CENTRAL RESEARCH LIBRARY
DOCUMENT COLLECTION

MARTIN MARIETTA ENERGY SYSTEMS LIBRARIES
3 4456 0251732 8

ORNL 166
PROGRESS REPORT

2A

CLASSIFICATION CHANGED TO: Declassified
BY AUTHORITY OF: TID - 1113
BY: E. Howard 10/22/56

~~LABORATORY RECORDS~~
1954

HEALTH PHYSICS DIVISION

QUARTERLY REPORT FOR PERIOD ENDING AUGUST 31, 1948

KARL Z. MORGAN, DIRECTOR

OAK RIDGE NATIONAL LABORATORY
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.
UCN-7969
(3 3-67)

OAK RIDGE NATIONAL LABORATORY

OPERATED BY
CARBIDE AND CARBON CHEMICALS CORPORATION
FOR THE
ATOMIC ENERGY COMMISSION
POST OFFICE BOX P
OAK RIDGE, TENNESSEE

[redacted]

TRANSMITTAL DATED 10-13-48

[redacted]

August 31, 1948
ORNL-166

This document consists of 12 pages.
Copy 2 of 75 Series A.

ISSUED: 706-A- Library

Contract No. W-7405-eng-26

* * * * * * * *

HEALTH PHYSICS DIVISION

* * * * * * * *

QUARTERLY REPORT FOR PERIOD ENDING AUGUST 31, 1948

[redacted]

Date Received: 9/29/48

Date Issued: OCT 13 1948

[redacted]

MARTIN MARIETTA ENERGY SYSTEMS LIBRARIES
3 4456 0251732 8

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

HEALTH PHYSICS DIVISION

Karl Z. Morgan, Director

QUARTERLY REPORT FOR PERIOD ENDING AUGUST 31, 1948

This report covers the activities of those groups in the Health Physics Division primarily engaged in Applied Research or Development. More or less routine activities of the Survey-Monitoring Section are covered in the Laboratory Weekly Progress Report.

INSTRUMENT DEVELOPMENT

Organization of the section was begun March 1st with the employment of Mr. W. M. Hurst as Section Leader. During the past quarter four men have been added to the group.

A primary objective of the Instrument Development Group is to improve the present Health Physics radiation instrumentation to a level comparable to that enjoyed by instruments produced in quantity by reliable production concerns. A program to achieve this end includes the following major activities.

(1) A critical study of existing radiation instrumentation and instrumentation needs; both within and without the AEC.

(2) Electrical and Mechanical Development by the group.

(3) Production Design Engineering and Specification Writing.

(4) Utilization of the highest skills and best techniques presently available in the field of commercial instrumentation.

Much of the time during the past quarter has been spent in the provision of laboratory facilities and in the orientation of personnel. These processes are incomplete.

Specifications have been written and contractual negotiations practically completed for the development and production of a number of oscilloscopes especially adapted to photographic, as well as visual, observation of random pulses with extremely short rise time. Specifications are contained in Report No. 9258 of the Hazeltine Electronics Corporation July 1, 1948, together with a supplement by W. M. Hurst, July 30, 1948.

Considerable effort has been devoted to the objective of making the Walkie Poppy (Alpha Survey Meter) the subject of a suitable commercial development contract.

[redacted]

[redacted]

Development projects in progress within the group include:

(1) Improvement of instrumentation used for the detection of Pu in body fluids;

(2) Exploration of preferred materials for portable instrument cases;

(3) Instrument coatings to permit easy decontamination;

(4) Design of a shake table suitable for determination of resonance points, structural weaknesses, and operational characteristics of instruments and components subjected to vibrations of known frequency and amplitude.

WASTE DISPOSAL STUDIES

A program involving the reorganization and expansion of waste disposal studies in the division was launched in July with the addition of Mr. Roy J. Morton, Sanitary Engineer, as Section Leader. The program is a joint undertaking with Oak Ridge National Laboratory, U. S. Public Health Service, Tennessee Valley Authority, and the Office of Research and Medicine of the Oak Ridge Directed Operations as participants. Major objectives of the program are:

(1) To evaluate and minimize radiation hazards incident to our own practices in the disposal of radioactive wastes;

(2) To provide fundamental information on the behaviour of released radioactive wastes as a basis for intelligent public health policies and protection standards; and

(3) To obtain information which may contribute to our national defense.

Senior members included now in the group are O.R. Placak, Sanitary Engineer assigned to ORNL by the U. S. Public Health Service for a two year period from April 1; L. R. Setter, Sanitary Stream Engineer, assigned to ORNL by TVA since May, and Conrad Straub, Sanitary Engineer, assigned to ORNL by the U. S. Public Health Service for a two year period beginning September 1. The activities of this group will be a part of a broader program participated in by Professor Paris Stockdale, Geologist of the University of Tennessee and Mr. J. Z. Holland, Meteorologist of the U. S. Weather Burau. The geological and meteorological programs are being sponsored by the Office of Research and Medicine, Oak Ridge Directed Operations of the AEC.

During the past quarter members of the section have been engaged largely in orientation, preliminary analysis of problems, tentative planning, procurement of supporting personnel; and setting up a laboratory. Orientation work has included some participation in routine activities of the Waste Monitoring Group of the Survey Monitoring Section of this division and study of Waste Monitoring records. Observation on the relation of radioactive contamination to plant life in the Settling Basin are contained in a memo from L. R. Setter

[redacted]

[redacted]

to W. D Cottrell June 1, 1948. Considerable study has been given to possible improvement of White Oak Dam to increase the effectiveness and safety of White Oak Lake in the storage of radioactive materials entering White Oak Creek.

Definite plans for preliminary surveys of the Watts Bar Reservoir, in cooperation with two branches of the TVA, the Fish and Wildlife Branch and the Stream Sanitation Branch, have been completed. The surveys will be begun in September, and will include studies of representative samples of water, sediment plankton, algae, and fish. It is expected that the results of these preliminary surveys will form the basis for more extensive joint studies with these agencies in the future.

An exploratory meeting with representatives of the TVA, U. S. Public Health Service, Tennessee Department of Public Health, and AEC Division of Engineering was held at Chattanooga, August 24, to discuss the general range of interests in problems of radioactive wastes and possible coordination among several public agencies.

THEORETICAL PHYSICS

Evaluation of Relative Stopping Power

Bloch's formula (Heitler, "Quantum Theory of Radiation", p. 218) for energy loss per cm of path is used to calculate the relative stopping power for alpha and beta particles. For fixed energy the relative stopping power per electron is a linear function of log Z. This is plotted on Figure I and II for energies above 1 Mev in the case of alphas and above .01 Mev in the case of betas.

The method is certainly not accurate much below these energies but seems trustworthy for higher energies and particularly on high atomic numbers. Comparison with Mano's experimental values for 6 Mev alphas reveals a maximum discrepancy of the order of 5% over the entire range of Z. The calculated values for 1.8 Mev betas are in substantial agreement with the experimental results of Gray, though here the data seems less trustworthy.

Evaluation of Slow Neutron Tolerance (Problems Incomplete)

The collision density due to bombardment of tissue by thermal neutrons is investigated under the following assumptions: (1) The tissue is represented as a slab 30 cm in thickness, the other dimensions being infinite. The total scattering cross section was taken as 2.95 barns and the absorption cross section as .023 barnes (2) a monoenergetic beam of neutrons impinges normally on one face of the slab with density of 1 neutron/cm^2/unit time, and the resulting distribution is assumed to have attained equilibrium. Backscattering from the surrounding space is assumed to be absent. (3) The energy of the neutron is assumed to remain constant during its passage through the tissue and scattering is assumed to be isotropic in the laboratory system of coordinates.

[redacted]

[redacted]

With these assumptions, the collision density, f(x), is given at depth λx by the integral equation,

$$(1) \quad f(x) = e^{-x} + \frac{\lambda - \lambda a}{2\lambda} \int_0^{30\lambda} f(y)\, E_1(|y - x|)\, dy$$

$E_1(x)$ is the exponential integral,

$$E_1(x) = \int_1^{\infty} \frac{e^{-tx}\, dt}{t}$$

This problem has been attacked by the "Monte Carlo" method. At each collision the neutron has three alterantives: (a) to go back a given distance (b) to go forward a given distance, and (c) to be absorbed. The probabilities of (a), (b) and (c) can be computed under the conditions (1), (2) and (3) of the problem. The solution of the problem is then effected by selecting a succession of random numbers whose interpretation decides the fate of the neutron at each step of its path. The interpretation is determined in such a way that the alternatives (a), (b) and (c) have the computed probability of occurrence at each step. By taking a large sample the resulting distribution of collisions is, in principle, the solution of Equation (1).

Actually a sample of 100 neutrons giving about 1800 collisions was taken. The data was smoothed and iterated in equation (1). The curves obtained are indicated in the accompanying graph (Figure III).

At present it seems desirable to do further work with the solution curve both by performing further iterations and by attempting to fit an analytical formula to the curve. The aim will be to obtain as complete information as possible and also to get some absolute bound for the error. Some preliminary work has been done in these directions, but the work is now awaiting the availability of further computational assistance.

Problems Under Study

(1) Radiation Effects due to Fast Neutrons

(2) Bremsstrahlung - It is intended to make the following evaluations:

(a) Determine cross sections ϕ (k, E) for the lower energy ranges to make them applicable for B. S. arising from the beta radiation of pile produced activities. In computing the cross sections account will be taken of errors involving the use of Born's approximation, screening effect and collision losses during time intervals separating two Bremsstrahlung encounters.

(b) Determine the frequency spectrum of radiation emitted by electron of initial energy E.

(c) Apply the above results and investigate problems concerned with health hazards arising from Bremsstrahlung.

[redacted]

EXPERIMENTAL PHYSICS

The personnel and facilities of this group have been largely devoted to problems for agencies other than the AEC. Measurements involving absorption and reflection of radiation under rather specific conditions are given in the following reports or memos:

(1) Shadow Shield Experiment, Roberson, Morgan and Rucker, July 30, 1948. Reflection of radiation from Lanthanum-140 by a right spherical ungula of air is determined.

(2) ORNL-145 - T. E. Bortner, 8-31-48. Reflection of radiation from Tantalum 182 by various materials under certain specific geometrical conditions is determined.

Results of other activities for outside agencies are not available for publication at the present time.

The paramount problem from our own laboratory has been the particulate radioactive contamination of the atmosphere in the ORNL area. Through the joint efforts of this group and the Survey group, some progress has been made in evaluating the extent of the contamination, but as yet the data are very incomplete. Data are given in memoranda by K. Z. Morgan, 8-2-48 and 9-15-48; and J. S. Cheka and H. J. McAlduff, 8-24-48.

Status of Problem of Particulate Contamination

Investigations to the present time indicate that:

(1) Large numbers of radioactive particles are carried by the air used to cool the pile and discharged through a 200 foot stack;

(2) The particulate contamination of the atmosphere from the pile may be much greater than normal during and immediately following the removal of a ruptured uranium slug from the pile;

(3) At certain times and locations the majority of the particles in the air are in dust swept up from the ground by traffic and wind; and

(4) Certain chemical operations may add to the particulate contamination of the atmosphere.

Particles ranging in size from 400 microns to 80 microns have been isolated, observed under a microscope, and counted for alpha and beta activities. Due to irregularities in shape, estimates of volume based on linear measurements are very rough, but perhaps the greatest variation to be expected in the results of experimental determinations of specific activities is, for alpha content, age in the pile and, for beta content, age out of the pile. Specific alpha activities ranging from 6×10^{-12} to 10^{-7} microcuries per cubic micron and specific beta activities ranging from 2×10^{-8} to 10^{-6} microcuries per cubic micron have been reported.

Particles smaller than 80 microns have not been isolated for observation under a microscope. Such particles are most readily detected by long exposure of an x-ray film in close proximity to the dust in which the active particles are collected. Rough indications of the activities of the particles are afforded by the diameters of the blackened spots on the developed film after exposure for a definite length of time. Extrapolations from the range of specific activities determined for large particles, while not reliable, indicate the size of particles observed autoradiographically probably extend down into or through the neighborhood of one micron.

No basis exists for an overall estimate of the hazards associated with radioactive particulate atmospheric contamination. Whether an individual particle has a finite probability of producing serious damage if taken into the lungs is not known. Lacking such knowledge it becomes desirable to reduce to negligible value, in the shortest possible time, the probability of breathing radioactive particles into the lung. Coordinated efforts in this direction by plant management and the various plant divisions are being undertaken by the Activity Hazards Committee.

EDUCATION AND TRAINING

The time of the Section Leader has been divided between participation in the Radioisotopes Training Program of the Oak Ridge Institute of Nuclear Studies and the planning and preliminary negotiation for the presentation of a 12 to 15 month course in radiation protection for holders of bachelor's degrees in science and engineering. The course structure and content have been worked out and discussions are being held with the University of Tennessee Physics Department and Graduate School to see if arrangements could be made for them to present the background material, administer the program and grant a master's degree on the strength of it. The University has so far indicated great interest and a meeting will soon be held to consider details of financing, technical direction etc.

During the month of July the Section Leader spent perhaps 30% of his working time on loan to the ORINS as instructor and radiation protection man for the Radioisotopes Techniques Course. The August session required considerably less time, though the September presentation will again require about 30% participation because the Institute is losing several of the instructors from the earlier courses.

A program to provide textual and reference material in the field of Health Physics has gotten under way with the employment of a junior physicist (Aug.15) and a technical stenographer (September 15) to assist in the compilation, editing, and production of appropriate materials.

In addition to these major developments, consideration has been given to numerous requests for short term training, long term individual apprenticeships, and various consultative activities. We have completed in this period the training of 2 one year students, and 4 ninety day trainees and still carry

[redacted]

at this time four 1 year students.

CONSULTATION

In addition to the more or less routine on-andoff-Area Consultation, Mr. W. H. Ray has designed for the New York Directed Operations, a model Radiochemical Laboratory, which, with some alterations, is now on display at the New York Golden Jubilee. He has also designed and constructed, with the cooperation of the Engineering Division, and ORNL display for the September meeting of the A. A. A. S. at Washington. This display consists of 12 booths featuring protection from radioactivity by prevention of inhalation, control of contamination, and control of irradiation dosage.

[redacted]

Unclassified

Aug. 6208

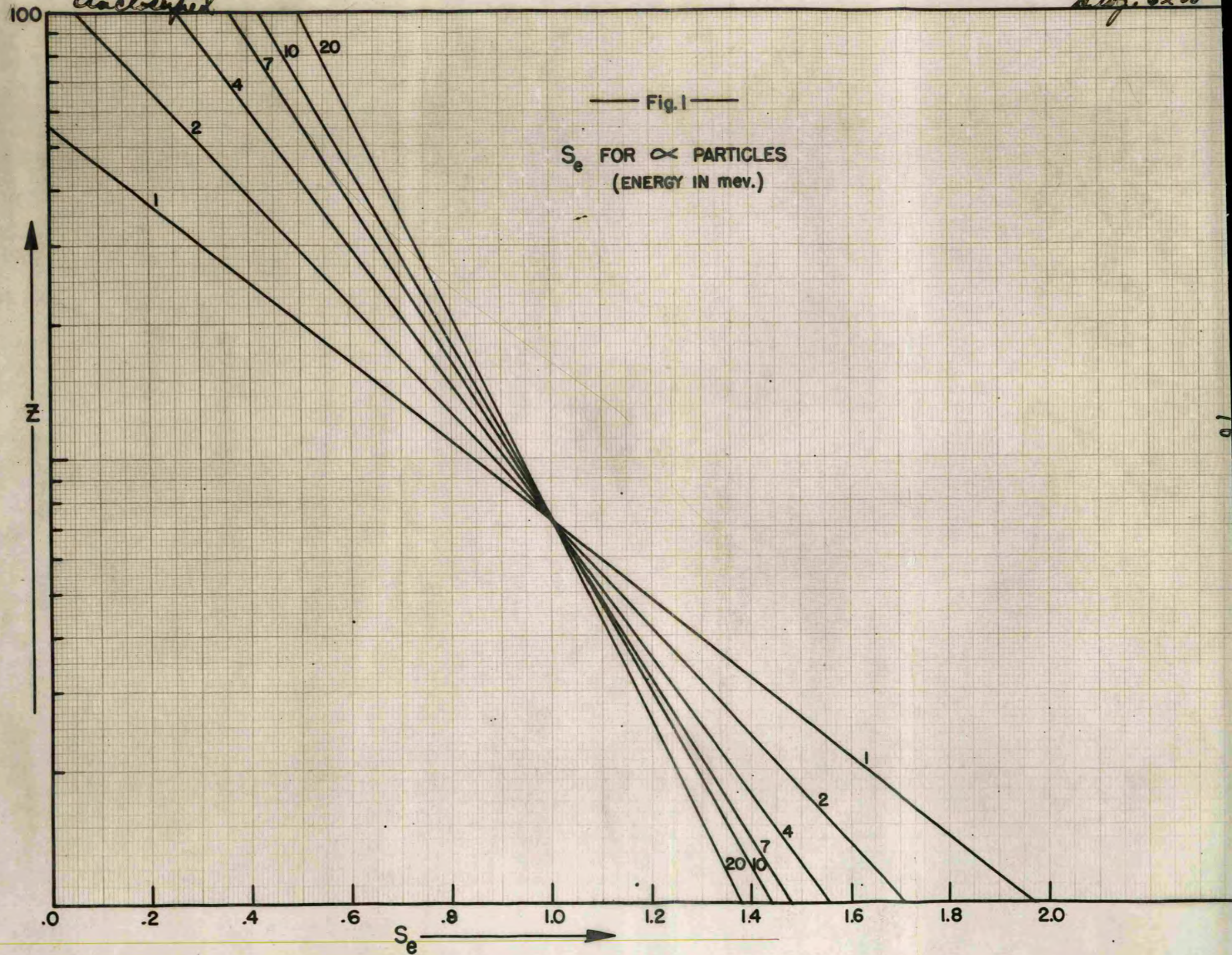


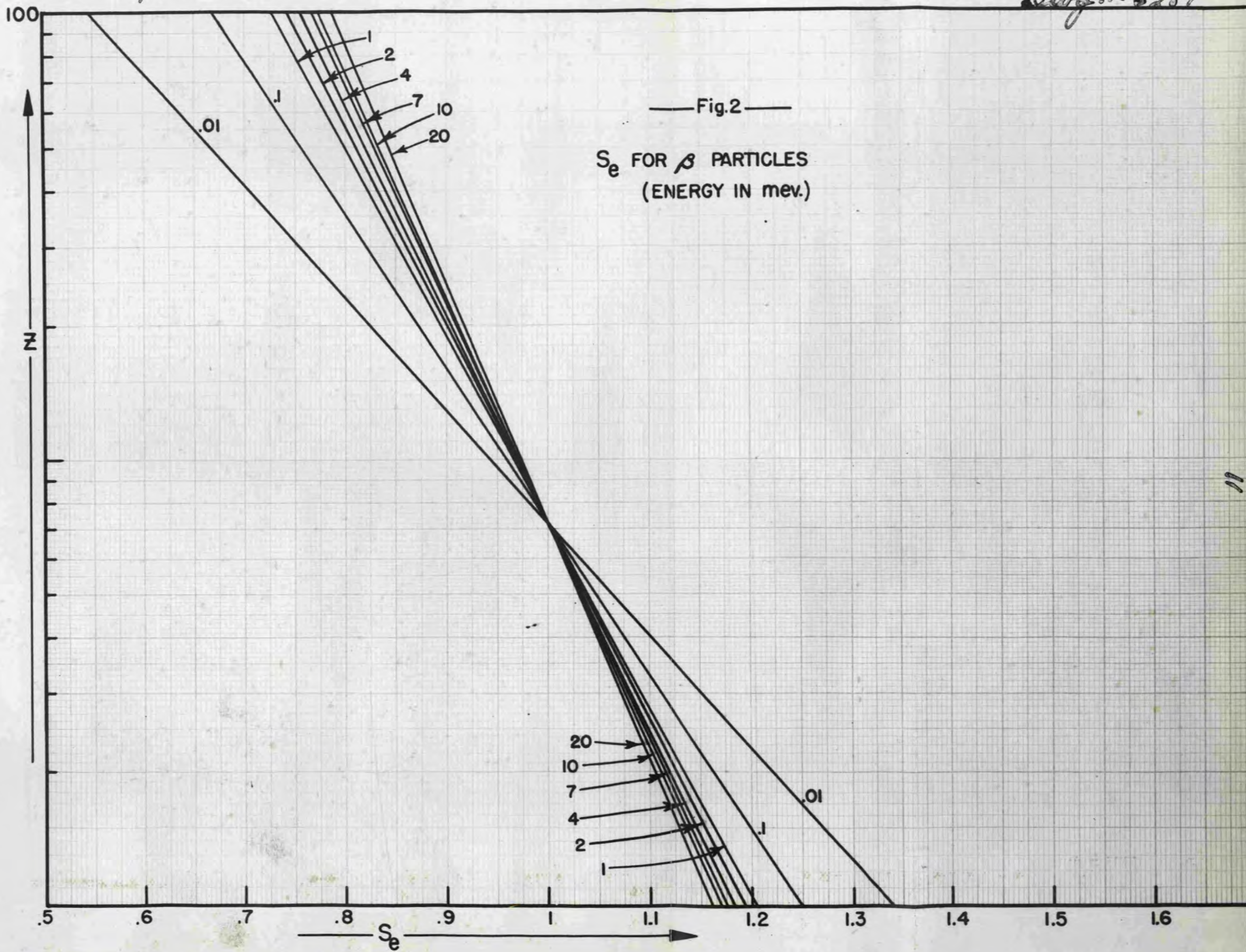
Fig. 1

S_e FOR α PARTICLES
(ENERGY IN mev.)

NO. 42,118. 20 DIVISIONS PER INCH (250 DIVISIONS) BY 2 4 1/2-INCH CYCLES RATIO RULING. CODEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS

Unclassified

Dwg # 6209



—Fig.2—

S_e FOR β PARTICLES
(ENERGY IN mev.)

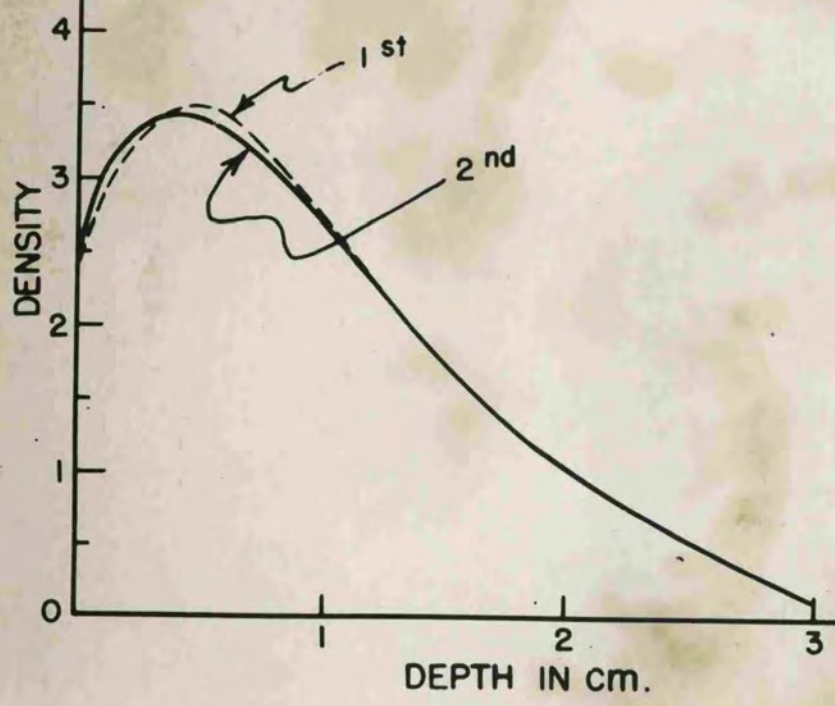
NO. 42,118. 20 DIVISIONS PER INCH (280 DIVISIONS) BY 2 4 1/2-INCH CYCLES RATIO RULING. COTTEX BOOK COMPANY, INC. NORWOOD, MASSACHUSETTS

HF-107-B

11

UNCLASSIFIED

Drawing # 6210

—Fig. 3—

FIRST & SECOND ITERATION IN INTEGRAL EQUATION