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REPORT

FOR

GENERAL RESEARCH

JANUARY 8, TO APRIL 30, 1951

(Project 64A-C)

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MONSANTO CHEMICAL COMPANY

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MOUND LABORATORY

Operated By

MONSANTO CHEMICAL COMPANY

MIAMISBURG, OHIO

REPORT
FOR
GENERAL RESEARCH
JANUARY 8, TO APRIL 30, 1951

(Alpha Neutron Volume)

RESTRICTED DATA
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Date: June 4, 1951

Approved By: M. M. Haring
M. M. Haring
Laboratory Director

MASTER

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SUMMARY

An experimental, gamma-sensitive, coaxial radioelectric cell has been tested by the Control Section. It was found to be as precise as the rotating sample gamma counter but much faster and simpler to operate . A gamma-sensitive, radioelectric cell of improved design has been constructed for the "Y" Section. A neutron-sensitive radioelectric cell has been tested over a range of pressures with various filling gases and with several combinations of hydrogenous electrode backings. Neutron to gamma discrimination ratios as high as 2,000 to 1 were obtained. A multiple electrode, alpha radiation, radioelectric cell using coated plastic electrodes gave increased current output, but the electrode life was quite short. Preliminary life tests indicated that aluminum electroscope foil would give excellent electrode life and techniques were worked out for making good electrodes of both aluminum and of gold electroscope foil. The vacuum-pressure gas system has been redesigned and completely rebuilt (p. 5)

The fast-neutron scintillation counter is much smaller and lighter than a B-wall proportional counter and a large moderator. The former is more efficient for polonium-beryllium neutron sources but is less efficient for radium-beryllium neutron sources or for polonium sources producing lower energy neutrons The fast-neutron scintillation counter would thus be very useful if the neutron to gamma discrimination ratio could be markedly improved Preliminary experiments indicate that this ratio can be improved by carefully tailoring the frequency response characteristics of the amplifier used. Phosphors are also being investigated from the standpoint of improving this ratio. Preliminary attempts to detect neutrons by measuring the neutron-capture gamma of cadmium were unsuccessful. However, the conversion gamma from alpha-beryllium neutron sources can be detected with high efficiency; and this might be used to determine the neutron flux from such sources even in the presence of high backgrounds of lower energy gammas (p. 8).

Maximum efficiency is obtained for polonium-beryllium neutron sources when the beryllium powder contains a minimum of oxide, when the polonium is "shot" into the source container and when the curie-to gram-of-beryllium ratio is in the range of 5 to 11 (p. 11).

Four mock-fission neutron sources have been prepared in an attempt to improve the efficiency which can be obtained by the evaporation technique (p. 13).

A polonium-boron neutron source of unusually high efficiency has been made by the evaporative procedure "Two further attempts to prepare polonium-boron neutron sources by volatilization gave low efficiency (p. 14).

Polonium, satisfactory for making neutron sources, has been reclaimed from large volumes of hydrochloric acid containing high concentrations of contaminating ions (p. 15).

Work has continued on the problem of determining the total energy emitted from a covered alpha source The effective thickness of a tantalum hold-down apparently increases with time. If a source does not contaminate acetone after 24 hours immersion, it can be considered as being satisfactorily sealed. It is believed that a satisfactory seal of a tantalum hold-down to a gold plated source can be obtained by using a gold foil ring between the hold-down and the source, clamping to give pressure, and heating in a vacuum (p. 16).

Problem Title - **Investigation of the Radioelectric Effect**

Report By - **J. H. Hutchinson and J. S. Stanton**

Work Done By - **J. H. Hutchinson and J. S. Stanton**

INTRODUCTION

The gamma-sensitive, coaxial radioelectric cell discussed last quarter[1] has been delivered to the Control Section for testing. Data indicate that this cell compares favorably with the rotating-sample gamma counter. A second and improved gamma-sensitive radioelectric cell for the "Y" Section has been constructed and is being tested.

A neutron-sensitive, coaxial radioelectric cell has been constructed and is now being used as an experimental model. This is not too satisfactory for developmental work because of the excessive time required to make up cylindrical electrodes; a simpler cell has been designed for the sole purpose of evaluating electrode materials and filling gases.

The multiple-electrode alpha-radiation radioelectric cell[2] for increasing current output was tested, but its life was not satisfactory. The use of eight plastic-base electrodes did increase the current, but their life was very short.

Much time was spent in developing a technique for making good electrodes from foils of aluminum and gold. A preliminary life test on an aluminum electrode indicated a greatly increased life over the plastic-base electrodes.

DETAILED REPORT

The gamma-sensitive, coaxial, radioelectric cell and electrometer designed for the Control Section has been delivered. This is an experimental device, and as soon as sufficient data have been accumulated, it will be modified to meet Control Section specifications It is being tested and compared with the rotating-sample gamma counter to determine their relative accuracies and reliabilities. Some difficulties have been experienced in using the radioelectric device because of zero drift of the electrometer. This will probably be corrected when the filament batteries now in use (mercury cells) can be replaced with air cells

Thus far, 150 samples have been checked with an average precision of 1.5 per cent compared with a precision of 1 8 per cent for the rotating gamma counter. The indicating meter used in the electrometer circuit is a 3-inch, general-purpose, panel-type meter. A greater degree of precision should be obtained with a large mirror-type meter or a long-scale switchboard-type meter. This would increase the readability and eliminate parallax errors One advantage of an indicating device of this type is that readings can be rapidly taken with a high degree of precision from radioactive samples. The assembled gamma-sensitive radioelectric cell and electrometer is shown in Figure 1.

A second and improved, gamma-sensitive radioelectric cell has been designed and constructed for the "Y" Section The first cell constructed for this section had two magnesium-evaporated-on-brass electrodes and one lead-dioxide-on-gold-plated-brass electrode The second model has three aluminum-foil electrodes and two lead-dioxide-on-gold-plated brass electrodes The cell construction is shown in Figure 2. This cell

has an open circuit voltage of 1.34 volts; the open circuit voltage of the magnesium-lead dioxide cell was 1 44 volts. This cell will be more efficient because of the increased number of electrodes, and it should be more stable and have a longer life. The assembled cell is shown in Figure 3.

An experimental, neutron-sensitive coaxial cell has been constructed and is being used at present to establish the design factors for the construction of an efficient cell with good gamma discrimination. Several different kinds of electrodes and filling gases have been tried in this chamber

The first test was made with carbon (conductive paint) on 0.003-inch polystyrene as the positive electrode and 0.0005-inch aluminum foil on 0.003-inch polystyrene as the negative electrodes. The polystyrene serves a dual purpose; it is a support for the electrode material, and it is also a good source of recoil protons. The responses of this cell to gamma radiation is approximately 0.8 per cent of the total count at a hydrogen gas pressure of 48 pounds per square inch. The plots of the hydrogen gas pressure versus current for these electrodes are shown in Figure 4.

The carbon-on-polystyrene electrode was replaced with carbon on 0.01-inch polyethylene. When hydrogen was used as a filling gas, the response to gamma radiation was approximately 0.13 per cent of the total current. The plots of the hydrogen gas pressure versus current for these electrodes are shown in Figure 5. Methane and neopentane were also used as filling gases; both produced higher currents than hydrogen, but the gamma discrimination ratio was not as good. These curves are shown in Figures 6 and 7 respectively.

In the next test, polyethylene was used in both sets of electrodes, with the same electrode materials as before (carbon and aluminum foil). With hydrogen as the filling gas, the total current was slightly less but the gamma discrimination was improved. The response to gamma radiation was 0.05 per cent of the total current. Figure 8 shows the results of this test. Isobutane was also used as a filling gas; the gamma response was approximately 0.15 per cent of the total current. The results of this test are shown in Figure 9.

A new chamber has been designed to simplify the job of evaluating electrode materials and filling gases. It is designed so that samples of electrode materials may be easily checked in different gas atmospheres.

A second experimental chamber is being designed to permit the study of multiple, parallel-plate electrode systems and of the problems involved in their construction.

The first, multiple-electrode, radioelectric cell (with four each of magnesium and Aquą-dag-coated plastic films) was tested and gave an output current of 4 microamperes through 2,000 ohms of galvanometer circuit. The characteristic potential of the cell was 1.6 volts. A single cell of similar electrode material previously tested[3] gave a current of 2.84 microamperes through a 400-ohm galvanometer. Both cells used the same source (except for a 3-month decay period) and operated in argon gas at approximately atmospheric pressure. Thus multiple-electrode construction increases the efficiency of the cell However, the plastic electrodes disintegrated in a few days because of the alpha-particle bombardment.

Since the life of the plastic films was so short and since the films were difficult and time-consuming to make, it was desirable to develop a technique for making the electrodes of electroscope foil. Suitable foil materials are gold and aluminum and should produce a characteristic potential of approximately 1.2 volts.

The first electrode of aluminum was made by stretching the foil across the 1 7/8-inch outside diameter by 1 1/2-inch inside diameter aluminum ring and securing the foil with dilute rubber cement. Although some electrodes made by this process were satisfactory, the majority had wrinkles too large to be used. One of these early electrodes was used for a life test. This test was discontinued after an exposure to the source for 21 days. There was no sign of failure at that time.

The procedure finally adopted for stretching the foils tighter consisted of expanding the foil on a talcum-covered piece of polished plate-glass heated on a hot plate. When hot, the foil was carefully and completely tacked around the edge to the glass by means of dilute rubber cement The glass plate and foil were removed from the heat and cooled. The contracted foil is then tight, free from all wrinkles, and easily picked up by the ring that has been previously coated with rubber cement. The excess foil is shaved off with a razor blade.

Gold foil was handled in a similar manner except more heat was used because of the lower coefficient of thermal expansion of gold. The supporting rings for the aluminum foil were punched from 0.003-inch aluminum stock and flattened between two talcum-covered peices of plate glass

The supporting rings for the gold foil were punched from 0.003-inch copper stock, annealed, flattened between glass plates, and gold plated. The same metal finish for the rings as for the foil is necessary to prevent the "third electrode effect" or the formation of a "bucking" voltage

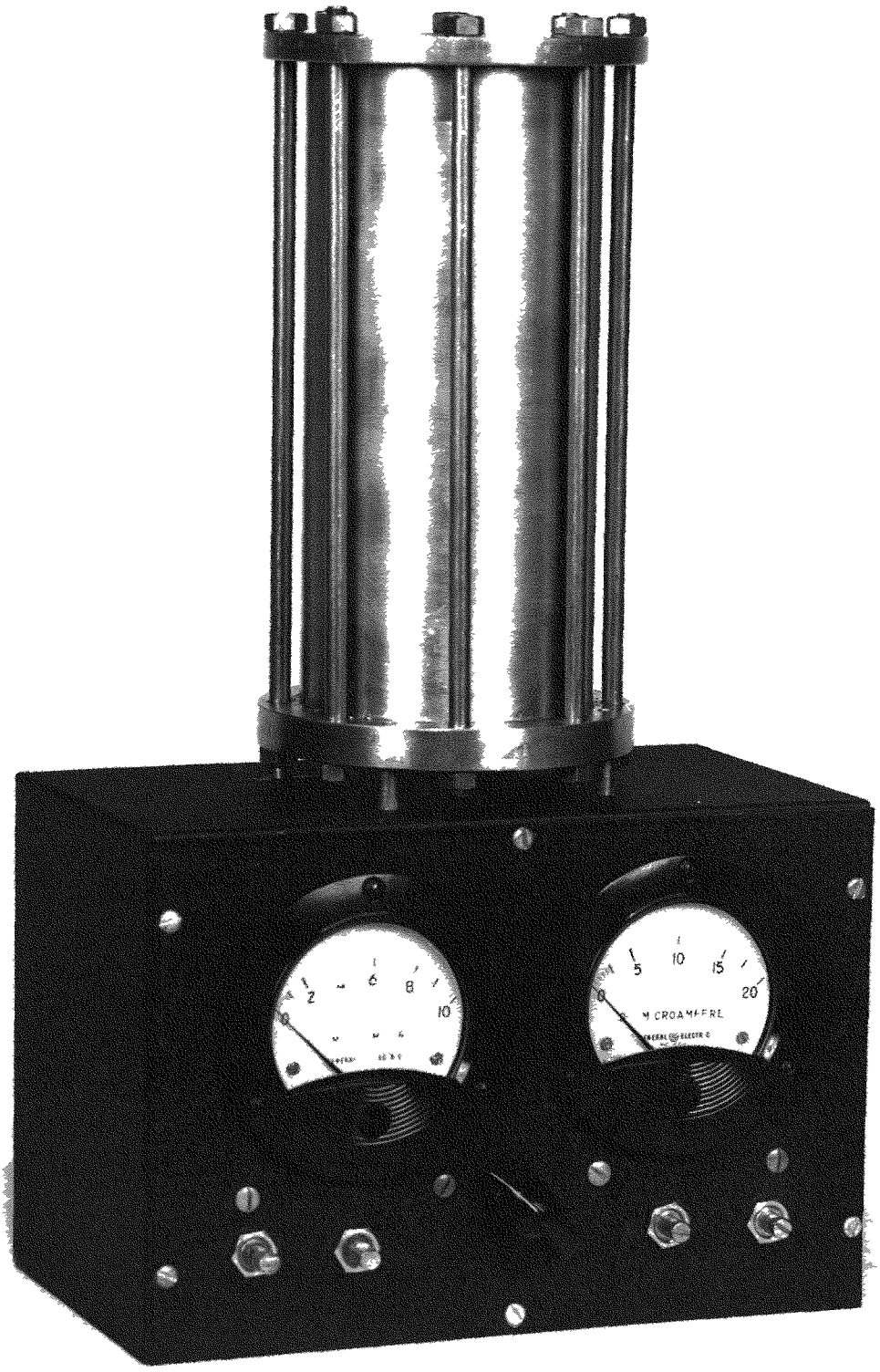
The electrodes are spaced by means of 0.003-inch polystyrene rings slightly larger in outside diameter and slightly smaller in inside diameter than the foil support rings This increase in ring width prevents many foil short circuits.

The new cell will employ six of each type of foil and, except for the above, no other changes will be made. All of the electrodes have been made and when the new, slightly stronger source is received, the cell will be assembled and tested. The original source is now 6 months old, and since an aluminum hold-down is required in place of the nickel hold-down, a new source was requested.

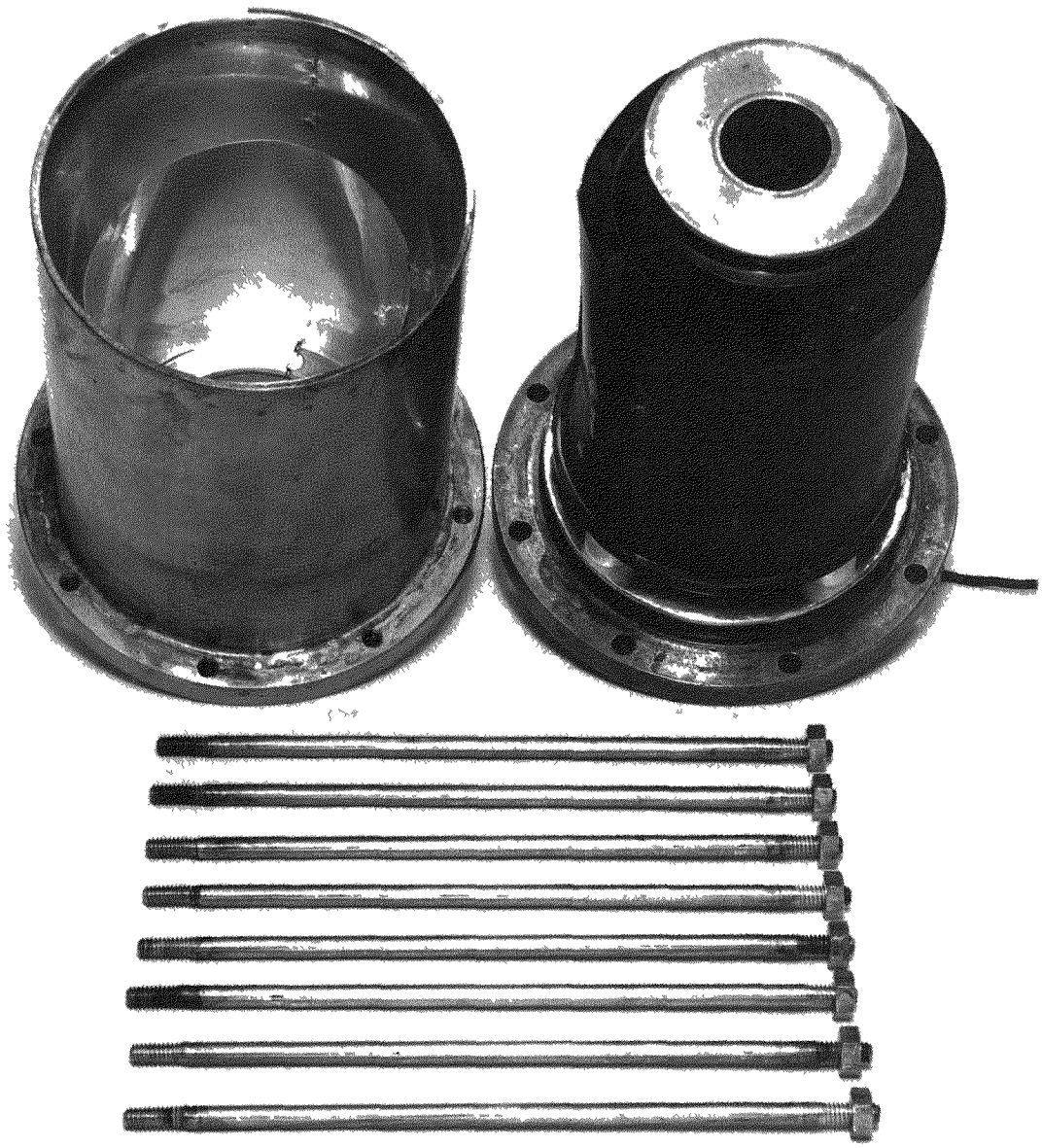
The vacuum and gas-filling system was rebuilt (Figure 10) so a more flexible and efficient system would be available for filling cells and for general laboratory uses.

REFERENCES

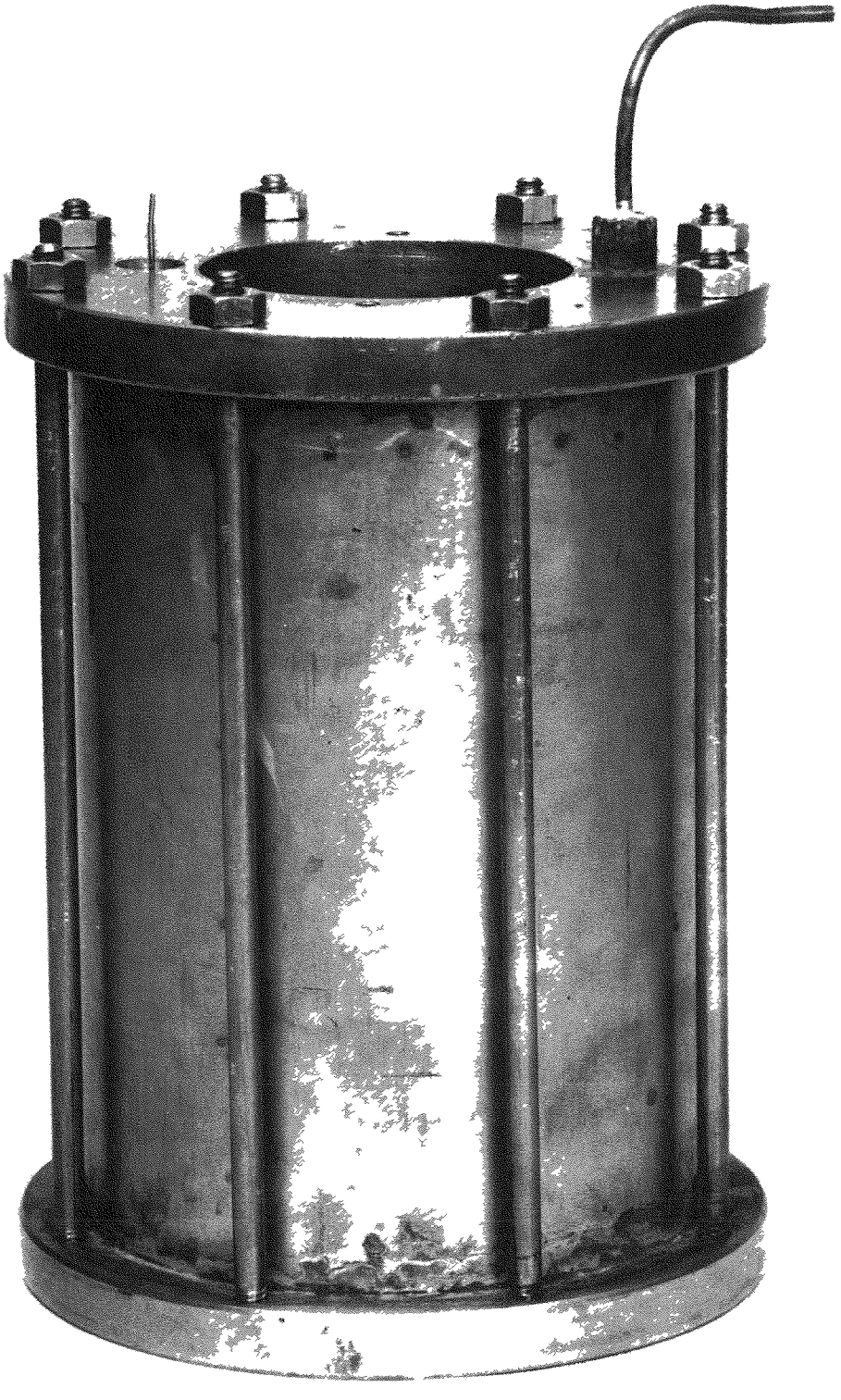
1. Hutchinson, J H. and Stanton, J. S., Rpt Gen Res., MLM-531, p. 29, February 12, 1951.
2. Ibid, p. 31.
3. Ohmart, P. E., Notebook Record, P. 242, 960, October 12, 1950.



CONTROL SECTION GAMMA-SENSITIVE CELL



"Y" SECTION GAMMA-SENSITIVE CELL, DISASSEMBLED



"Y" SECTION GAMMA-SENSITIVE CELL, ASSEMBLED