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MOUND LABORATORY

BURG, OHIO

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

(Project 64A-C)

CCRP
CLASSIFICATION CANCELLED
DATE 4/9/75
For the U.S. Energy Research and Development Administration
Division of Classification

MONSANTO
CHEMICAL COMPANY

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MLM-MU-[illegible]-66-0022

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MLM-563

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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)

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Date: June 4, 1951

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

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(Alpha-Neutron Volume)

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.

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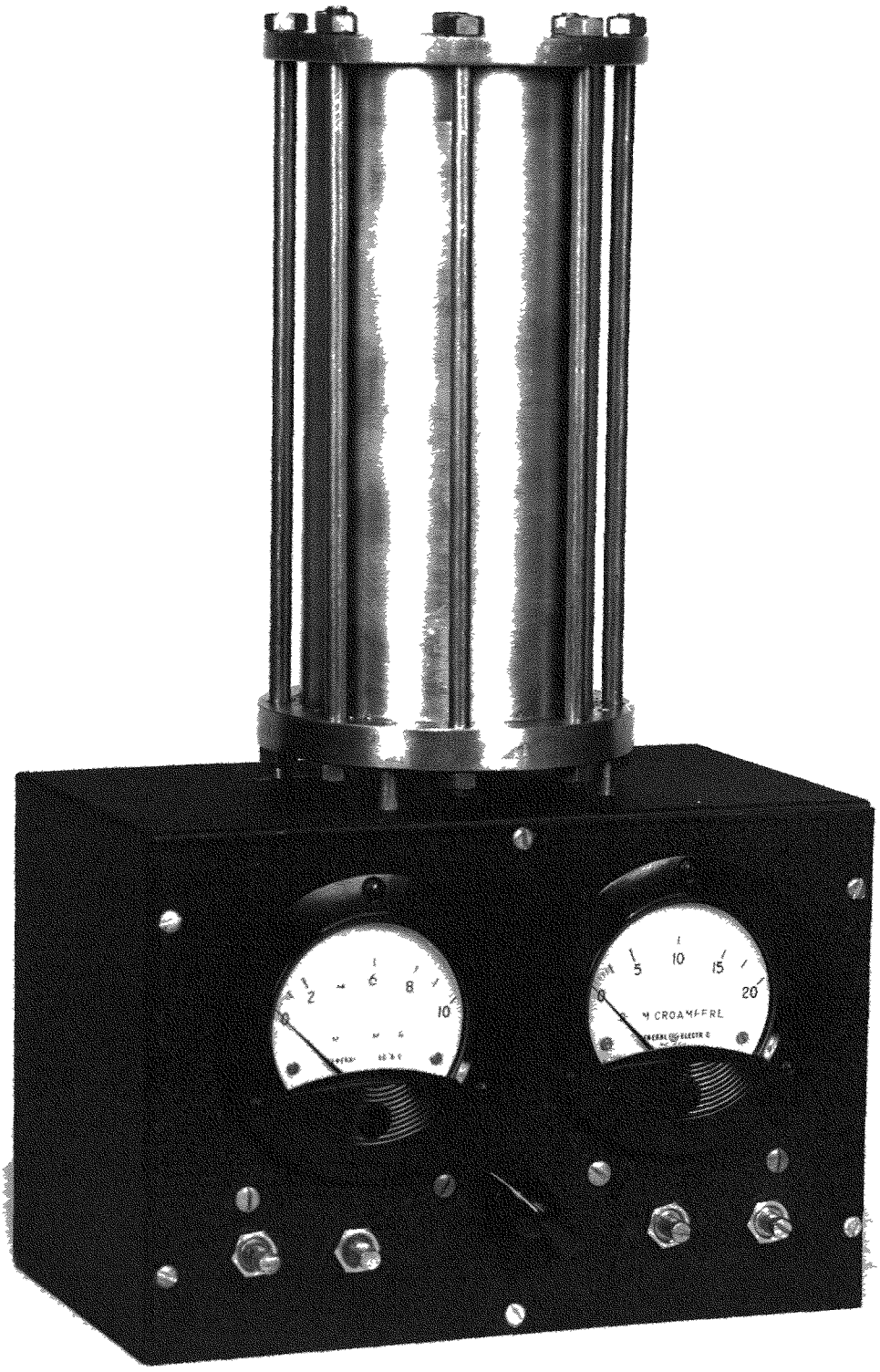
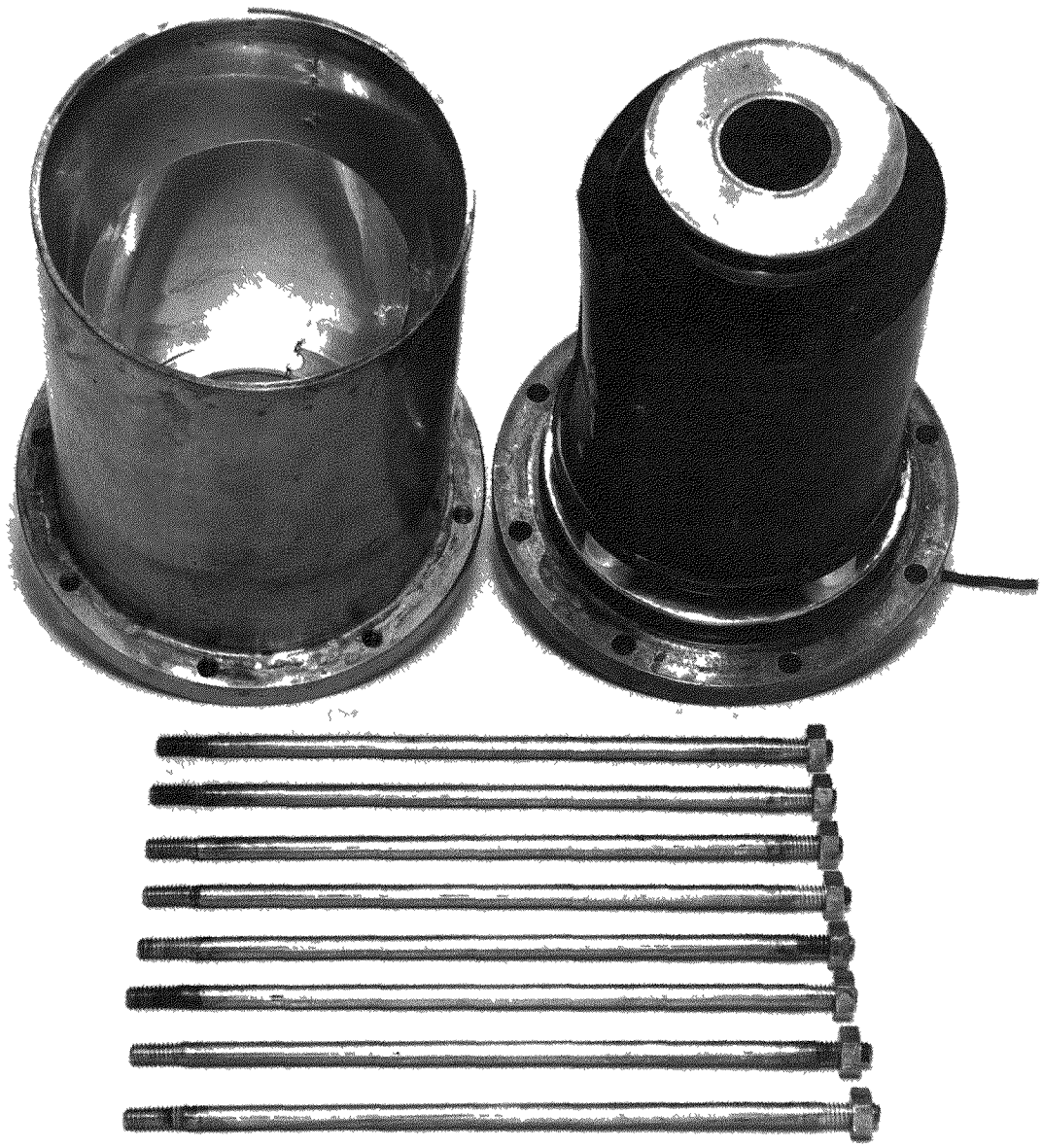
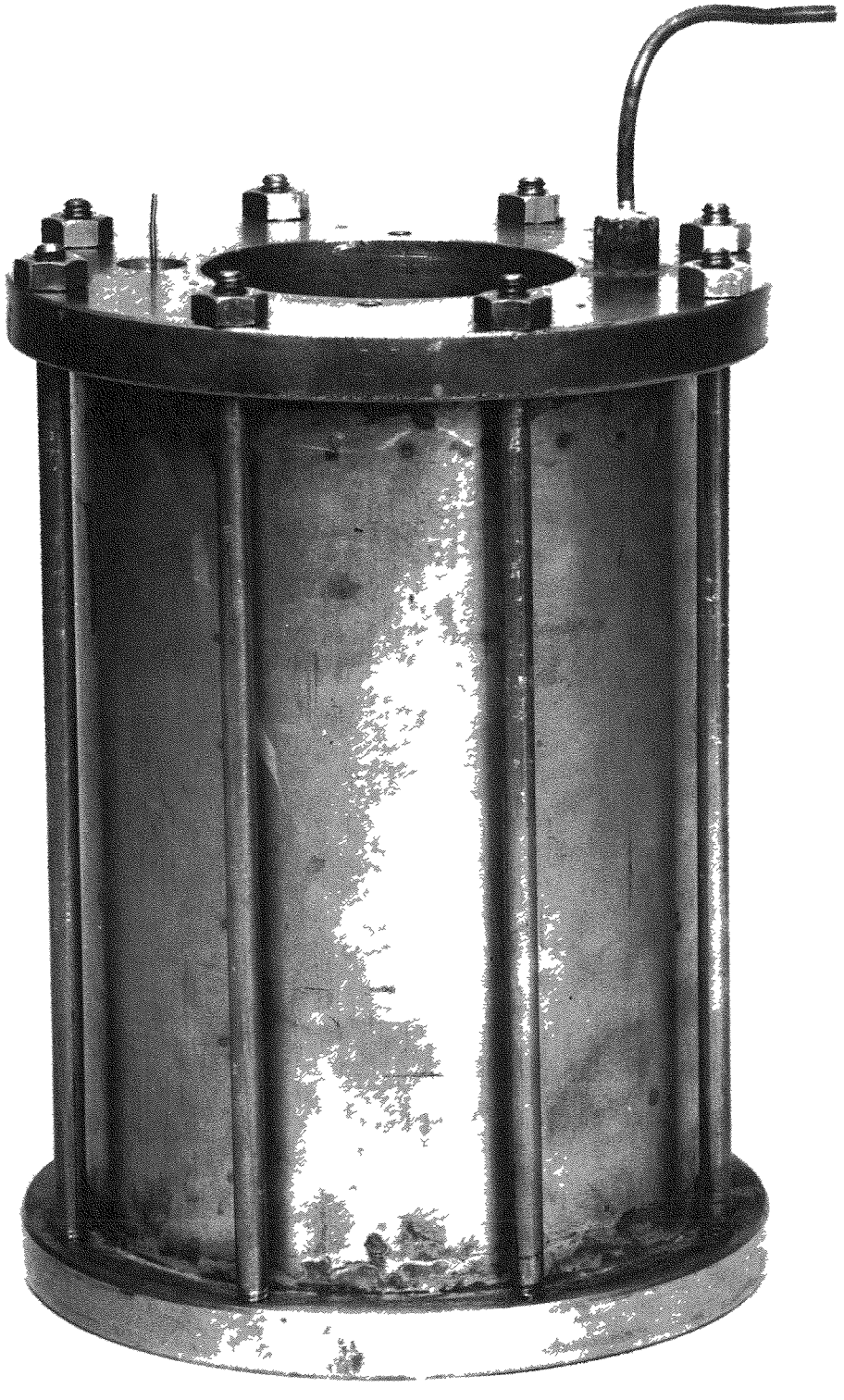
2. Ibid, p. 31.
3. Ohmart, P. E., Notebook Record, P. 242, 960, October 12, 1950.



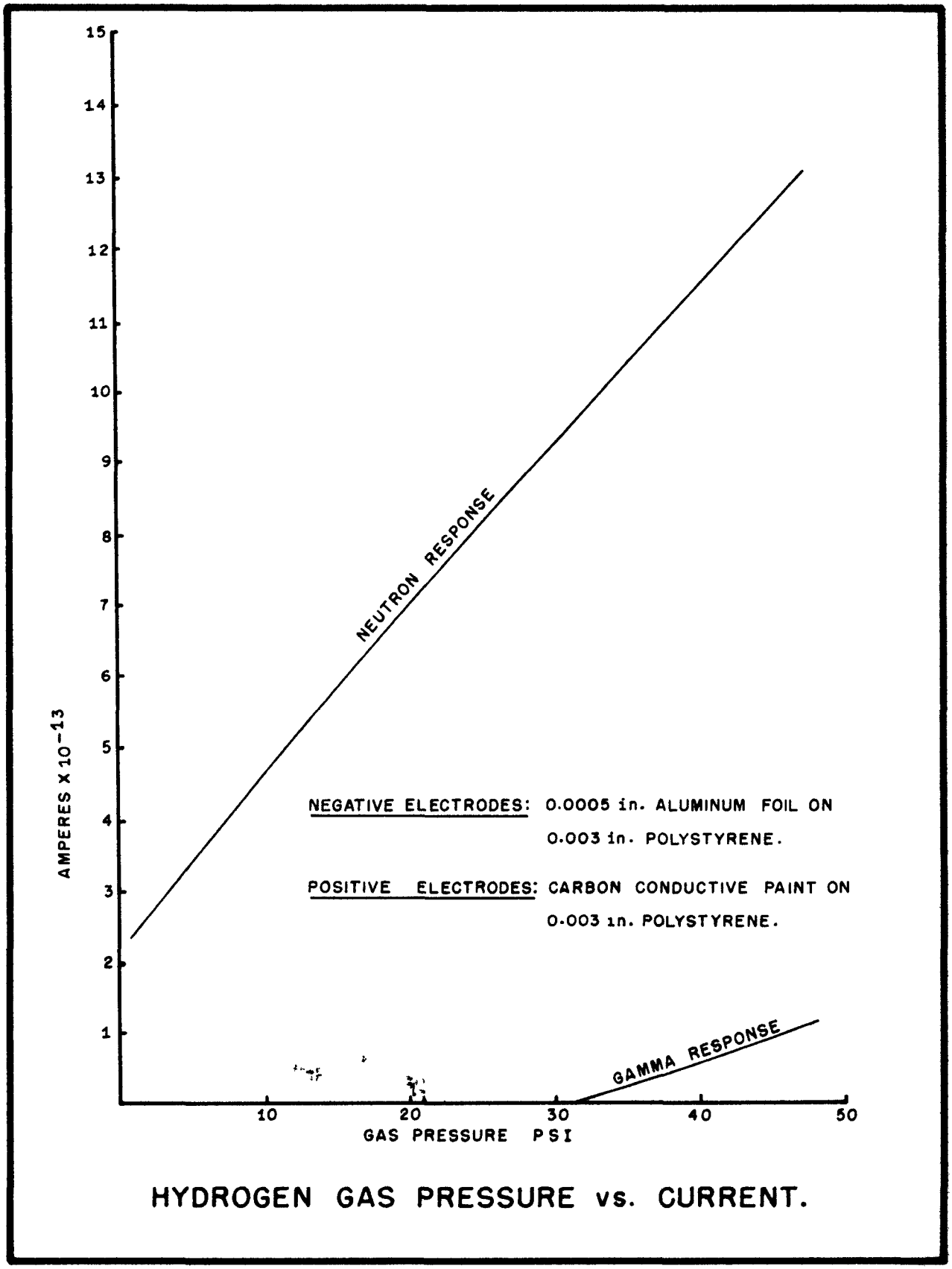
CONTROL SECTION GAMMA-SENSITIVE CELL



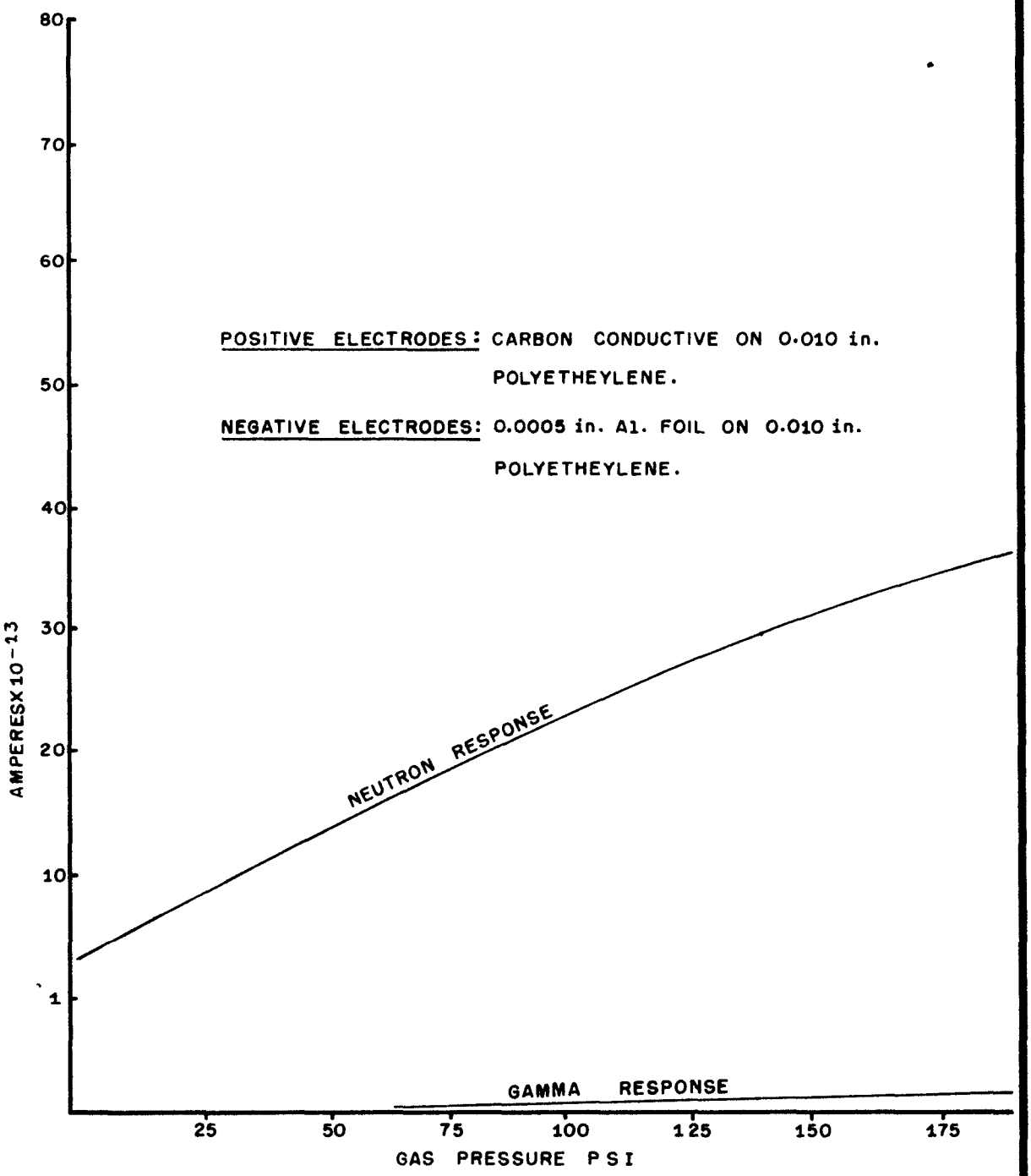
"Y" SECTION GAMMA-SENSITIVE CELL, DISASSEMBLED



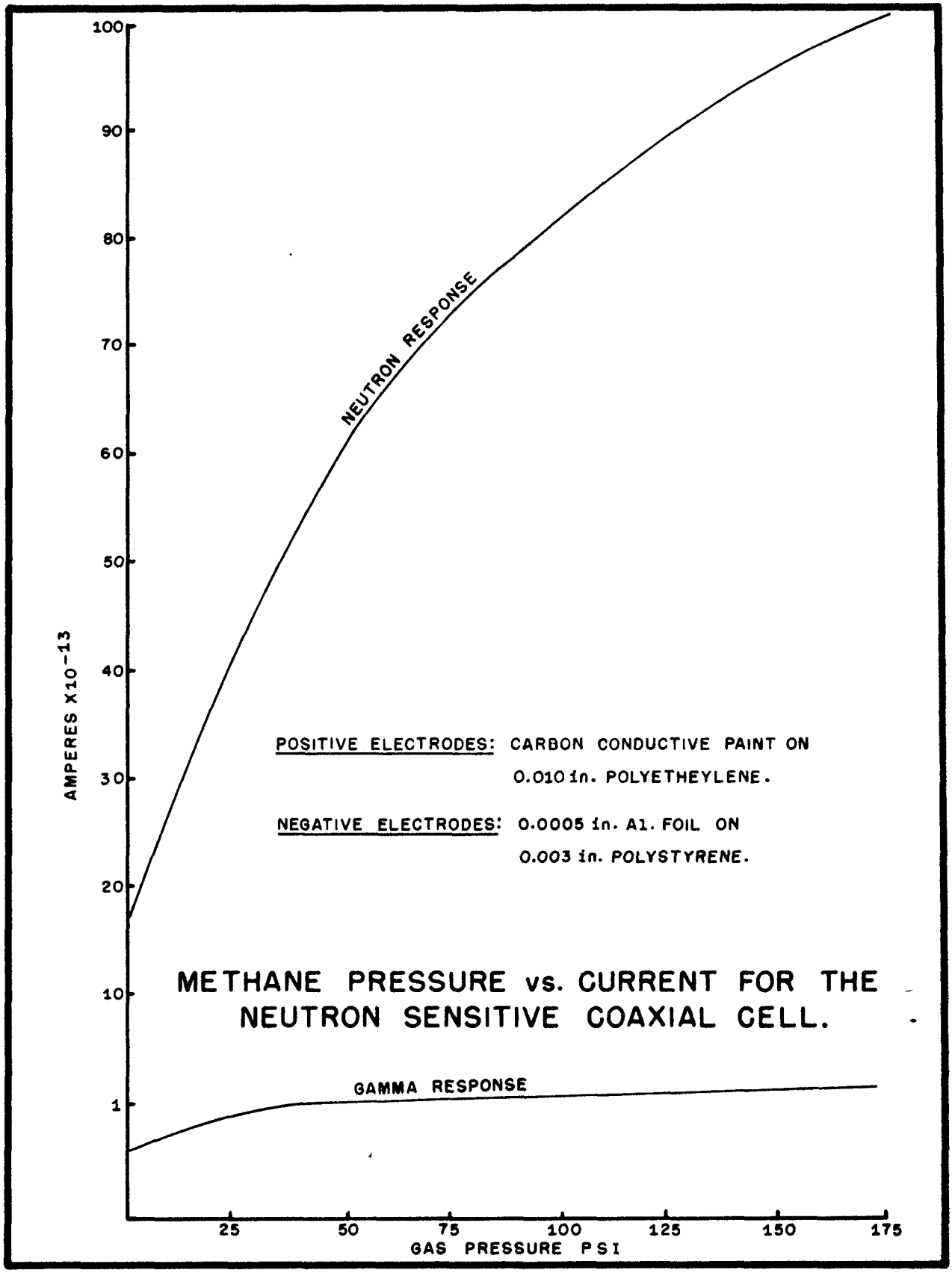
"Y" SECTION GAMMA-SENSITIVE CELL, ASSEMBLED

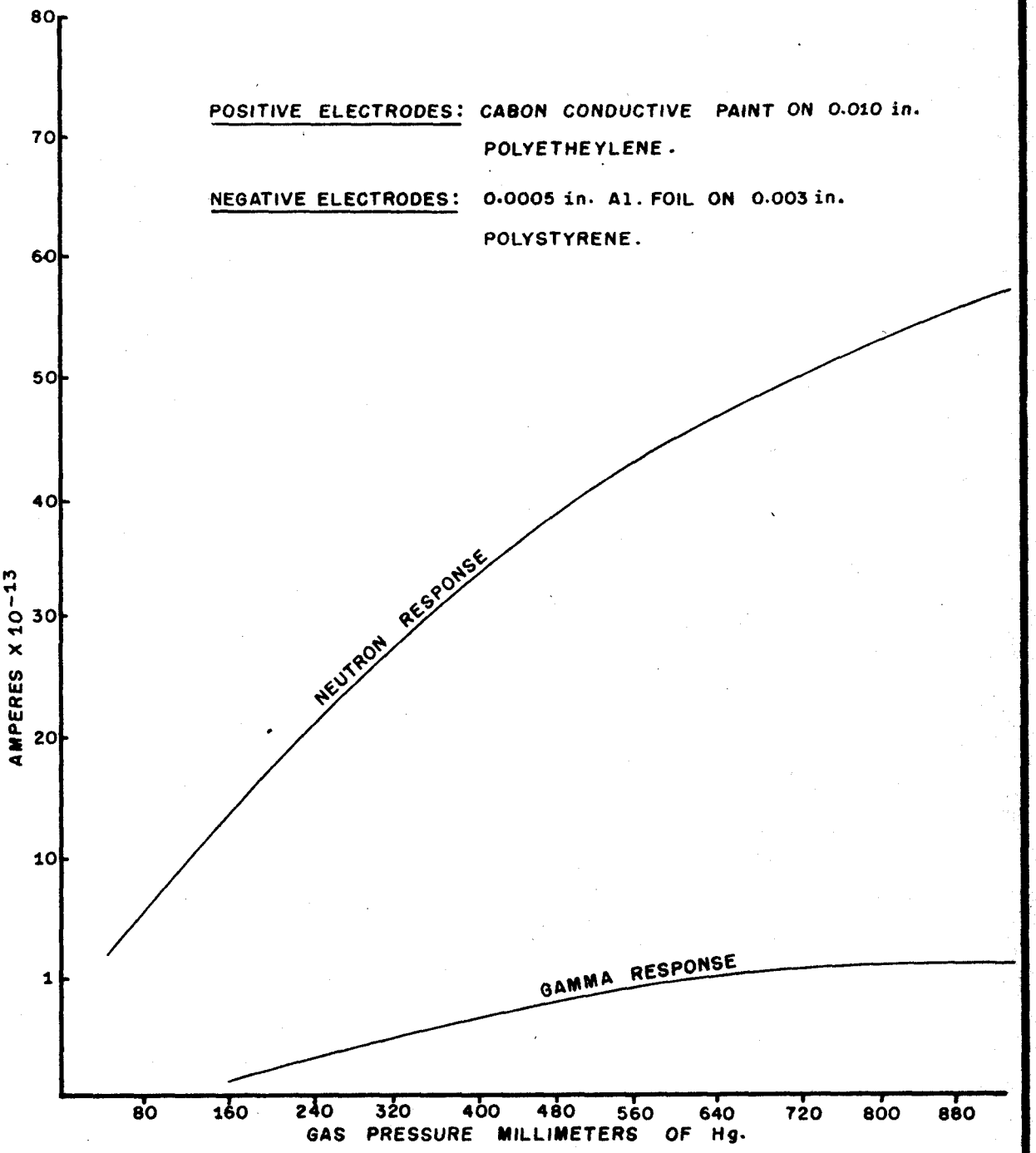


HYDROGEN GAS PRESSURE vs. CURRENT.

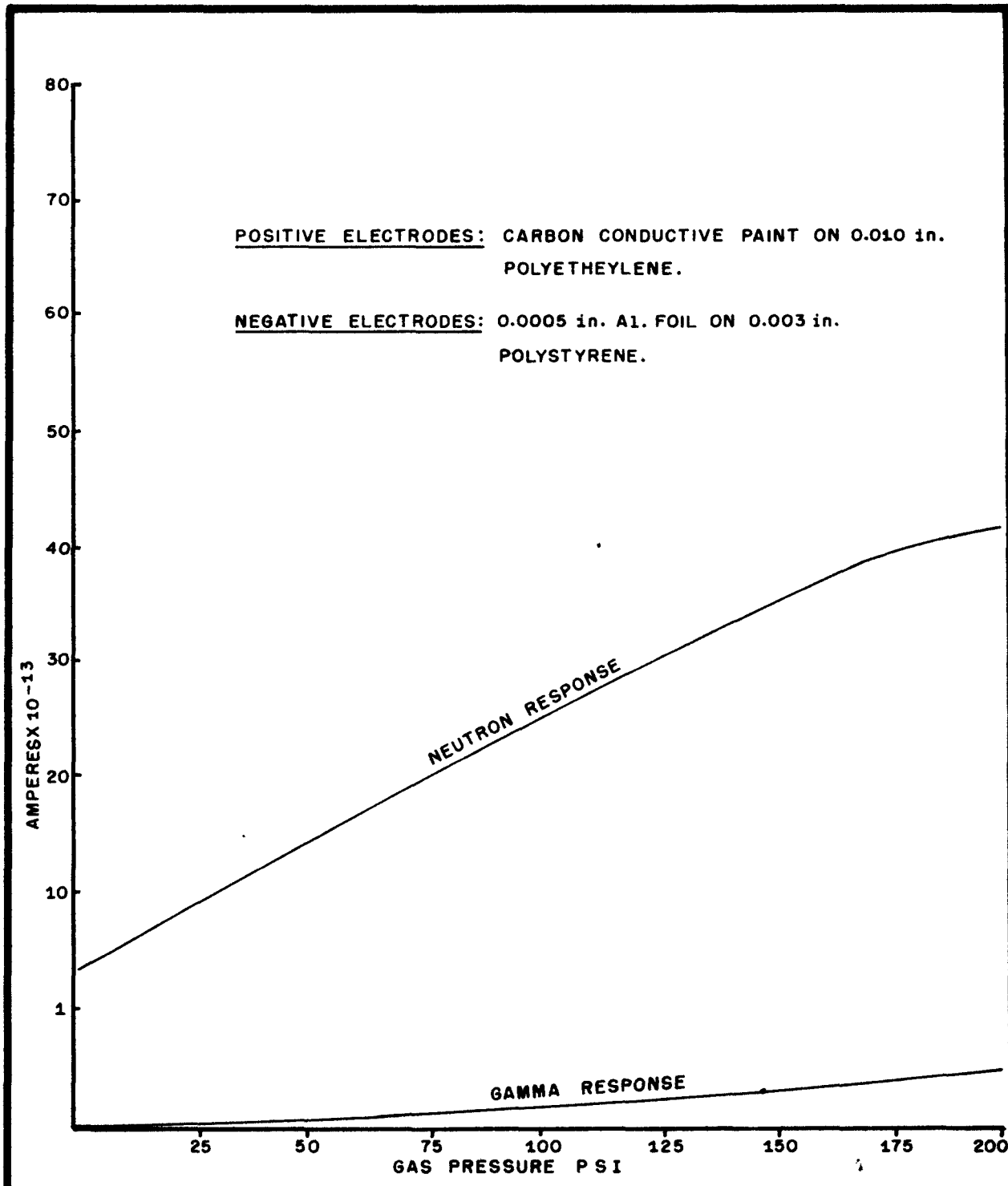


HYDROGEN GAS PRESSURE vs. CURRENT FOR THE NEUTRON SENSITIVE COAXIAL CELL.

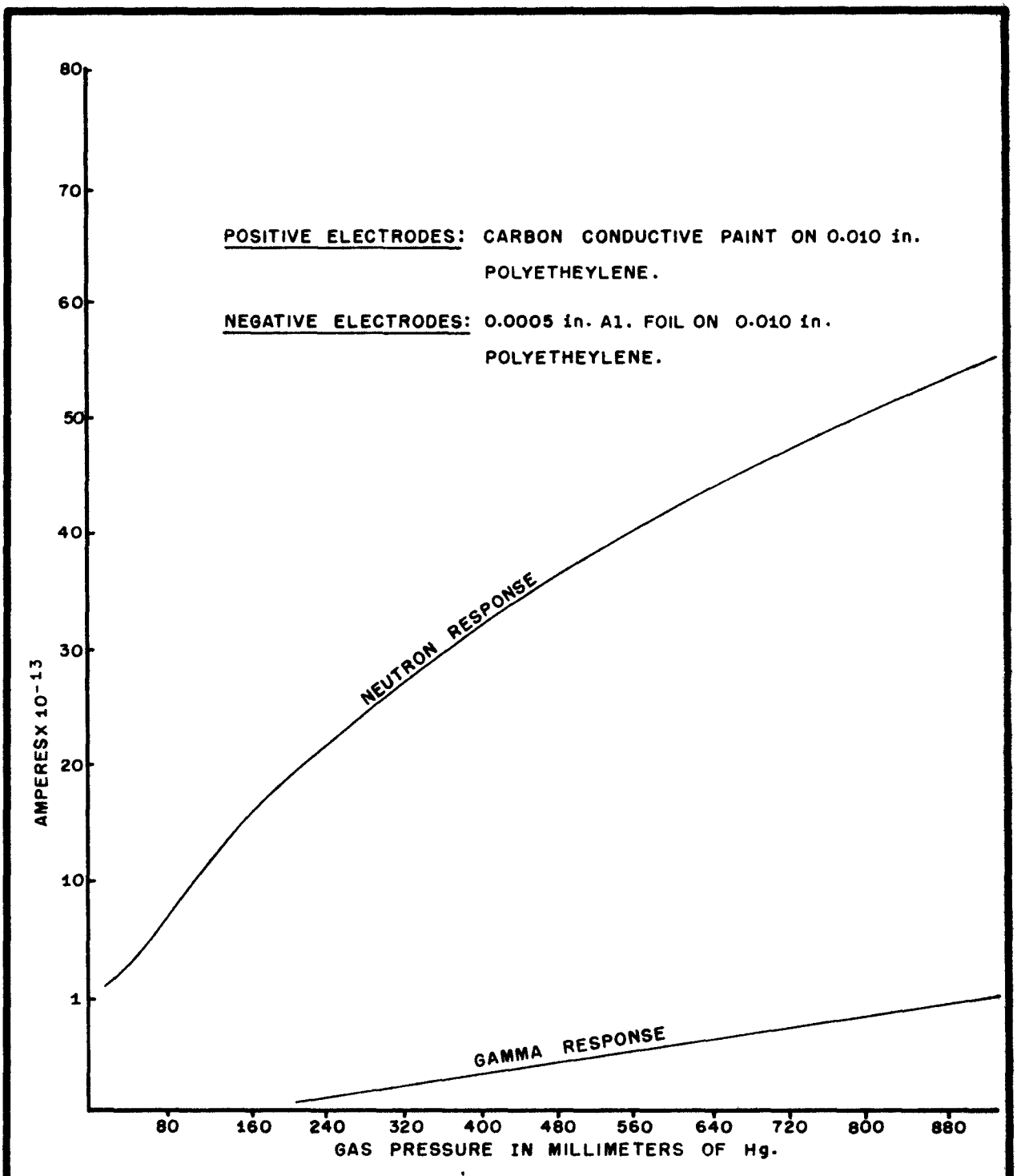

100
90
80
70
60
50
40
30
20
10
1
AMPERES X10⁻¹³
NEUTRON RESPONSE
POSITIVE ELECTRODES: CARBON CONDUCTIVE PAINT ON 0.010 in. POLYETHEYLENE.
NEGATIVE ELECTRODES: 0.0005 in. Al. FOIL ON 0.003 in. POLYSTYRENE.
METHANE PRESSURE vs. CURRENT FOR THE NEUTRON SENSITIVE COAXIAL CELL.
GAMMA RESPONSE
25
50
75
100
125
150
175
GAS PRESSURE PSI



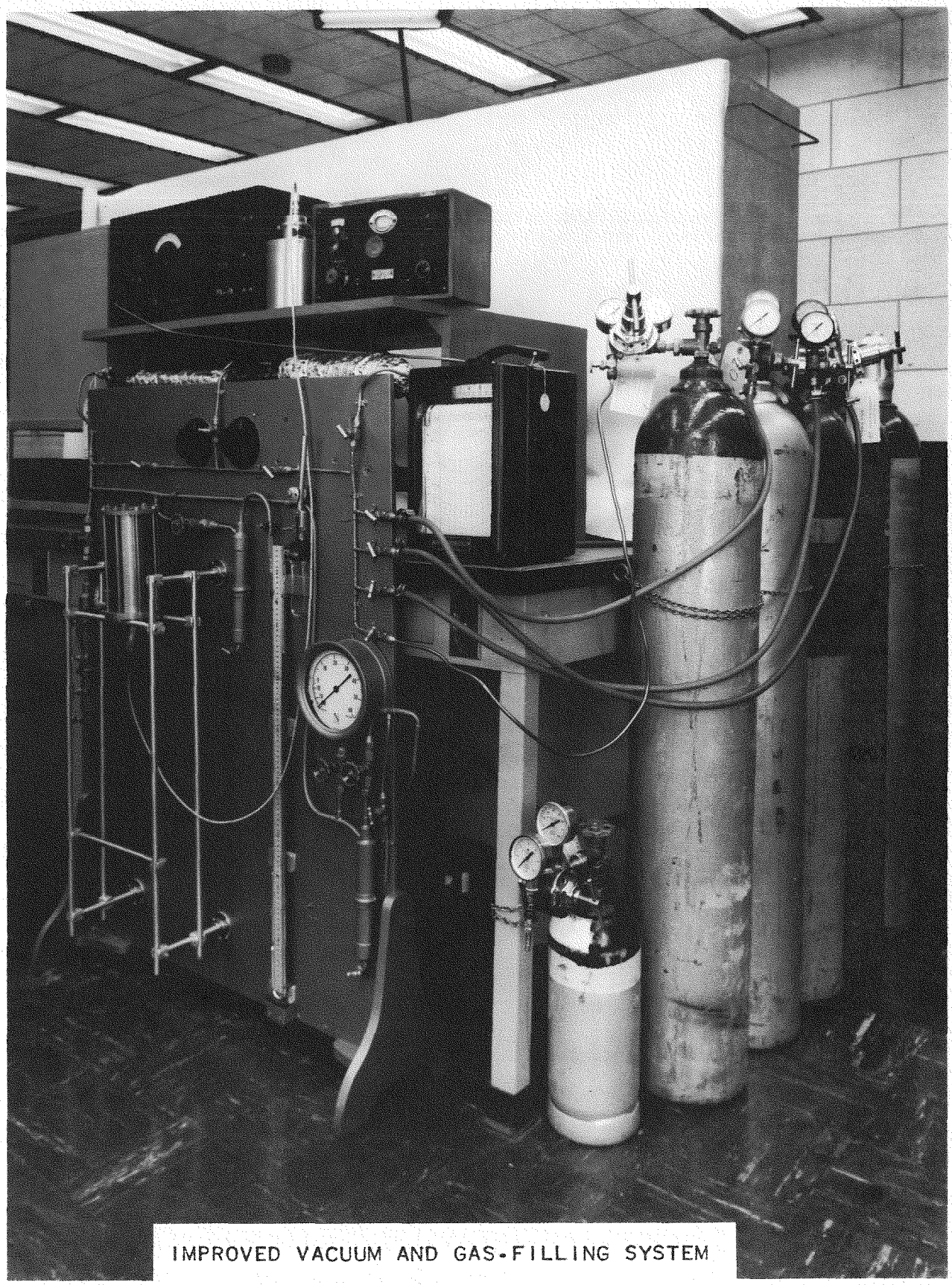
NEOPENTANE GAS PRESSURE vs. CURRENT FOR THE NEUTRON SENSITIVE COAXIAL CELL.



HYDROGEN GAS PRESSURE vs. CURRENT FOR THE NEUTRON SENSITIVE COAXIAL CELL.



ISOBUTANE GAS PRESSURE vs. CURRENT FOR THE NEUTRON SENSITIVE COAXIAL CELL.



IMPROVED VACUUM AND GAS-FILLING SYSTEM

Problem Title - **Neutron Scintillation Counting**

Report By - **R L Shipp, Jr.**

Work Done By - **R. L Shipp, Jr**

INTRODUCTION

The boron-lined proportional chamber (B-wall tube), which is used for most routine neutron counting, is inefficient and requires the use of a large moderator when used to count fast neutrons.

The fast-neutron scintillation counter offers advantages over the B-wall tube for certain applications, perhaps the greatest advantage is in size and weight. A scintillation phosphor, multiplier photo tube and socket occupies a cylindrical volume 3 inches in diameter by 9 inches in length and weighs about 3 pounds The moderator for a 12-inch B-wall tube would be in the order of 20 inches in diameter by 16 inches in length and would weigh about 150 pounds Theoretically the scintillation counter should be more efficient than the B wall tube because of the possibility of providing a larger neutron-sensitive cross section in the scintillation phosphor than is possible on the walls of the B-wall tube[1].

In practice, greater efficiencies have been obtained with the fast-neutron scintillation counter than with B-wall tube for counting the neutrons from polonium-beryllium neutron source with no other gamma present than that of the source The fast-neutron scintillation counter can be used to detect those neutrons which produce pulses that are stronger than those of the highest energy gamma present. Thus the same scintillation counter that was more efficient than the B-wall tube for counting neutrons from a polonium-beryllium source proved to be less efficient when radium gamma had to be discriminated against or when a source of lower energy neutrons was used

The efficiency of the fast-neutron scintillation counter is dependent upon both the energy of the gamma present and the energy of the neutron flux being measured An improvement in gamma discrimination will tend to decrease the energy dependence of the scintillation counter by permitting lower energy neutrons to be detected. The phosphors we have been using apparently convert gamma energy into light more efficiently than they convert neutron energy Phosphors may be found with a better neutron-to-gamma efficiency ratio There is some evidence indicating that the pulses from neutrons have a greater width and slower rise time than pulses from gamma Some arrangements are also being considered whereby resonant neutron capture materials will be combined with fast-neutron phosphors to provide both fast and thermal neutron sensitivities in the same phosphor.

The instrumentation is being improved so that more reliable data can be obtained on the effects of gamma and neutron excitation on pulse shape An anthracene crystal and two terphenyl crystals which have been obtained should be valuable in obtaining comparisons between our results and those reported elsewhere

In the past, a polonium gamma source has been used to determine the polonium gamma threshold This is not too satisfactory because of the action of the alpha particles in the source on light-element contaminants to produce a neutron flux This flux tends to mask the gamma threshold To overcome this a manganese-54 gamma source has been ordered. This source emits a single gamma of 0 84 million electron volts and is not an alpha emitter

DETAILED REPORT

The neutron portion of the combined gamma-neutron counter[2] which was built for the "Y" Section did not operate properly The instrument was designed from data obtained with neutrons from polonium-beryllium source however the flux to be measured by the instrument in practice consisted of neutrons produced by the alpha bombardment of light-element contaminants in polonium These neutrons are apparently less energetic with the result that the efficiency of the counter was too low to properly operate the rate meter An attempt was made to increase the efficiency of the counter by replacing the liquid phosphor with a larger-diameter plastic phosphor This proved unsatisfactory because of excessive light losses in a conical, Lucite, light pipe used to couple the larger phosphor to the multiplier photo tube Further tests with "Y" Section samples disclosed an apparent energy spectrum variation from sample to sample Under these conditions the fast-neutron scintillation counter would have to be made less energy sensitive as well as more efficient before it would be satisfactory for this service. The effects of energy spectrum on efficiency are shown in Figure 1 It seemed impossible to obtain the necessary improvements in the counter within the time limit set by "Y" Section. As a result the rate meter from the scintillation counter was revised to operate from a B-wall tube, and equipment was rearranged under the hood to make room for a large moderator With this arrangement the sample has to be moved between neutron and gamma counts instead of permitting both counts to be made with one placement of the sample.

A linear amplifier, Atomic Instrument Co Model 204-C, was obtained and some tests were run with it to determine the effect of amplifier frequency response on gamma discrimination. The frequency response of the amplifier with different control settings is shown in Figure 2. Gamma and neutron curves are shown in Figure 3 for feed-back control settings of positions 1 and 5. From these two curves it can be seen that with the feed-back control set at position 5, which favors lower frequencies or broader, longer-rise-time pulses, the neutron counting rate at the gamma-discrimination point is considerably higher than with the setting position 1 which favors narrower faster-rise-time pulses This could indicate a difference in shape between neutron and gamma pulses. Some difficulties were experienced with the amplifier during these runs, also the frequency range of the amplifier is not as great as is desired. Modifications in the set up are under way to permit better data to be obtained.

A run was made with a polonium-beryllium neutron source and a polonium gamma source both having the same amount of activity and counted with the same geometry. Two items of interest appear from this curve (Figure 4) Even when the neutron count is extended well into the gamma region, the gamma portion of the count is still small, in the order of a few per cent. At the gamma threshold the neutron counting rate is still increasing exponentially with decreasing pulse height. The energy spectrum of the neutrons from a polonium-beryllium source determined by Foster[3] indicates a peak at 2.75 million electron volts. The passing of such a peak in a counting-rate-versus-pulse-height-discrimination plot should have produced a pronounced decrease in the slope of the curve at energies below that point Since this break in the curve does not even appear at energies below the 0 8 million-electron-volt gamma-discrimination point, it seems apparent that the phosphors are more efficient in converting gamma energy than neutron energy into light If this ratio could be made close to unity,

the fast-neutron scintillation counter would probably be satisfactory for most polonium neutron sources. For satisfactory operation with radium neutron sources a phosphor with a preferential response for neutrons over gamma would be indicated

An effort will be made to determine the relative conversion efficiencies of some of the phosphors for gamma and neutrons

An attempt was made to count the neutron-capture gamma radiation from cadmium with a thallium-activated sodium iodide crystal on the multiplier photo tube. No increase in the counting rate above small variations caused by the instrument were noted with or without the cadmium However the sodium iodide crystal can be used to measure the conversion gamma from the neutron source. Since this gamma is proportional to the neutron flux of a polonium-beryllium source it may provide a satisfactory method of measuring the neutron flux from these sources This gamma is sufficiently high in energy that there is no trouble in discriminating against the pulses from polonium gamma, and probably from radium gamma

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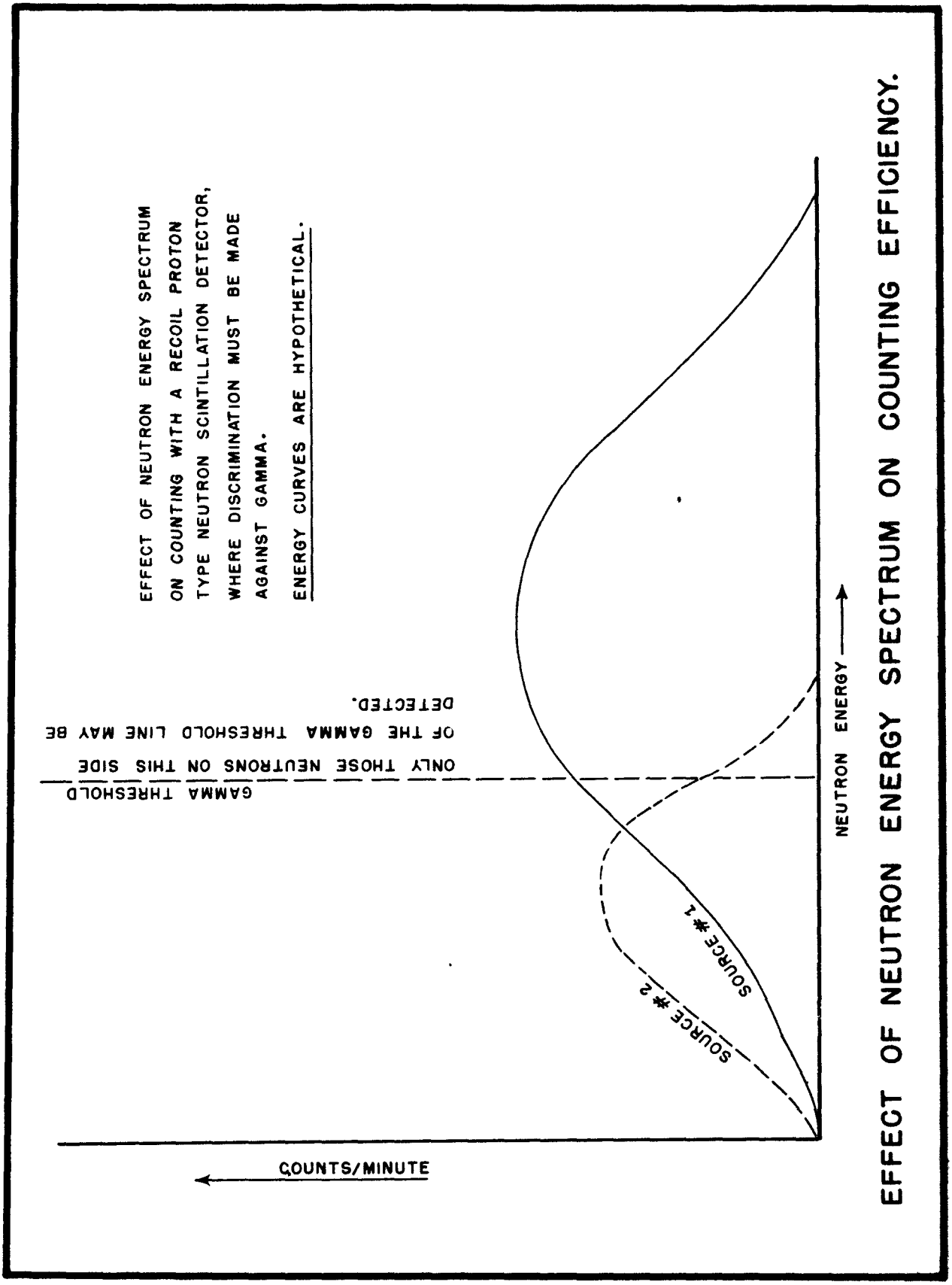
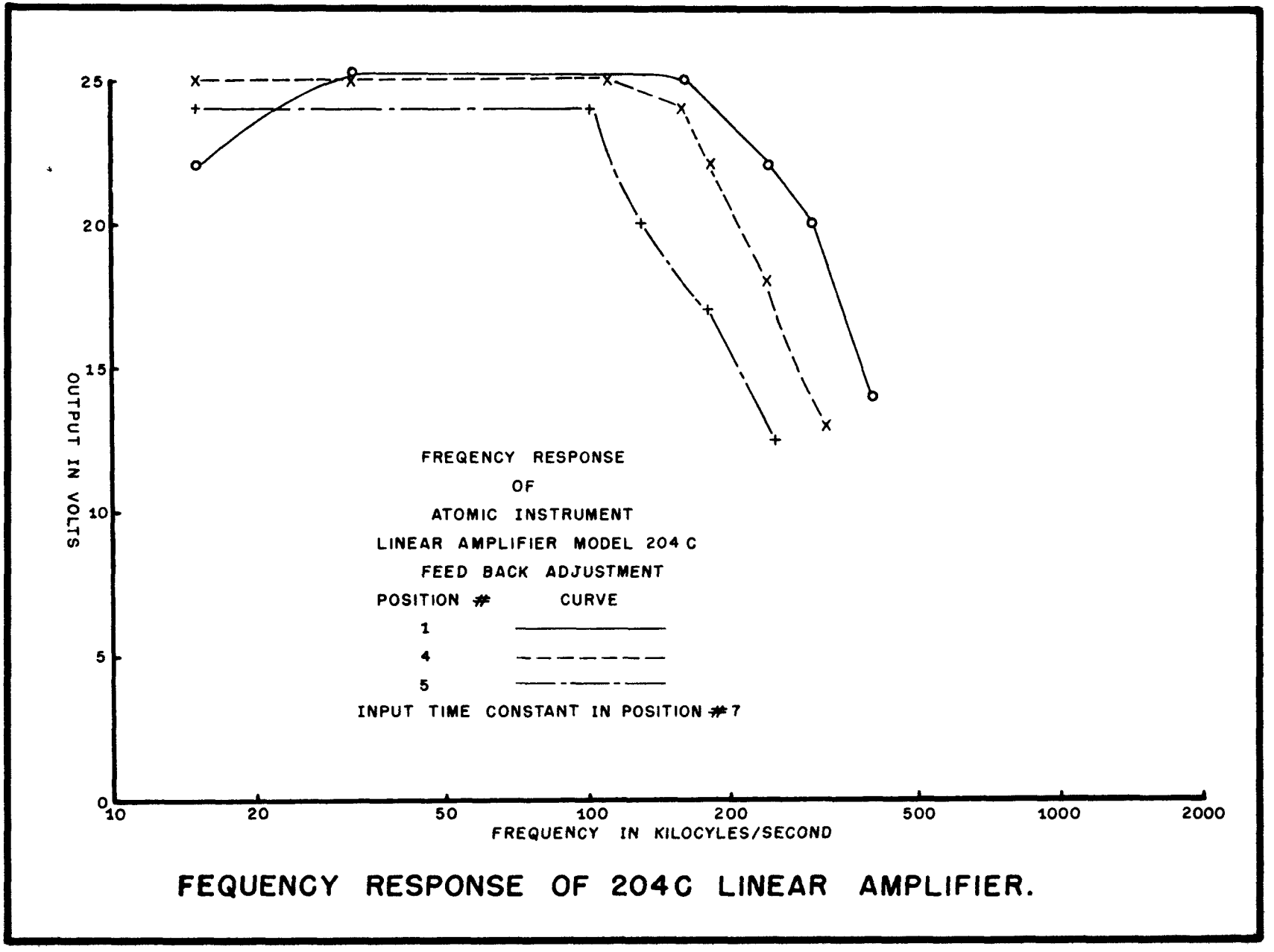
1 Shipp R L Jr Rpt Gen Res MLM-507 p 49 November 20 1950

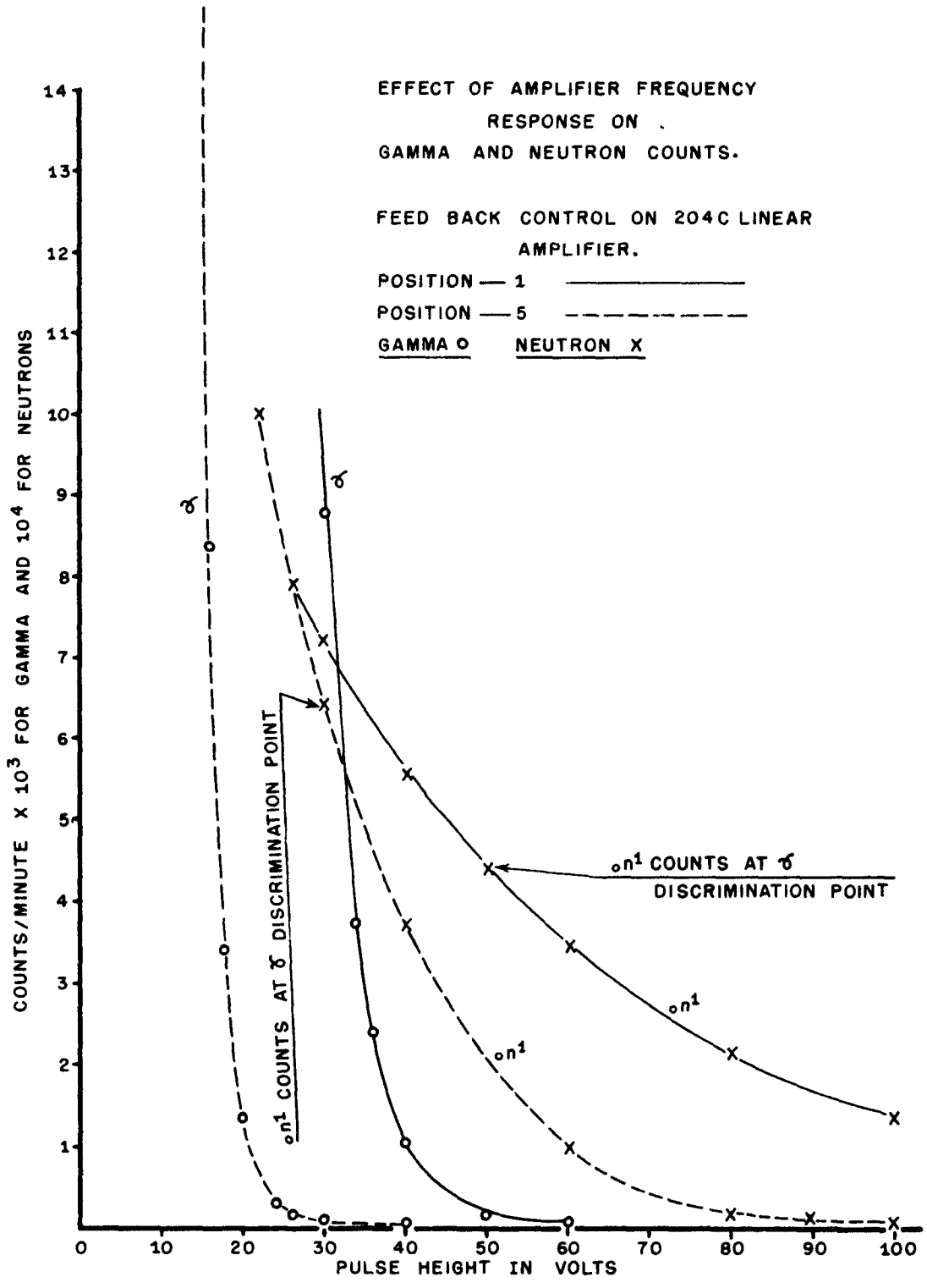
2 Shipp R L Jr Rpt Gen Res MLM 531 p 43, February 13 1951.

2 Foster K W Rpt Gen Res MLM-507 p 39 November 20 1950

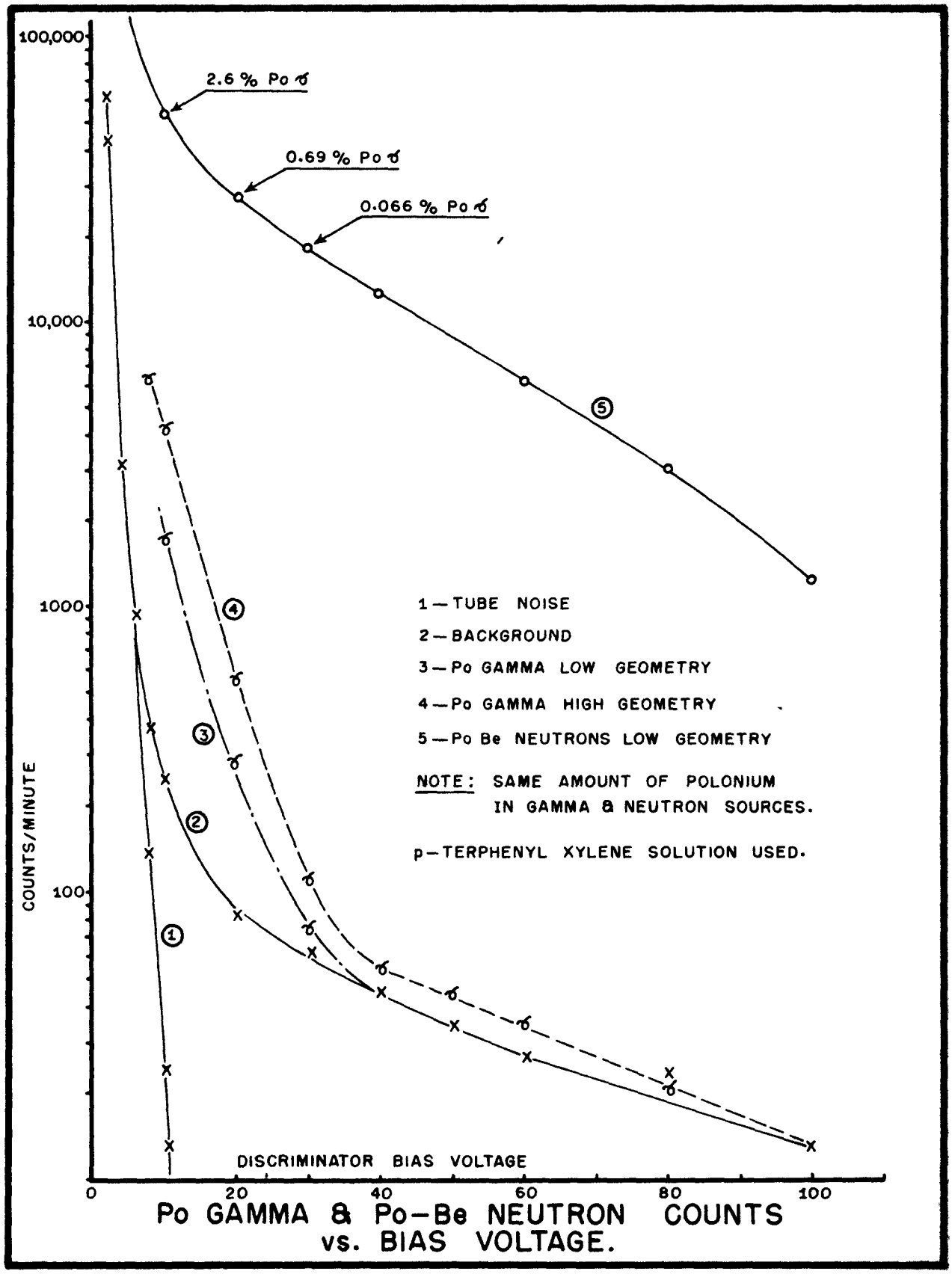

EFFECT OF NEUTRON ENERGY SPECTRUM ON COUNTING EFFICIENCY.
NEUTRON ENERGY
COUNTS/MINUTE
SOURCE #1
SOURCE #2
GAMMA THRESHOLD
ONLY THOSE NEUTRONS ON THIS SIDE OF THE GAMMA THRESHOLD LINE MAY BE DETECTED.
EFFECT OF NEUTRON ENERGY SPECTRUM ON COUNTING WITH A RECOIL PROTON TYPE NEUTRON SCINTILLATION DETECTOR, WHERE DISCRIMINATION MUST BE MADE AGAINST GAMMA.
ENERGY CURVES ARE HYPOTHETICAL.



FEQUENCY RESPONSE OF 204C LINEAR AMPLIFIER.



EFFECT OF FREQUENCY RESPONSE ON NEUTRON COUNTING EFFICIENCY.



Po GAMMA & Po-Be NEUTRON COUNTS vs. BIAS VOLTAGE.

[redacted]

UNCLASSIFIED

Problem Title **Standardization of Neutron Source Production Beryllium Sources**

Report By **W J Schrantz, Jr.**

Work Done By **- M R Hertz and W J Schrantz, Jr.**

INTRODUCTION

For the past three years neutron sources have been prepared by volatilizing the polonium over the beryllium powder Throughout this time many avenues of research have been explored with the hope of producing sources with a higher efficiency Neutron source efficiency was increased about 5 per cent when the process of "shooting" the polonium into the source container was inaugurated[1] Another 7 to 8 per cent increase was noted when sources were prepared from a batch of new powder[2]. The old powder had probably been oxidiz ed inadvertently by the users

The half-thickness studies made last year indicated enough absorption of neutrons by the beryllium-powder and nickel container that another 7 to 8 per cent can be deducted from the theoretical efficiency of 100 per cent[3] This effectively made the top efficiency obtainable between 92 - 93 per cent The sources that are now being produced are in the range of 88 - 93 per cent efficient To achieve more consistent results the purity of the polonium and beryllium powder will have to be improved

DETAILED REPORT

A list of the sources made during the last period is shown in Table I The biggest differential between source efficiencies is accounted for by the curies-to-gram-of-beryllium ratio When this figure is in the range of 5 to 11, the efficiencies of the various sources vary within a range of 5 per cent If the curie-to-gram ratio is 35 as in PB-195 the efficiency decreases about 6 per cent A possible explanation is that the polonium is so highly concentrated on the beryllium powder that there is self-absorption of the alpha particles

REFERENCES

1 Hertz M R Rpt Gen Res . MLM-481 p 77 August 28 1950

2 Hertz M R Rpt Gen Res , MLM 507 p 27-28 November 20, 1950

3 Schrantz W J Rpt Gen. Res , MLM 507 p 33 34 November 20 1950

TABLE I

CHARACTERISTICS OF RECENT SOURCES

Source Number	Curie Value	Grams Beryllium Powder	Neutron Count	Efficiency In Per Cent	Curie-to-Gram Ratio
PB-186	5.38	1.55	1.37×10^7	89.5	3.48
PB-187	10.94	1.0	2.91×10^7	93.3	10.94
PB-188	1.07	1.8	2.78×10^6	91.1	0.60
PB-190	12.5	4.0	3.16×10^7	88.6	3.13
PB-191	1.28	1.5	3.33×10^6	91.5	0.85
PB-193	11.02	1.8	2.80×10^7	89.1	6.12
PB-195	53.61	1.55	1.27×10^8	83.0	34.6

Problem Title - **Standardization of Neutron Source Production - Mock-Fission Sources**

Report By - **R. M. Watrous**

Work Done By - **J. L. Richmond and R. M. Watrous**

INTRODUCTION

As the volatilization of compounds of polonium in the preparation of mock-fission neutron sources was tried unsuccessfully, a further study was made of the evaporation method of preparation Sources were pressed in steel dies to get higher densities and a better method of packaging.

DETAILED REPORT

Several neutron sources were made by evaporating polonium-active hydrofluoric acid solutions from the mock-fission powder in one-mil-platinum evaporation dishes. One evaporation dish was made by forming the platinum over a tapered fluted plug, while the other was formed over a small-sized stopper. The sources were pressed in steel dies to shape and then self-coated with nickel from nickel carbonyl. The first source contained 0.29 gram of powder, 30.68 curies of polonium, and had an efficiency of 49 per cent. The second source contained 0.25 gram of powder, 11.96 curies of polonium, and had an efficiency of 45.3 per cent.

The first source was pressed into the shape of a right cylinder and the second into the shape of an oblate spheroid.

The active, hydrofluoric acid, mock-fission-powder mixture has a tendency to creep up and over the sides of low-form platinum dishes during evaporation which made these sources particularly difficult to make. To overcome this difficulty an evaporation can was fabricated of 10-mil platinum so that it was 2 inches high and 1-1/2 inches in diameter. Two sources were made by evaporating polonium-active hydrofluoric acid from mock-fission powder in this can. To make the third source the dried powder was scraped out of the can into a die and pressed. The fourth source had the powder placed in a one-mil platinum dish and then pressed in a die. In the third source the active powder was coated with nickel directly After coating, the sources were placed in separate brass containers which were sealed with nickel The third source was heated too hot during the sealing process causing some of the powder to ooze out. The source lost in efficiency as a result. The third source contained 0.49 gram of powder, 40.68 curies of polonium, and had an efficiency of 33.5 per cent The fourth source contained approximately 0.50 gram of powder, 31.52 curies of polonium, and had an efficiency of 51.0 per cent.

Problem Title - **Standardization of Neutron Source Production - Boron Neutron Sources**

Report By - **W. J. Schrantz and R. M Watrous**

Work Done By **W. J. Schrantz and R. M. Watrous**

INTRODUCTION

A polonium-boron neutron source was prepared by the evaporation method and placed in a standard nickel container. The source had an unusually high neutron production efficiency An attempt to produce a boron source by volatilization of polonium into a boron-lined container was unsuccessful

DETAILED REPORT

Boron powder (1.4 grams, mesh size - 120 + 140, Run No. D 7616) was placed in a special glass beaker Polonium-active hydrochloric acid solution was evaporated from the powder. The dried powder was transferred to a standard nickel container and the remaining free space filled with inactive boron powder. The container was capped and sealed with nickel The source contained 1.9 grams of boron 29.1 curies of polonium, and had an efficiency of 88 7 per cent.

Another attempt to prepare a boron-polonium source by volatilization has been unsuccessful A possible explanation is that when the source is heated, the polonium is volatilized over the boron powder; however upon cooling, the nickel container cools faster than the nonconducting boron powder, and the polonium condenses on the container walls. This is borne out by monitoring the neutron count during the heating and cooling cycle.

To prevent this from occurring an attempt was made to condense a layer of boron inside a nickel container. Volatilization of boron from a tantalum wire proved unsuccessful because the two elements reacted. An attempt to sinter a layer of boron powder inside the nickel container was successful, so it was used to make a source. Polonium (6.72 curies) was volatilized into the nickel can and boron powder added. The source was sealed by nickel deposition. It was counted and gave an efficiency of 40 per cent. When heated, the source doubled in neutron flux which meant that it was about 80 per cent efficient. Upon cooling the source, the neutron count dropped off to its previous value. Evidently the sintered boron layer was porous enough to allow the polonium to pass through and condense on the container walls. This source was dissolved and the polonium will be recovered.

Problem Title – **Recovery of Waste Solutions**

Report By – **W. J. Schrantz, Jr.**

Work Done By – **W. J. Schrantz, Jr.**

INTRODUCTION

During the fabrication of a neutron source, large volumes of dilute hydrochloric acid containing 2 to 40 curies of polonium are accumulated. High concentration of contaminating ions (iron, nickel, lead, tin, zinc, and beryllium) in this acid prohibits its being handled in the normal manner. These contaminated solutions have been stored in a vault until a recovery program could be initiated.

To eliminate an expensive waste problem, it was decided to attempt a plating operation whereby the waste polonium could be reclaimed.

DETAILED REPORT

A plating apparatus, including electrode holder and stirrer, was designed; and a four unit plating control and power supply were employed. To approximate the pattern of normal polonium plating with regard to kind and normality of solutions, it was necessary to plate the polonium from the large volume of hydrochloric acid and redissolve in 1.5 normal nitric acid. For this initial plating, two dry cells were used as a source of power. The voltage on the plating cell was controlled by a variable resistor. Voltage current measuring devices completed the circuit.

The polonium was plated on 5-mil-thick platinum strips, 7 millimeters wide and 32 millimeters long. At the present time 25 curies have been reclaimed from waste solutions containing about 30 curies. The only required specifications for polonium used in the fabrication of neutron sources are (1) that it can be volatilized at a reasonable temperature and (2) that it is free enough from impurities that the efficiency of the source will not be decreased.

Part of the recovered polonium was used to make a polonium-beryllium neutron source (WS-29). Specification No. 1 was verified when 10 curies were volatilized into a nickel container with comparative ease. Specification No. 2 was verified when a 10.96-curie source gave a neutron flux of 2.70×10^7, for an efficiency of 90.6 per cent.

Problem Title - **Radiation Chemistry**

Report By - **P F Dismore**

Work Done By - **P. F. Dismore**

INTRODUCTION

Whenever solutions of radioactive materials are used, there is always decomposition of the solvent; and since the work in this laboratory does involve aqueous solutions of alpha emitters, it was thought advisable to investigate the radiolysis of water by alpha radiation. To accomplish this goal, alpha sources must be prepared to meet rigorous specifications, and the total energy emitted by the sources must be measured

DETAILED REPORT

Because of the press of other work, the counting room was unable to provide personnel to operate the long-tube Logac This problem of operating the counter was solved by moving the scaler unit into the "R" Building so that the instrument could be operated by one man After the move was made, it was found that Source 51-5 did not give the expected counting rate By decaying the activity evaluated from results obtained two months previously, the expected counting rate was found to be 236,000 counts per minute while the observed counting rate was 61,322 counts per minute The amount of polonium remaining in the sample was determined by calorimetry The expected calorimetric value was 0 6389 curies and the source was found to contain 0 6380 curies. These data indicated that there was no loss of activity but that the effective thickness of the alpha-transparent window must have increased thus causing more of the alpha particles to be absorbed in the window. Inspection of the source showed a change in the color of the tantalum window directly above the active deposit

In some cases, even though no activity could be wiped from the source, the acetone used to rinse the source became very contaminated A few sources, however, were unaffected by this treatment It is suggested that sources be tested for tightness by letting them stand in acetone for twenty-four hours If the acetone is not contaminated, the source can be considered satisfactory

Because of this contamination trouble with the present type of alpha source, it was deemed advantageous to try to find an improved method of source preparation It was thought that a welding process would give a tighter seal than the nickel carbonyl deposit A pressure weld was attempted and showed some promise of success It was found that if gold was heated to about 800°C under pressure, it would serve as a welding material An attempt was made to use gold to weld a 0 001-inch tantalum window to a gold-plated nickel base by heating to 800°C After the assembly cooled, it was observed to be partially welded but the tantalum had been badly oxidized The experiment was repeated in a vacuum by heating to about 900°C for 3 hours After this treatment, the tantalum was still ductile and most of the tantalum was welded; but some of its surface did not weld

These early "cold" runs indicate that this method of source preparation may be an improvement over the present method; but there is still considerable developmental work to be done