[redacted]

ORNL 864
Series A 9
Progress Report

AEC RESEARCH AND DEVELOPMENT REPORT

MARTIN MARIETTA ENERGY SYSTEMS LIBRARIES
3 4456 0050901 9

PHYSICS DIVISION

QUARTERLY PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 20, 1950

Classification Cancelled
Or Changed To
By Authority Of AEC 9-13-71
By O. Goldberg Date 11-5-71

LABORATORY RECORDS
1954

CENTRAL RESEARCH LIBRARY
DOCUMENT COLLECTION

LIBRARY LOAN COPY

DO NOT TRANSFER TO ANOTHER PERSON

If you wish someone else to see this document, send in name with document and the library will arrange a loan.

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
CARBIDE AND CARBON CHEMICALS DIVISION
UNION CARBIDE AND CARBON CORPORATION
POST OFFICE BOX P
OAK RIDGE, TENNESSEE

CLASSIFICATION CANCELLED

David R. Hamrin ORNL CO 6/26/2013
ADD Signature Date
Single review of CCRP-declassified documents was authorized by DOE Office of Declassification memo of August 22, 1994.

[redacted]

[redacted]

ORNL 864
Progress

This document consists of 24 pages.
Copy 9 of 105 . Series A

Contract No. W-7405, eng 26

PHYSICS DIVISION

A. H. Snell, Director
E. O. Wollan, Associate Director

QUARTERLY PROGRESS REPORT
for Period Ending September 20, 1950

DATE ISSUED: JAN 8 1951

OAK RIDGE NATIONAL LABORATORY
operated by
CARBIDE AND CARBON CHEMICALS DIVISION
Union Carbide and Carbon Corporation
Post Office Box P
Oak Ridge, Tennessee

[redacted]

MARTIN MARIETTA ENERGY SYSTEMS LIBRARIES
3 4456 0050901 9

[redacted]

ORNL-864
Progress Report

INTERNAL DISTRIBUTION

1 C. T. Felbeck (C&CCD)
2-3 706-A Library
4 706-[illegible] Library
5 Biology Library
6 Health Physics Library
7 Metallurgy Library
8-9 Training School Library
10-13 Central Files
14 C. E. Center
15 C. E. Larson
16 W. B. Humes (K-25)
17 W. D. Lavers (Y-12)
18 A. M. Weinberg
19 J. A. Swartout
20 E. D. Shipley
21 E. J. Murphy
22 F. C. VondrLage
23 A. H. Snell
24 E. H. Taylor
25 A. Hollaender
26 K. Z. Morgan
27 F. L. Steahly
28 M. T. Kelley
29 W. H. Pennington
30 E. O. Wollan
31 D. W. Cardwell
32 A. S. Householder
33 L. D. Roberts
34 J. A. Lane
35 M. M. Mann
36 R. N. Lyon
37 W. C. Koehler
38 W. K. Ergen
39 E. P. Blizard
40 G. E. Boyd
41 Lewis Nelson
42 R. W. Stoughton
43 C. E. Winters
44 W. H. Jordan
45 E. C. Campbell
46 D. S. Billington
47 M. A. Bredig
48 R. S. Livington
49 C. P. Keim
50 G. H. Clewett
51 C. D. Susano
52-57 Central Files (OP)

EXTERNAL DISTRIBUTION

58-65 Argonne National Laboratory
66-68 Atomic Energy Commission, Washington
69-72 Brookhaven National Laboratory
73-74 Knolls Atomic Power Laboratory
75-76 General Electric Company, Richland
77-80 Los Alamos
81-82 New York Operations Office
83 Patent Branch, Washington
84-86 NEPA Project
87-101 Technical Information Branch, ORE
102-105 University of California Radiation Laboratory

[redacted]

[redacted]

TABLE OF CONTENTS

INTRODUCTION AND SUMMARY 5

RADIATION DAMAGE 6

- Irradiation Effects in Beryllium Metal 6
- Handling and Measuring Equipment for Radiation-damage Tests on HEW Uranium-Aluminum Alloy Fuel Slugs 6
- Thermal Conductivity of Uranium-bearing Materials 8
- Irradiation Creep Experiment 14

RESONANCE ABSORPTION OF NEUTRONS BY U^{238} CYLINDERS 17

GAMMA RAYS ASSOCIATED WITH NEUTRON BOMBARDMENT OF U^{235} 19

SHIELDING PROGRAM 21

- New Bulk Shield Testing Facility 21

CONTROLS 22

- MTR Controls 22
- Control System for Bulk Shielding Facility Reactor 22

[redacted]

[redacted]

LIST OF FIGURES

Fig. 1	Special Carrier for Fuel Slugs	7
Fig. 2	Slug Stripper	9
Fig. 3	Gage for Measuring Diameter of Slugs	10
Fig. 4	Axial Heat-flow Thermal-conductivity Apparatus	11
Fig. 5	Behavior of Beryllium-Uranium Sample in Axial Thermal-conductivity Apparatus	13
Fig. 6	Effective Resonance Integral of U^{238}	18

[redacted]

[redacted]

INTRODUCTION AND SUMMARY

This report covers classified work for the interval June 25 to September 20, 1950. The unclassified section of the Quarterly Report appears separately (ORNL-865).

Hanford irradiations of Be metal show no changes in electrical resistivity or density within the errors of measurements, 0.5% and 0.05%, respectively. New handling equipment for Hanford irradiation of fuel slugs has been constructed. Irradiation of uranium-bearing materials Be-U and Zr-U is continuing, and no change in behavior of the samples since the previous report has been observed. Temperature fluctuations during irradiation still constitute a problem, and steps are being taken to reduce them. The construction and testing of creep-measuring equipment previously reported on is not yet complete.

An experiment to measure the resonance absorption of neutrons in U^{238} cylinders which was begun by one of our summer visitors last year has been continued and essentially completed this summer with assistance from one of our theoretical physicists. The results are of special importance for the design of reactors with cylindrical fuel elements.

In connection with a cloud-chamber study of capture γ rays, some measurements were also obtained on the γ rays from neutrons on U^{235}. The spectral distribution data show a heavy preponderance of γ's toward the lowest measureable energy, 1 Mev.

The work of the Shielding Group has been reported in detail in the ANP Quarterly Report (ORNL-858) since most of the efforts of the past quarter have been directed toward this program. A brief summary paragraph is included here, and there is a discussion of the control problems connected with the Bulk Shielding Facility. Work on the MTR controls is also briefly discussed.

[redacted]

RADIATION DAMAGE

Irradiation Effects in Beryllium Metal (L. C. Templeton). Density and electrical resistivity measurements were carried out on specimens of forged metal, extruded cast, extruded turnings, and QT metal that had been exposed at Hanford for a period of 267 effective days (nvt = 1.73 to 1.86 × 10^{20}). They are part of the cooperative project on radiation effects in beryllium, in which ORNL, Battelle Memorial Institute, MIT, and the Bureau of Standards are cooperating. For results on specimens irradiated for 30 and 150 days see ORNL-480, *p*. 17 (September, 1949). The latest measurements confirm the previous ones in showing no changes in electrical resistivity greater than 0.5%. This is the reproducibility of the present measurements, which for as yet unknown reasons was somewhat lower than might be expected.

The density of the specimens was found to be unchanged within the limits of precision, *i.e.*, 0.05%.

Handling and Measuring Equipment for Radiation-damage Tests on HEW Uranium-Aluminum Alloy Fuel Slugs (S. E. Dismuke). Handling and measuring equipment was constructed which is to be used with a special assembly of fuel slugs fabricated by members of the Metallurgy Division and irradiated in the Chalk River reactor (Central Files document No. 50-6-147 by W. D. Manly).

Owing to the great length of the assembly containing 10 fuel slugs (8 in. each), a special carrier was constructed for its return to Oak Ridge after it had been irradiated at Chalk River. The carrier is a lead-filled pipe 9 ft 4 in. long with an outside diameter of 18 in. A 5-ft middle section is, in addition, wrapped with a 1-in.-thick lead sheet. The inside diameter is 2 in., and the recesses at the ends for plugs are 4 in. in diameter and 8¾ in. long. The inner tube is of stainless steel with water connections of 1-in. pipe to the outside of the carrier. Water is circulated by thermal convection through the carrier, a radiator, and a water tank. A counterbalance is provided for the end plugs, to aid in handling under water. There is also a hollow cone that slips into the plug hole and serves as a guide when inserting the fuel rod (Fig. 1).

The design was made in cooperation with C. D. Cagle, F. H. Greene, J. R. Gissel, and members of the Engineering Design Branch of the Engineering Department.

PHOTO 6648 [redacted]

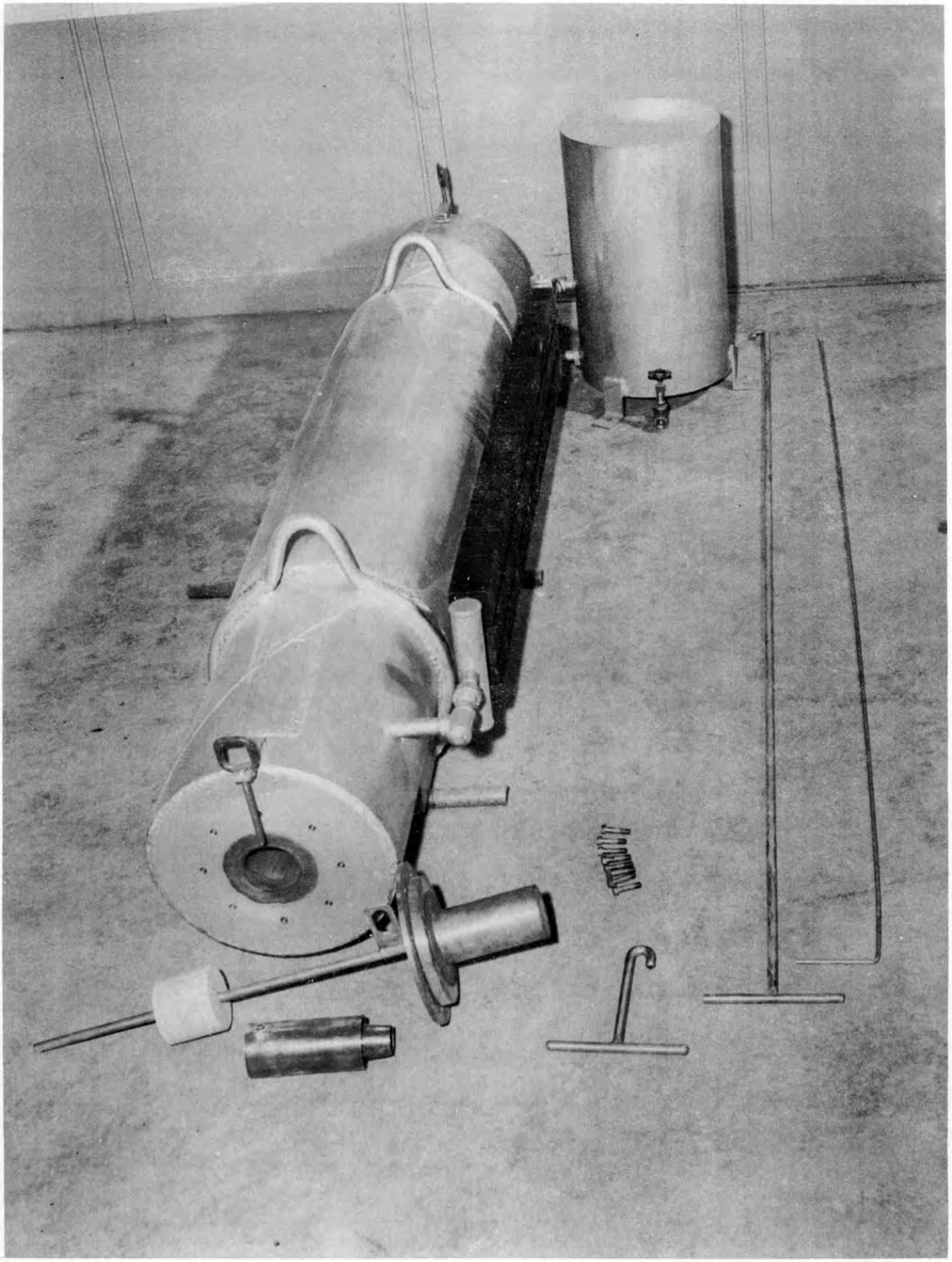


FIG. I

The fuel slugs whose dimensions are to be measured are encased in a 2S-aluminum tube that has been drawn around them. To remove this casing, the assembly, while under 8 ft of water, will be cut into sections 9in. in length. These sections will then individually be put through a slug stripper (Fig. 2) which consists of a brass block mounted 1 ft above a massive base of iron and a long screw mounted on a yoke above the block. The screw is used to push the slug through the block, which consists of a short guide section, then through two rotary cutters with wedges mounted directly below them. The wedges spread the aluminum sheath so that the sample can be readily removed.

The design was made in cooperation with F. H. Greene.

The gage for remotely measuring the diameters of the slugs is a block 1 in. wide with a V-shaped cutout (Fig. 3). A micrometer head is located near the bottom of the V. The micrometer head is insulated from the legs of the V so that contact of the micrometer and slug may be determined electrically. A 10-in. pipe holds the gage. A rod inside permits adjusting the micrometer.

The design was made in cooperation with M. A. Bredig and R. H. Ward.

The gage for remotely measuring the length of the slugs is still under construction.

Thermal Conductivity of Uranium-bearing Materials* (R. G. Berggren, J. K. Redman, and W. Primak**). The irradiation studies of the Be-U and the Zr-U samples described previously[1] are continuing. The behavior of these samples has not changed since the last report; after four months of irradiation there is no evidence of a change in their thermal conductivity. Because of the fluctuations in the thermocouple readings described, a change of about 20% would be required before it could be noticed.

The design of the axial thermal-conductivity apparatus[2] was completed. It was constructed as shown in Fig. 4 and assembled with a Be-U sample *a*. A new feature, the copper shields *b*, was introduced to help decrease the thermal

* Sponsored by Argonne National Laboratory.

** Consultant, Argonne National Laboratory.

(1) Berggren, R. G., Redman, J., and Primak, W., "Thermal Conductivity of Uranium-bearing Materials," *Physics Division Quarterly Progress Report for Period Ending June 15, 1950*, ORNL-781, 7 (August 10, 1950).

(2) *Ibid.*

PHOTO 6646

[redacted]

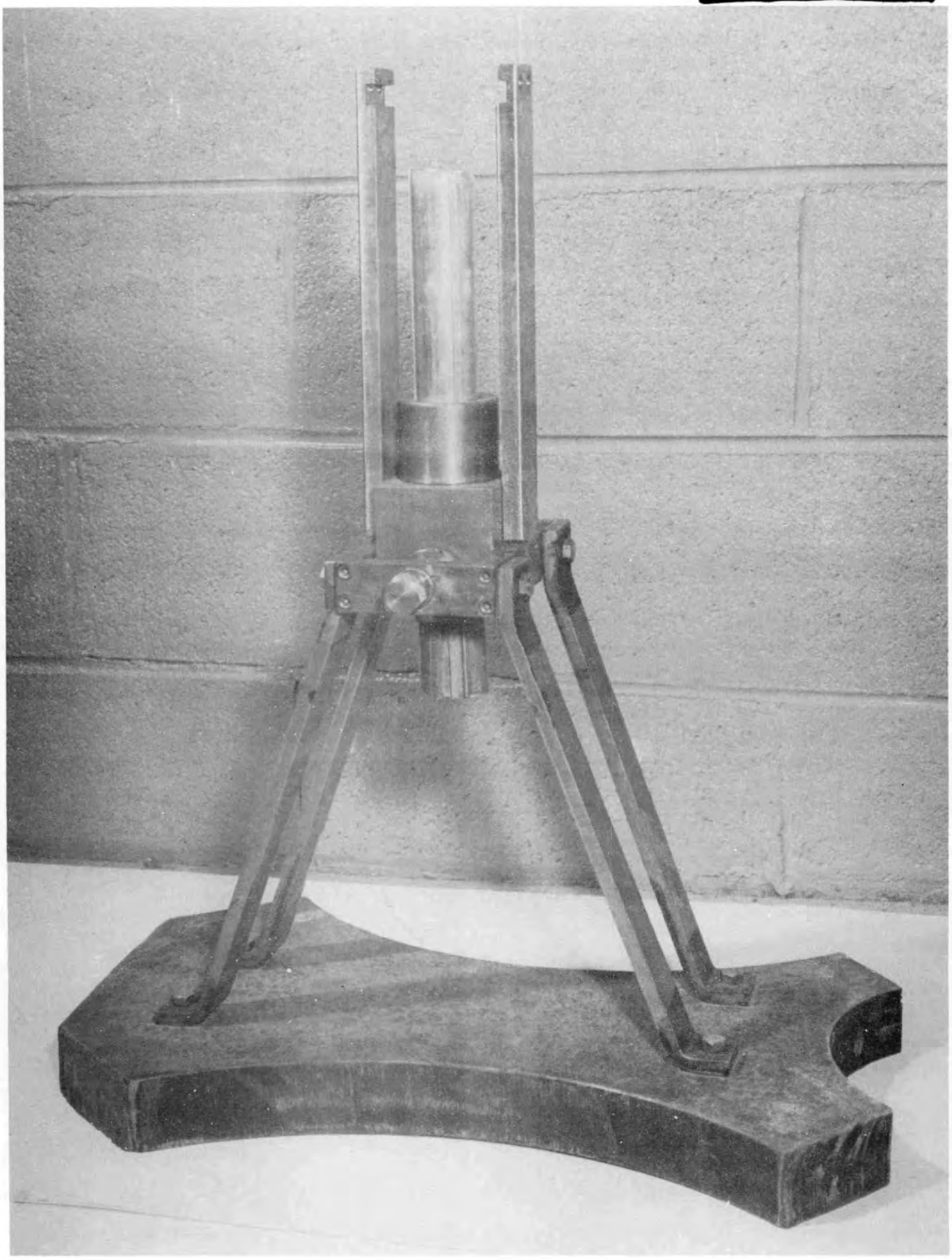


FIG. 2

PHOTO 6647

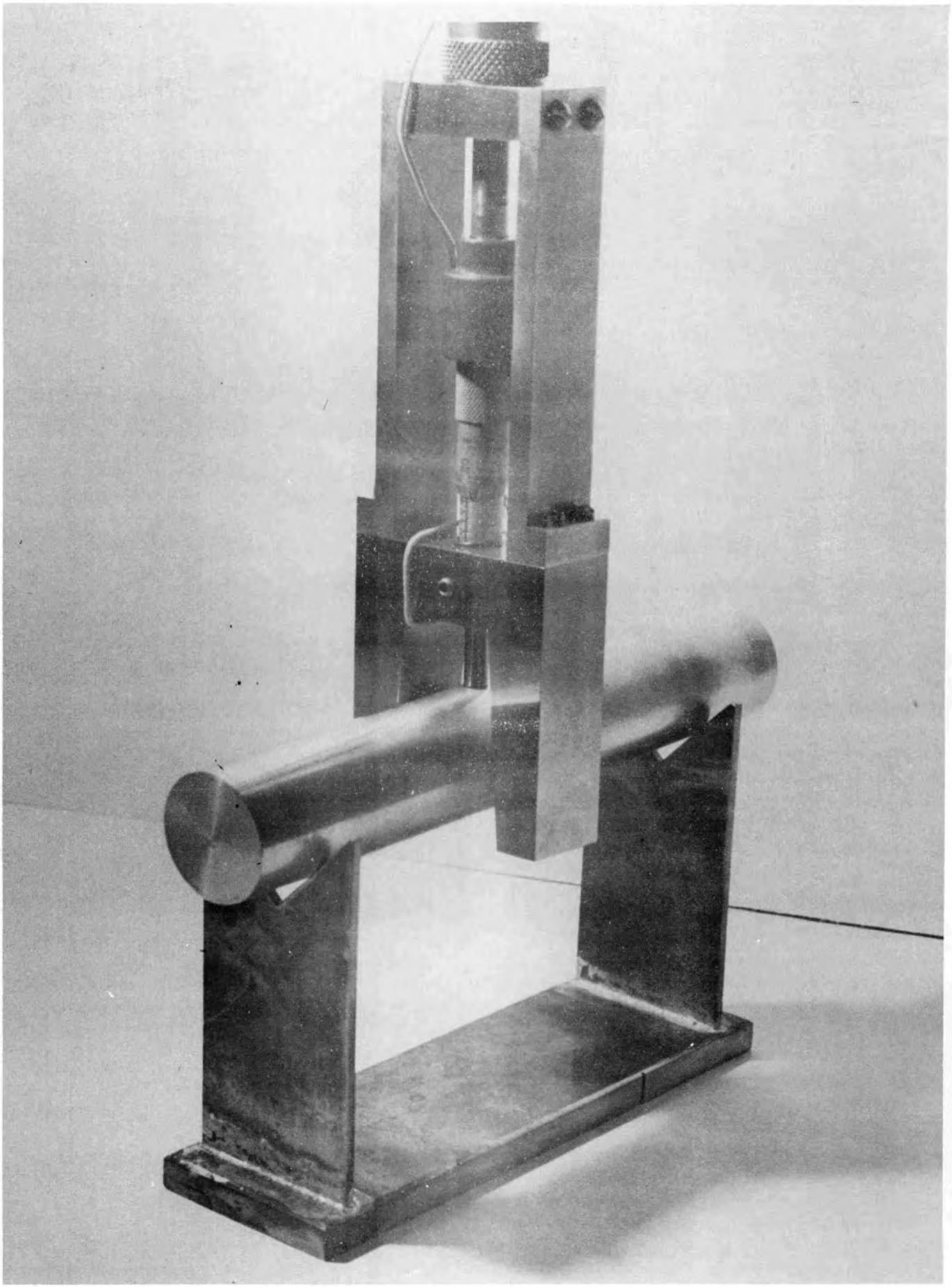


FIG. 3

[redacted]

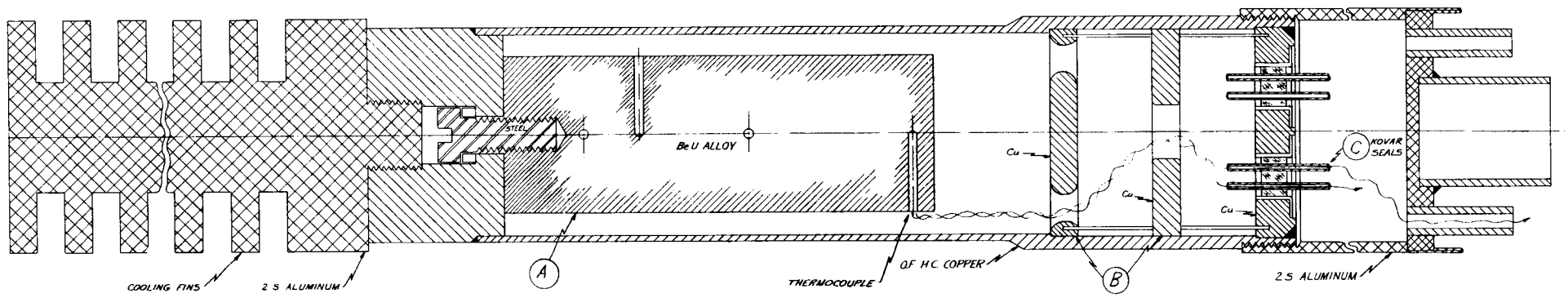


Fig. 4
AXIAL HEAT FLOW THERMAL
CONDUCTIVITY APPARATUS

gradient across the Kovar seals *c*, previously shown[3] to be a serious source of spurious emf's. This sample was inserted into the X-10 reactor and ΔT's of about 40°C were obtained. An irregular ΔT curve was obtained, a portion of which is shown in Fig. 5. It is similar to the curves shown by Hunter[4] and to the curve described[5] for the Zr-U specimen.

The causes of these fluctuations have not yet been determined. The fluctuations observed in the new Be-U sample are clearly greater than any possible spurious emf's. Spurious emf's and faulty thermocouple readings would not be any larger than the smallest observed fluctuations in any sample. To check the effect of loading neighboring holes, the Zr-U specimen was watched on several occasions when strong absorbers were placed in such holes, but no effect was observed. It might be concluded that the fluctuations are caused by alterations in the neutron flux and/or flux spectrum in the neighborhood of the sample in a manner different from that indicated by the pile controlling devices (located in the shield). This conclusion is being investigated experimentally.

The carbon sample described previously[6] was inserted into an intermediate-temperature thermal-conductivity apparatus[7] and placed in the X-10 reactor. The axial (longitudinal) thermal conductivity of this sample was measured after impregnation as described previously[8] and found to be 0.034 ± 0.001 cal/cm^2 (°C/cm) sec. During the first month of operation no change in thermal conductivity could be observed. For a graphite sample the thermal conductivity would have been expected to drop to half its initial value in about two and one-half weeks.

Two possible methods of checking the apparent variation in the flux at the sample are being considered. The first consists in placing an electrical heater on the sample and determining the thermal conductivity from the temperature change produced by introducing a known amount of heat electrically.

(3) Berggren, R. G., *et al.*, *op. cit.* (ORNL-781, *p.* 7).

(4) Hunter, L. P., "Thermal Conductivity of Uranium-bearing Material Under Irradiation at High Temperatures," *J. Metallurgy and Ceramics*, TID-66, No. 2, *p.* 49 (January, 1949).

(5) Berggren, R. G., *et al.*, *op. cit.* (ORNL-781, *p.* 7).

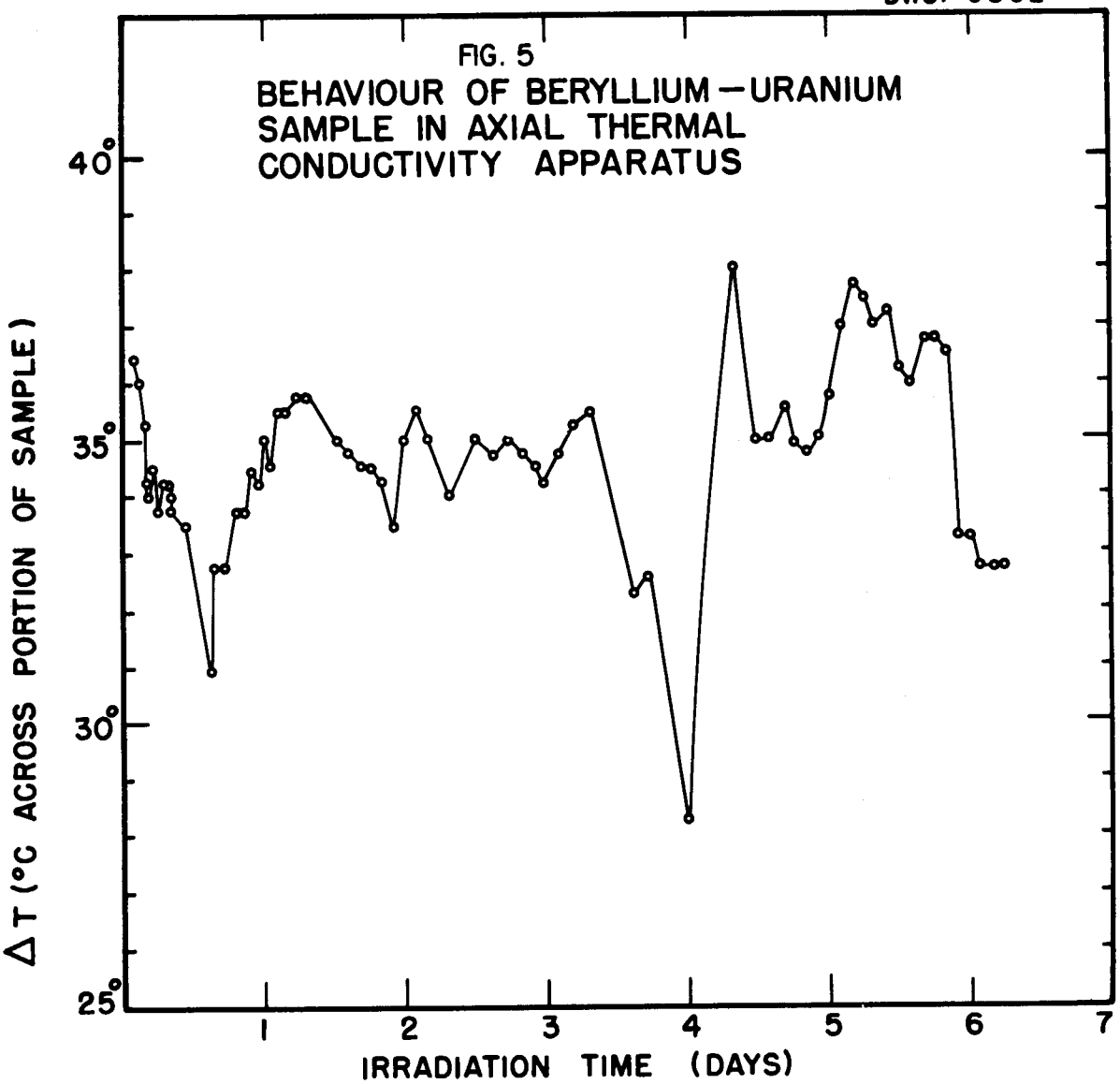
(6) Berggren, R. G., Kincaid, J. M., and Primak, W., "Thermal Conductivity of Uranium-bearing Materials," *Physics Division Quarterly Progress Report for Period Ending March 15, 1950*, ORNL-693, 30 (May 18, 1950).

(7) *Ibid.*, *p.* 37n.

(8) *Ibid.*, *p.* 30.

[redacted]

DWG. 9802



This would also permit a check on the dosage. The method seems feasible at X-10, but at Hanford it would probably be necessary to use a heater of higher wattage per volume than could be built. Alternatively, the temperature drop across the sample could be compared with that developed by a fission heater in a sample whose thermal conductivity was known to remain unchanged. It is felt that air fills this requirement, but it is intended to incorporate an electrical heater to permit regular calibration. The low conductivity of the gas permits the use of a small electrical heater. It is estimated that 1 watt for 20 cm^2 would give a suitable temperature difference. In the design currently being constructed the electrical heater will be built in a manner similar to that used by one of the authors in another application.(9) Nichrome wire will be wound on a mica sheet and placed between two mica sheets. Sheets of U^{235} alloy will be placed on either side of the mica, and the whole pressed flat in an aluminum case. Heating other than in the fission heater should be slight. It is intended to mount this heater unit (about ¾ in. by 1½ in.) in a slot in a bar of aluminum with 4 to 5 mm clearance around it and to measure the temperature difference between the heater case and the aluminum bar. This device should work equally well at HEW if the appropriate concentration of U^{235} alloy is used.

Design of equipment for measuring changes in the thermal conductivity of Zr-U alloy on irradiation in HEW reactors(10) is continuing.

The authors are indebted to Chester Ellis for assistance in assembly of equipment.

Irradiation Creep Experiment* (W. E. Brundage, A. S. Olson, and W. Primak**). The construction and testing of the creep equipment discussed previously(11) is continuing.

1. Temperature Control. The creep equipment with a hollow tube replacing the specimen was mounted in the furnace described.(12) The furnace was

* Sponsored by Argonne National Laboratory.

** Consultant, Argonne National Laboratory.

(9) Primak, W., and Quarterman, L., "Determination of the Stored Energy in Graphite from the Heat of Reaction with Potassium," *Argonne National Laboratory Summary Report for January, February, and March, 1948,* ANL-4204, 27 (Dec. 20, 1948).

(10) Berggren, R. G., Redman, J., and Primak, W., "Thermal Conductivity of Uranium-bearing Materials," *Physics Division Quarterly Progress Report for Period Ending June 15, 1950,* ORNL-781, 7 (August 10, 1950).

(11) *Ibid., p.* 10.

(12) *Ibid.*

regulated for a temperature of 235°C by means of a thermocouple mounted at the center of the specimen. The potentiometer circuit consisted of a Rubicon type S potentiometer used with a Rubicon No. 3501 galvanometer. The light beam of the galvanometer was focused on a 929 photocell used with the thyratron circuit previously described.[13] The current for the potentiometer was obtained from three lead storage batteries connected in parallel and placed in a constant-temperature box, regulated with a mercury thermoregulator to ½°C. The cold junction was placed in a regulated oil bath. During a 50-hr test, temperature fluctuations at one point within the specimen (center) were found to be less than 0.1°C when corrected for the slow constant decay of the lead storage cells. The temperature was constant along the specimen to within ½°C, as shown by probing the specimen in the manner previously described.[14] This temperature control is considered adequate for the tests. However, some improvements in performance are expected when the creep test is set up since it is intended to (*a*) place the potentiometers in a constant-temperature box, (*b*) improve the behavior of the oil bath in which the cold junctions are mounted, and (*c*) balance the heating coils of the furnace more carefully.

2. *Loading Mechanism.* The two loading mechanisms previously mentioned[15] have been constructed. The ball-bearing pulley was improved by the use of a better bearing. The starting friction (Table I) seems well within the

TABLE I

Load on pulley (lb)	132	245	361
Starting friction (g)	<30	<40	<65

limits previously set.[16] The second arrangement is a pulley mounted on knife-edges. A 5-to-1 mechanical advantage is obtained by means of the wheel-and-axle principle, thus permitting the use of smaller weights. Its per-

(13) Brundage, W. E., and Primak, W., "Irradiation Creep Experiment," *Physics Division Quarterly Report for Period Ending March 15, 1950*, ORNL-693, 34 (May 18, 1950).

(14) Berggren, R. G., *et al.*, *op. cit.* (ORNL-781, *p.* 10).

(15) *Ibid.*

(16) Brundage, W. E., and Primak, W., *op. cit.* (ORNL-693, *p.* 34).

formance has not yet been tested. In both mechanisms steel tape will pass over the pulleys, and the load will be transmitted to the specimen by means of thin steel rods.

3. *Extensometer.* The extensometer arrangement previously described[17] was tested. The core of the linear differential transformer was clamped, and the oscillator and amplifier were permitted to operate undisturbed. Using the most sensitive scale of the amplifier, the record made by the Brown recorder fluctuated about 3% of the chart width over most of a two-week test period. Occasional larger fluctuations occurred which have not been explained and which are being investigated. A core displacement of 0.015 in. caused a pen displacement over the full chart width. The instrument was thus capable of reading 0.45 mil if it could be made to operate reliably. Some improvement in performance will be necessary.

4. *Creep Experiment.* Equipment for a creep experiment is being assembled for operation in the laboratory, using the components described above. A 4-in. zirconium specimen fabricated for an earlier type of creep apparatus[18] was adapted to the present equipment. The apparatus is being mounted on a specially constructed test bench which will permit the use of the dead-weight loading devices now being tested for the pile setup.

(17) Segaser, C. L., Stilson, C. E., and Morgan, J. G., "Irradiation Creep Experiment," *Physics Division Quarterly Report for Period Ending June 25, 1949*, ORNL-365, 15 (July 27, 1949).

(18) The new design of the wire model apparatus mentioned previously (ORNL-480, *p.* 22) has not been described in detail. It was a modification of similar apparatus designed by C. Segaser earlier in the work. The new apparatus has improved chucking arrangements and improved pressure seals.

RESONANCE ABSORPTION OF NEUTRONS BY U^{238} CYLINDERS

J. R. Risser and G. B. Arfken, Jr.

Previous measurements of the effective resonance integral for U^{238} have been subject to possible errors owing to the presence of U^{235} and to the use of cyclotron-produced neutrons rather than the normal pile flux. Also, previous measurements on metal have been limited to relatively small sizes. To obtain more accurate data for uranium cylinders in sizes of interest in pile design, the effective resonance integrals have been measured for six cylinders, ranging from 5/8 in. to 3 in. in diameter. Calibration of the data in absolute units is not complete. Preliminary calibration confirms roughly the extrapolation of previous data and shows clearly the depression due to the self-shielding of the nonresonance neutrons.

Natural uranium cylinders were employed. Each cylinder was cut and milled to receive a depleted uranium foil (1 part of U^{235} in 30,000). The foils, shaped like a sector of a disk, gave representative samples of the volume of the cylinder. To reduce leakage of resonance neutrons past the surface, the foils were fitted in place with the aid of a moderate-power microscope. To further minimize this possible error and to minimize the contamination caused by fission-product recoils from the cylinder, the foils were made 2½ mils thick.

Each experiment consisted of a 12-min exposure in the $1/E$ spectrum of the X-10 pile, the β's from the decay of the resulting U^{239} being counted with a proportional counter.

The neutron flux at the surface of the cylinders was monitored by thin indium foils. To eliminate inequalities in shielding by the cylinders of varying size, the monitors were backed by thick indium foils. All cylinders and monitors were shielded with cadmium.

The calibration in barns is being carried out by a series of experiments on thin surface foils and on foils shielded by various thicknesses of uranium. The data for the cylinders (in relative units) are plotted in Fig. 6 Each point represents up to five runs with a variation of less than 1% from the mean. Upon completion of the calibration a formal report will be issued.

[redacted]

DWG. 9800

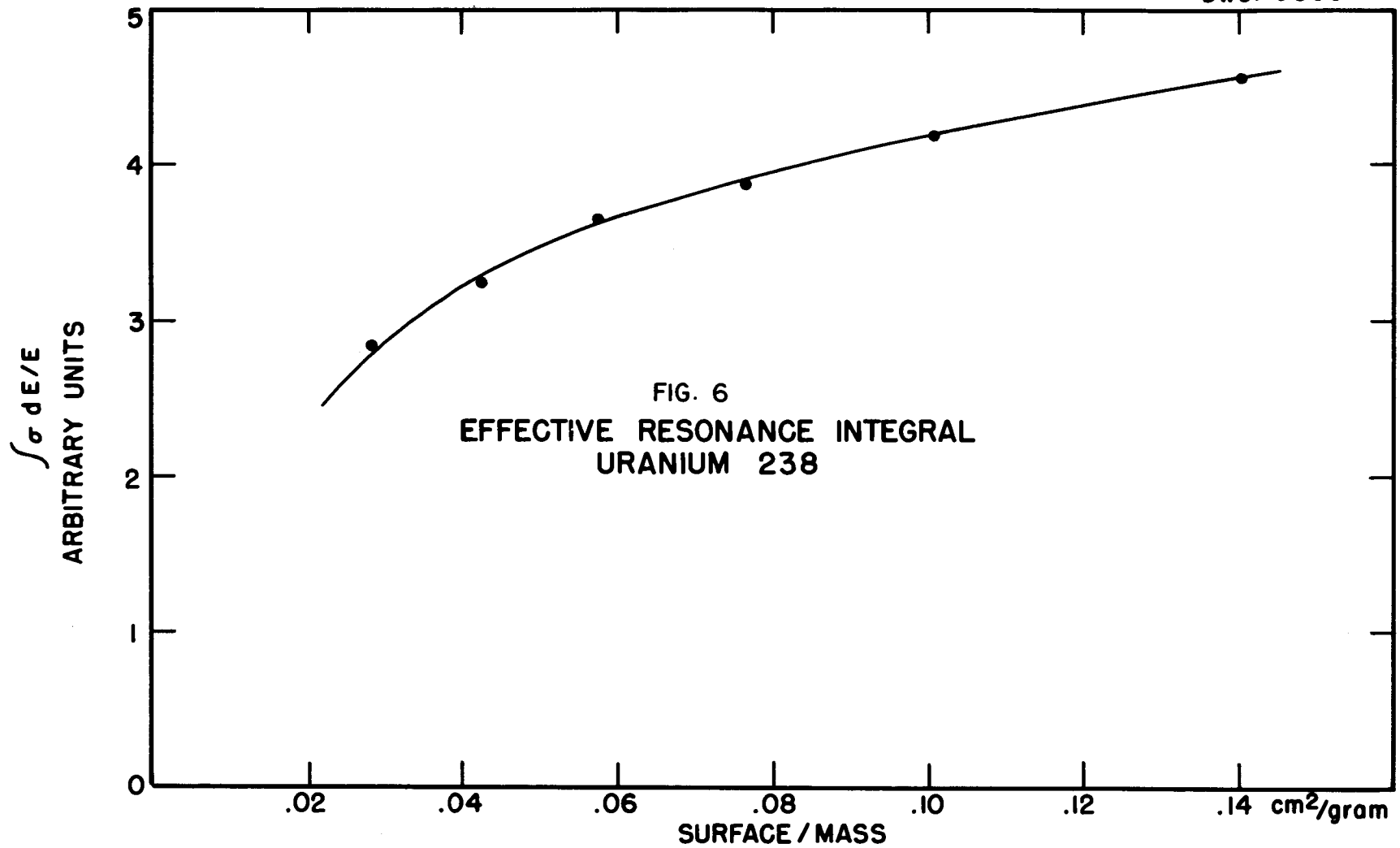


FIG. 6
EFFECTIVE RESONANCE INTEGRAL
URANIUM 238

GAMMA RAYS ASSOCIATED WITH NEUTRON BOMBARDMENT OF U^{235}

C. D. Moak
J. W. T. Dabbs, Jr.
Grace McCammon
Thelma Arnette

During the course of some cloud-chamber studies of capture γ rays, it was suggested that a study of the γ rays from U^{235} under neutron bombardment might be useful to those interested in shielding problems.

The target, made of an aluminum alloy with enriched U^{235}, was bombarded beginning 3 sec before cloud-chamber expansion and ending just after expansion. The γ rays, including prompt fission γ rays and some of the shorter lived fission-product activities, were passed into the cloud chamber where a lead pair-radiator gave electron tracks which were used to study the energy distribution.

It was found that the pair yield was much lower than had been observed for the capture γ-ray experiments on Cd and Cl. The reason for this was that most of the pairs observed were of low energy, in which cases the pair-production cross section was low.

Most of the pairs observed were in an energy region in which experimental errors were quite large owing to the small radius of curvature, excessive multiple scattering in the radiator, etc., so that the data to be listed here must be considered as only a qualitative guide to the trend in the γ-ray distribution. The measurement errors amount to approximately 30% at 2.5 Mev and decrease to less than 10% at 7.00 Mev.

The data are given in Table II, which lists the number of pairs lying in intervals of E to E + 0.25 Mev. The third column shows an estimate of the γ-ray spectrum, allowing for the variation of pair-production cross section with energy.

TABLE II

Gammas Accompanying Fission of U^{235}

Measured by C. D. Moak in a Cloud Chamber—Data Taken from Film by T. Arnette

E (Mev)	NO. OF PAIRS		BACKGROUND	
	UNCORRECTED FOR σ_p	CORRECTED FOR σ_p	UNCORRECTED	CORRECTED
1.00	2			
1.25	47	627	3	42.8
1.50	52	325	2	12.5
1.75	31	119		
2.00	24	65	2	5.3
2.25	14	28		
2.50	13	20.3		
2.75	11	13.9	1	1.3
3.00	9	9.6		
3.25	6	5.6	1	5.9
3.50	2	1.7		
3.75	1	0.75		
4.00	5	3.5		
4.25	4	2.6	1	0.64
4.50	5	3.0		
4.75				
5.00				
5.25				
5.50	1	0.48		
5.75	3	1.4		
6.00	1	0.44		
6.25	1	0.42		
6.50				
6.75	1	0.39		
7.00				
7.25				
7.50				
7.75				
8.00	1	0.33		

Duty cycle: 0 to 4 sec, U^{235} exposed to nv_{th}
3 to 3.2 sec, chamber records
45 sec, repeat

Pairs from Pb foil in cloud chamber are counted; energy taken from sum of curvatures.

SHIELDING PROGRAM

E. P. Blizard

Progress in the shielding program for the quarter ending August 31, 1950, is reported in ORNL-858, the ANP Quarterly Report. Progress during this period has included measurement of a 1/3 Pb - 2/3 H_2O uniform shield. The effect of adding boron to the water for reduction of capture γ rays has been investigated, and subsequent to this the Pb-H_2O system was optimized by adjusting the position of the layers of lead for minimum shield weight. A system has been devised for this minimization on an experimental basis. The Health Physics fast-neutron dosimeter has been used in the lid tank, so that shield thicknesses are now estimated on a sounder basis. Fast-neutron detection has also been accomplished using the sulfur (n,p) reaction. The recoil proton-neutron spectrometer has also been improved. The first liquid-metal-duct experiment has been planned and is to be carried out during the next quarter in the tank above the thermal column. The shielding reactor facility is expected to measure its first shield at about the end of 1950.

On the theoretical side, calculations of neutron attenuation have been made which are in excellent agreement with lid-tank data for the Pb-H_2O system. Some simple calculations have been made of the heat dissipation in the inner region of a shield. Methods devised during the TAB summer session for shield calculations are now being applied to several designs which are of interest for the Aircraft Reactor Experiment. Some work is being done on analysis of large ducts required for an air-cycle reactor, and present indications are that the shield weight for this cycle will be excessive.

New Bulk Shield Testing Facility (W. M. Breazeale and J. L. Meem). A more detailed discussion of the program for this facility can be found in the current ANP Quarterly Report (ORNL-858). The contractor expects to be out of the building by the latter part of the month, and laboratory employees will then move in and install the reactor, measuring equipment, etc.

Initially it is planned to measure the effectiveness of an aircraft shield. Design and construction of the mock-up of such a shield suitable for testing in the new facility are now underway at NEPA. It is hoped installation of the reactor and other equipment will be completed and measurements will be started during the first quarter of 1951.

CONTROLS

E. P. Epler T. E. Cole
W. H. Jordan S. H. Hanauer
J. C. Gundlach

MTR Controls. It has been agreed that ORNL will supply all special instruments required for operation of the Materials Testing Reactor. This includes the ionization chambers, amplifiers, and servo system. The design work is now complete, and the instrument shop is making layout drawings preparatory to manufacturing the instruments in quantity. Inasmuch as these instruments are also being used with the Bulk Shielding Facility and the Homogeneous Reactor, the number of instruments required of each type is fairly large.

The work of the Control Group on the MTR has diminished considerably during the past quarter. Concern is chiefly with transmitting information to Blaw-Knox and helping them on the layout of the cubicles and control and instrument rooms. A fission-chamber withdrawal mechanism is being designed, which, it is hoped, will be more reliable than the one originally proposed.

Control System for Bulk Shielding Facility Reactor. Work has been begun on a control system for this reactor. The reactor consists of a modified MTR assembly with fuel elements of the same type as those proposed for use in the MTR, and is to be suspended from a bridge which travels on rails secured to the edge of a large concrete tank similar to a small swimming pool. This bridge is to be the mount for all the reactor instrumentation, and therefore the only cables connecting the bridge and the rest of the building will be the power cables.

The reactor has been designed to be cooled by water in the tank, circulation of water to be by convection. The maximum steady operating level has been set at 10 kw, and the operating level is to be over a range of 10^5, *i.e.*, from 0.1 to 10^4 watts. In view of the relatively low level of operation, the problems normally concerned with depletion, poisoning, etc., are negligible, and the excess k required for normal operation is very small, about 0.4%. The reactor, then, with all rods removed, will have a steady-state period of around 5 sec, and this is relatively easy to control. The control rod proposed has an effectiveness of about 0.6% k efficiency; therefore this rod will be the only control element needed.

A more complete description of the reactor, building, and general principles is given in ORNL CF 49-12-92 and 50-2-19 and the ANP progress reports. It is planned that a detailed report covering the different phases of this project will be issued in the future, as soon as time permits. A brief description of some features of the control system follows.

The reactor will have two safety rods and one control rod, each of which will be supported from an electromagnet. Current will be supplied to the magnets from a safety system similar to that on the MTR; in fact, MTR-type instruments are being used as much as possible.

The two safety rods will be movable and controlled by small 3-phase a-c motors. These motors will be interlocked with the control rod in such a way that the safety rods must be withdrawn before the control rod can be moved. Thus they are in position to act as safeties in case they are needed.

The control rod will be available for manual or for automatic control. The Instrument and Control Group at NEPA has experimented with several types of drive suitable for use in an automatic control system and have built a system involving eddy-current clutches for use on the reactor. Work has also been done at ORNL along the same lines, and a 2-phase servo system has been developed that promises to be satisfactory for this same application. The reactor will be provided with the following instruments, which make up a reasonably complete system, considering the range to be covered and the type of use to which they will be put.

1. A fission chamber for use during startup, with associated amplifiers and a logarithmic count-rate meter, the indication to be recorded on a Brown recorder. A scaler will be installed for use during critical experiments.

2. A differential ion chamber connected to a galvanometer for use as a reference instrument.

3. A differential ion chamber connected through a Leeds and Northup electronic galvanometer to a Brown recorder for reading the flux at the ion chamber, and in addition providing a signal for the automatic control system. This type of device was resorted to when the requirements for automatic control of level over a range of 10^5 in flux were set forth.

4. A differential ion chamber connected to a Log n and Pile Period Chassis for use as an operating instrument to facilitate operation of the reactor.

[redacted]

5. Two safety chambers connected to sigma amplifiers and magnet amplifiers as in the MTR safety system.

In addition the control panel will provide switches for manipulation of the rods, fission chamber withdrawal, indication of limiting positions on the fission chamber and rods by indicating lights, and selsyns on the three rods. J. E. Owens of the Instrument Division has done most of the design work on the electrical control system, which is nearly completed.

This project is progressing in a satisfactory manner. The major causes of holdup seem to be in delivery of parts and instruments by outside manufacturers. At present it appears that all major components should be in hand by the middle or latter part of October.

[redacted]