to measure relative thermal neutron fluxes. The foils are thin and usually small in area. It was early realized that the foil itself depresses the thermal flux since it removes neutrons from the surrounding media in order to be activated and, after the capture of the neutron, eliminates the possibility of the neutron's being scattered back to the same point. As the foil thickness approaches

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[1] This work was carried out at the School of Nuclear Science and Engineering, Argonne National Laboratory, Lemont, Illinois.

zero, its activation is directly dependent upon its volume. Finite foils must, of course, be used; therefore, a self-absorption phenomenon also exists.

Bothe (*1*) gives a correction for foil depression. Tittle (*2*) modified this theory by replacing the scattering mean free path with the transport mean free path. Tittle also applied Bothe's sphere formulas to a disk and states that this gives a better fit to the experimental data. Foil depression factors for disk shaped detectors can be obtained from

$$F = (1 + 0.34\alpha R/\lambda_{tr})^{-1}, \quad R < \lambda_{tr}$$

where $R$ is the actual radius of the foil, $\lambda_{tr}$ is the transport mean free path, and $\alpha$ is the average probability of absorption. The average probability of absorption is

$$\alpha = 1 - (1 - ud)e^{-ud} + (ud)^2 Ei(-ud)$$

where $u$ is the linear absorption coefficient of the detecting medium, $d$ is the thickness of the foil, and $Ei(-ud)$ is the the exponential integral function. Since the foil is of finite thickness, a correction for self absorption must also be made. This correction (*3*) is

$$\epsilon = \alpha/2ud.$$

Skyrme (*4*) gives an approximate formula for the rate of capture of thermal neutrons by a thin circular disk. The ratio between this factor and the actual thermal neutron flux gives the foil depression factor. Thompson (*5*) compares experimental measurements with the Bothe and Skyrme theories but does not include a correction for self-absorption when using Bothe's work. Klema and Ritchie (*6*) did include the self-absorption correction, and consequently, their data compares favorably with the two existing theories.

Measurements of the flux depression caused by indium foils in the Argonne National Laboratory Standard Pile (Building 203) have been made. Foils of 0.75- and 1.50-inch diameters were irradiated to saturation and counted with a NaI crystal in contact with a 5819 photomultiplier tube. A disk of aluminum was placed over the sample while counting to eliminate beta activity. The foils varied in thickness from approximately 0.5 to 5 mils. The samples were irradiated bare and cadmium-covered to determine the thermal neutron activity. No backing material was used for the foils since they were placed in slots in the graphite stringers of the pile.

A plot of saturated activity per unit thickness versus thickness is shown in Figs. 1 and 2 for the indium foil diameters of 0.75 and 1.50 inches, respectively. These data are arbi-

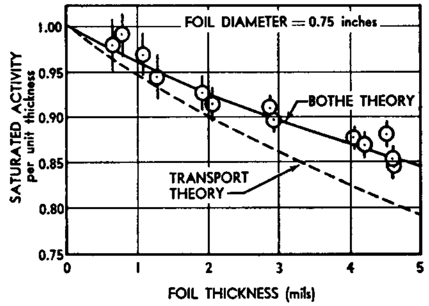

FIG. 1

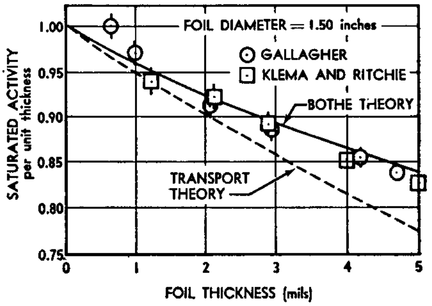

FIG. 2

FIG. 1. Saturated activity *versus* thickness for 0.75-in. diameter indium foil in graphite.
FIG. 2. Saturated activity *versus* thickness for 1.50-in. diameter indium foil in graphite.

trarily normalized since the point at zero thickness was not available. The experimental points for the 0.75-inch diameter foils fall on the Bothe theory curve within the experimental error of counting. The 1.50-inch foil diameter data does not follow either theory throughout, but seems to fit the transport correction slope in the range 0.5 to 1.5 mils and Bothe's slope in the range 1.5 to 5.0 mils. Figure 2 also shows the comparison between the data taken at ANL and ORNL. Agreement of the two measurements is within the standard error of counting.

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