Argonne National Laboratory

**QUARTERLY REPORT
JUNE, JULY, AND AUGUST, 1949**

INSTRUMENT RESEARCH AND DEVELOPMENT DIVISION

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INSTRUMENT RESEARCH AND DEVELOPMENT DIVISION QUARTERLY
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F. R. Shonka, Division Director

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I. Basic Research

A. Range-Energy Measurements

The work on range-energy measurements has continued although as in all other phases of the work this quarter, the report covers only two months of actual work due to vacation periods. The absorption cell technique referred to in ANL-4260 has given a good deal of trouble due to difficulties with the thin windows and leaks in the chambers. An improved model of this chamber has been completed and is operating very satisfactorily. There are no new results to report on at this time.

B. Dynamic Condenser Electrometers

A simplified dynamic condenser amplifier and detector has been built for use with the 60 cycles/sec. reactance modulator. These modulators were obtained from surplus. The complete system has five tubes including preamplifier and rectifier.

Two sensitivities are included. These are 10 and 100 mv. full scale. Zero drift is generally less than 1 mv./day. The system is stable and almost free from microphonic effects.

C. Monitors Using Dynamic Electrometer

The two $C^{14}O_2$ monitors have been in use by Dr. Norbert Scully for some time. At first, considerable trouble was found due to electrolytic currents from moisture on the insulators and high resistors and stress currents in the "lead-thru insulator" in the sealed flow chamber. Moisture troubles were minimized by coating resistors with silicone varnish and installing a 25 watt nichrome heater wound around the high impedance insulator assembly. Redesign of the O-ring seal of the "lead-thru insulator" and substitution of polystyrene for fluorothene reduced stress currents to negligible levels.

The room monitor has a volume of five liters; a full scale sensitivity of 70 millivolts, and with a $9 \cdot 10^{11}$ ohm resistor a current sensitivity of $8 \cdot 10^{-14}$ amps full scale. This operates with a circular chart Brown potentiometer.

The monitor for the controlled atmosphere system has a volume of one liter and sensitivities of 0-10, 10-20, ---, 90-100 mv. full scale, and 0-100, 100-200, ----, 900-1000 mv. full scale. This operates with a strip chart Brown potentiometer. Both systems have mercury switches which may be set at any part of full scale to activate relays for control apparatus.

D. Dynamic Condenser New Type

A rotating capacity has been constructed by the shop and is ready to test for contact noise.

Two faults are apparent in the initial model: 1) only one rotating condenser plate results in a dynamic imbalance of the rotating shaft, and 2) the synchronous motor is too heavy for the delicate bearings of the system and fails to run synchronously at the low voltages permissible.

However, this model will be useful to evaluate contact noise, and, if these results are promising, a new model will be constructed with a dynamically balanced shaft, and, probably, a rotating light weight permanent magnet motor.

E. Synthetic Sapphire Insulators

Synthetic sapphire discs with holes in the center have just been received from Linde Air Products Company for use as insulating lead-throughs. These may be soldered to metal and should have low stress currents. These insulators may prove to be useful in a wide variety of applications including usages under conditions of high neutron flux.

F. Air Proportional Alpha Counter

A mock-up of the new proposed molded probe has been constructed, and is about ready for test. This has a built-in housing for the cathode follower and high voltage filter section. A new system of insulators for supporting the ten wires are used which incorporate a guard ring system. The whole system will be sealed from dust and moisture.

G. Fluorophotometer

Testing of the uranium fluorescence photometer is nearly completed. This receives the 120 cycles/sec. fluorescent light from the uranium sample on a vacuum phototube and amplifies it about 100,000 times before detecting synchronously. Another phototube viewing the mercury lamp provides the synchronizing voltage after amplification. Maximum sensitivity is about 10^{-9} g of U/O.1 cc., for a full deflection on a

4" meter scale. Resistor noise is the present limitation on signal to noise ratio. Larger condenser lenses will be tried to increase intensity of the exciting light and improve signal to noise ratio.

H. Scintillation Counter Instrumentation

1. Differential Pulse Analyzer

Another differential pulse analyzer has been constructed similar to the one described in the last report. This has been used considerably and has proved satisfactory. In use, the gain of the amplifier is adjusted to give maximum pulses of about 100 volts, and the rate at which pulses occur within a one volt interval, which may be measured between 2 and 100 volts, is recorded. The interval is generally shifted continuously with an electric clock so that the complete range of pulse size is covered in a twelve hour period.

2. Precision Pulse Generator

A pulse generator has been constructed for checking the differential pulse analyzer. This consists of a 10.5 volt battery from which a standardized 10.0 volt source is obtained, which is applied to the terminals of a ten turn helipot. The voltage from the slides on the helipot charges a condenser through resistance. The condenser is discharged through another resistor 60 times a second by means of a relay with mercury wetted contacts. The resistance through which the condenser is discharged is tapped down to give the desired range of output voltage. The pulses generated are those of a condenser discharged through a resistor and simulates those normally present on the output plate of the photomultiplier tube when the R C is much longer than the decay of the fluorescence. The success of this pulse generator is due largely to the low contact noise of the mercury wetted relays.

3. Precision Counting Rate Meter

A counting rate meter has been constructed in which the height and width of a univibrator pulse has been accurately controlled. This pulse feeds a constant amount of charge into a condenser for each initiating impulse. The voltage across the condenser is measured and recorded with a special Brown strip chart potentiometer. The height of the pulse is controlled by a battery and a biased diode and the width of the pulse by a delay line. The operation is satisfactory except in cases where the counting rate is so low that the statistical variations in the number of counts occurring in the integrating time period is too great. In these cases it is found more practical to record the recorder pulses on an Esterline-Angus recorder.

4. Growth of Crystals

Work has continued on the growth of anthracene crystals. Relatively clear, large crystals have been grown in the diaphragm oven.

A high temperature oven has been designed for inorganic crystals. This will be a vacuum furnace for operation to 1600°C.

5. Gamma Ray Pulse Height Distribution Curves

A number of pulse height distribution curves have been made using an anthracene crystal $1/2" \times 3/4" \times 1"$ and a collimated beam of gamma rays which traverse only the central region of the crystal. The pulse height distributions look very much like the distributions expected from the Klein-Nishina formula. It is easy to distinguish between mono-energetic gamma rays of different energy. Comparison of the calculated maximum electron recoil energies with observed distribution cut off indicates good proportionality of pulse height with recoil electron energy. The resolution as an energy discriminator is good enough to barely detect the presence of two distinct lines in the Co^{60} spectrum.

II. Development Work and Special Techniques

A. Special Gamma Chamber

A special chamber of about one liter capacity which is to be independent of gamma ray energy was developed and constructed for Mr. Martinelli. The chamber operates very satisfactorily and is built to fit on the adaptor of the standard vibrating reed electrometer.

B. Dust Collecting Conducting Coating

A conducting coating which consists of a mixture of floating graphite and Apiezon "N" grease has been used with very gratifying results. Dosimeters using this conducting coating have been baked in the oven for a period of one week at 170°F. with no detrimental results to the insulators. The graphite particles seem to keep the grease from flowing freely even at this elevated temperature. This dust collecting technique has been used in the microscope barrel to collect all the dust which might ordinarily settle on the reticle. No graphite was mixed with this grease, and at elevated temperatures, disastrous results followed since the viscosity of the grease at this high temperature is very low. The graphite grease mixture is now being used in all the dosimeters with confidence, since it appears quite certain that no trouble will develop in the field under the normal conditions under which these dosimeters are used. Since the

dosimeters are sealed, it appears that they will be able to withstand any temperature, etc., changes which the person wearing them can withstand.

C. Reticles

It had been discovered, rather accidentally, that when certain plastics are molded at very high temperatures, they reproduce even minute imperfections found in the molds very faithfully. This technique is being developed for the purpose of molded reticles. The reticles for the present model dosimeters now cost approximately three dollars each, and they are barely satisfactory in appearance. Molded reticles, on the other hand, would cost less than ten cents each, and the entire problem seems to depend on whether engraving on such small scales can be accomplished successfully. Engraving is being tried by use of special diamond scribes which have a total included angle of less than 90° . With this angle lines should appear totally black due to internal critical angles of reflection.

D. Pocket Dosimeters

Within the last quarter, approximately 1200 man hours have been expended on the production of 200 pocket dosimeters. This work included everything other than the machining of the aluminum barrels and the microscope spacing sleeves which had been machined before this quarter. To date, there are 170 dosimeters complete, except for the chamber barrels and charging buttons. Of 115 dosimeters tested for insulator leakage, only 10 of them leak more rapidly than at the rate of 1 mv. -- 24 hours. This leakage is being measured with brass chamber barrels, and it is expected that there will be somewhat less when energy independent chamber barrels will be used.

The reason why these dosimeters are not being completed with the assembly of the chamber barrel and charging button is that a new conducting bakelite tube has been perfected by Formica Corporation. Tests on samples of this new material have shown that the resistance from end to end of the approximately 3" length of tube used for the dosimeters is less than 100,000 ohms. With this good conducting barrel, it will not be necessary to use the aluminum sleeve in which the charging button assembly has been molded. This aluminum sleeve has been the cause of considerable trouble, due to fracturing of the plastic and gas leakage around the aluminum sleeve. The new plastic buttons are molded entirely out of plastic, except for the conducting pin at the center of the charging button. The number of man hours mentioned above included the construction of about 50% of the new type of charging buttons. The assembly time which will be required for the chamber barrel and charging button will be only a small percentage of the total effort.

E. BF₃ Counters

The construction of 100 special BF₃ counters for the Van de Graaf group was undertaken. These counters will involve gas tight seals of welded aluminum joints. All the techniques with which new trouble might be anticipated have been tried while awaiting delivery of materials from the shop.

F. Boron

During this last quarter, a good deal of filling of special chambers and counters has been done. Five boron coated counters have been sent to Monsanto at Dayton.

The last sample of boron coated counters from General Electric has been tested and found to come up to standard of the A.N.L. counters. It is hoped very much that General Electric will be able to supply these counters, relieving A.N.L. of this burden. Fine platinum wires have been coated for the Naval Reactor Group at Site D.

III. Contact with Outside Agencies and Industry

A. G-M Counters

Samples of the latest halogen counters developed under the auspices of the Naval Research Laboratory and Bureau of Ships have been received from the Bureau of Ships. These counters have not yet been completely tested.

B. Bomb Effects Handbook

Chapter 11 of the Bomb Effects Handbook, dealing with radiation detection and measurement, has been reviewed by eight persons, most of whom are recognized authorities in this field. The comments have been rather flattering, with one exception. This comment was very lengthy, point by point criticism. These criticisms, unfortunately, did not prove to be helpful since they were either incorrect or did not apply in most cases.

C. Instrument Advisory Panel on Radiation Instruments for Military Use

The work on budget recommendation for all military branches is now complete. One of these panel meetings included a session with the budget committee of R.D.B. A letter of appreciation was received for A.N.L.'s participation in this panel. This letter was signed by all members of R.D.B.

D. Dosimeter Model

A sample of a new dosimeter has been sent to AFSWP through the AEC office. AFSWP intends to construct a large (perhaps a 6') model of a pocket dosimeter for display purposes for which model they wish to use the A.N.L. dosimeter.