CENTRAL RESEARCH LIBRARY
DOCUMENT COLLECTION

MARTIN MARIETTA ENERGY SYSTEMS LIBRARIES
3 4456 0360384 8

[redacted]

ORNL 255 cy 6A
REACTORS

DECLASSIFIED
LABORATORY RECORDS
1964

CLASSIFICATION CHANGED TO:
BY AUTHORITY OF: AEC-LIST-4
BY: N. Johnstone 10/22/56

TECHNICAL DIVISION

CAM-TYPE PLATE-SPACING GAGE FOR THE MATERIALS TESTING REACTOR FUEL ASSEMBLIES

BY
J.A. KYGER
F. KERZE
W.H. WILSON

OAK RIDGE NATIONAL LABORATORY
CENTRAL RESEARCH LIBRARY
CIRCULATION SECTION
4500N ROOM 175
LIBRARY LOAN COPY
DO NOT TRANSFER TO ANOTHER PERSON
If you wish someone else to see this report, send in name with report and the library will arrange a loan.
UCN-7969 (3 9-77)

[redacted]

OAK RIDGE NATIONAL LABORATORY

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

[redacted]

7-5-49

[redacted]

ORNL 255

This document consists of 11 pages.

Copy 6 , of 88, Series A.

Issued: J. S. Library

Contract No. W-7405, eng 26

TECHNICAL DIVISION

CAM-TYPE PLATE-SPACING GAGE FOR THE MATERIALS TESTING REACTOR FUEL ASSEMBLIES

by

[redacted]

J. A. Kyger
F. Kerze
W. H. Wilson

[redacted]

DATE ISSUED

JUL 5 1949

OAK RIDGE NATIONAL LABORATORY

operated by
Carbide and Carbon Chemicals Corporation
for the
Atomic Energy Commission
Post Office Box P
Oak Ridge, Tennessee

[redacted]

MARTIN MARIETTA ENERGY SYSTEMS LIBRARIES

3 4456 0360384 8

ABSTRACT

A cam-type gage has been developed for measuring the internal spacing between the active plates of the Materials Testing Reactor fuel assemblies. Measurements are made rapidly and are of adequate accuracy. Conventional gaging methods were found inadequate due to the narrow, deep spaces involved.

INTRODUCTION

As development work in the fabrication of Materials Testing Reactor fuel assemblies progressed, the problem of determining the internal plate-spacing became increasingly important.

This dimension was of special interest because of apprehension over the possible consequences of non-uniform spacing on local water flow rates, cooling rates, metal expansion, and plate warping.

FUEL ASSEMBLY BODY

The main body of the Reactor fuel assembly is shown in Figure 1. It consists of 18 thin, curved, active plates brazed to grooved side plates. The outer two plates are 28-5/8" long and the remainder are 24-5/8" long. The active plates are 0.064" thick, 2.839" wide and curved on a radius of 5.5". The plate spacing measured parallel to the plane of lateral symmetry should be 0.113" ± 10%. Earlier specifications called for an even closer tolerance of ± 5%.

CAUTION

This document contains information affecting the National Defense of the United States. Its transmission or the disclosure of its contents in any manner to an unauthorized person is prohibited and may result in severe criminal penalties under applicable Federal laws.

RESTRICTED DATA

This document contains restricted data as defined in the Atomic Energy Act of 1946.

[redacted]

Photo Neg. # 3998

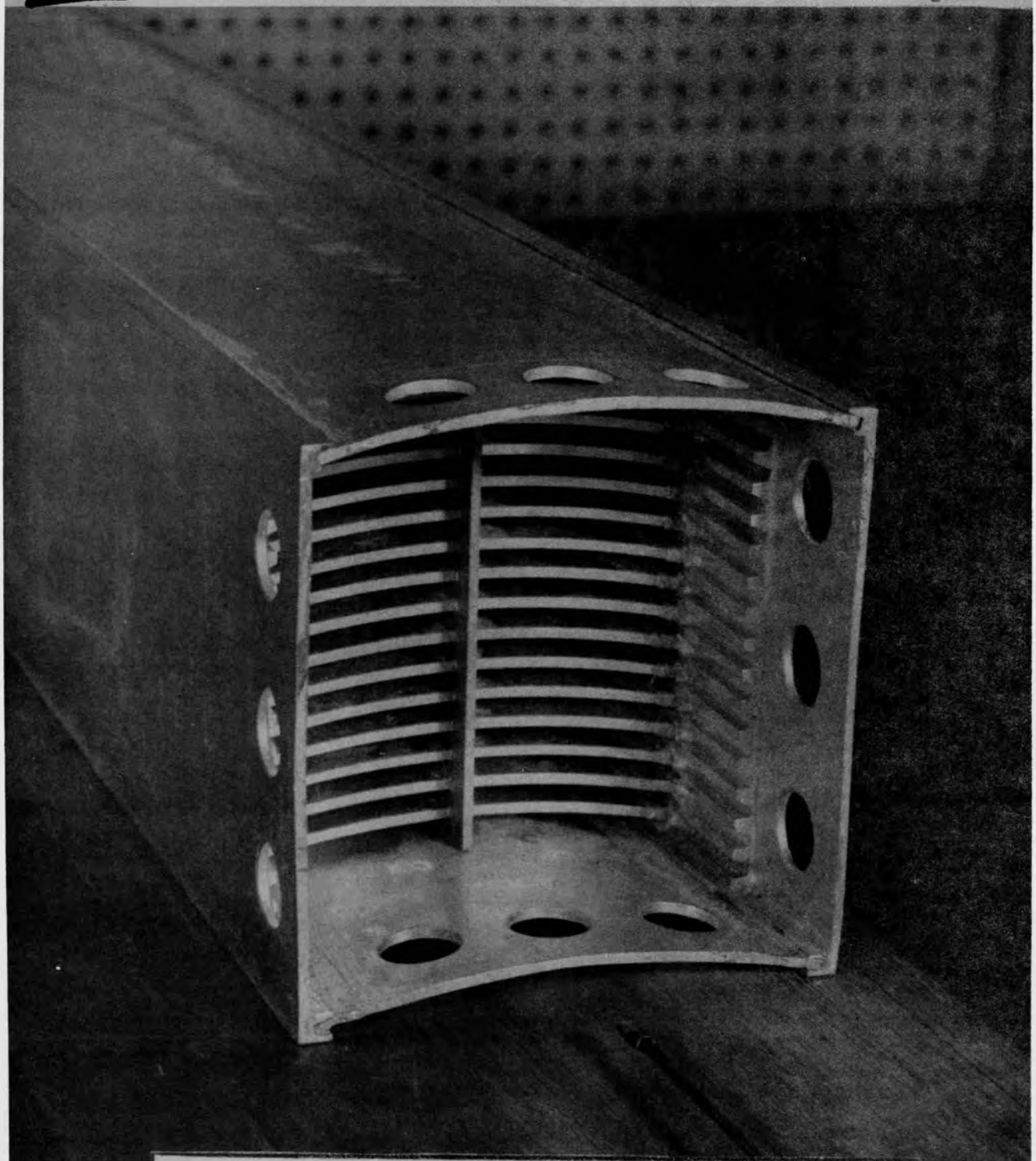

FIG. I MATERIALS TESTING REACTOR FUEL ASSEMBLY BODY

[redacted]

MEASUREMENT PROBLEM

The plate spacing is determined chiefly by the following items:

Item	Operation
1. Side plate flatness	
2. Side plate groove accuracy	milling
3. Active* plate thickness	rolling
4. Active plate width	milling
5. Active plate longitudinal straightness	die forming
6. Active plate lateral curvature	die forming
7. Brazing jig characteristics	brazing

Brazing can produce serious distortion which is usually reflected in excessive plate spacing variation. Variations in lateral curvature tend to a maximum along the plate center-line. It was agreed that adequate indication of spacing accuracy could be obtained from four measurements in each channel, along the center-line.

The first measurements were limited to the plate ends and were made with a caliper or a cathetometer. As these dimensions improved along with fabrication techniques, increased attention was given to the problem of internal measurements. It was apparent that some type of small gaging device capable of reaching the fuel rod mid-point, simple in construction, and rapid in operation, should be developed

---

* containing uranium alloy

SURVEY OF METHODS

Manufacturers of measuring devices were contacted but no suitable suggestions were received. Some of the measuring methods considered were:

1. Small-Hole gage.- This gage is used in conjunction with a micrometer and is not suitable for rapid measurements. It was not available in the size and length desired.
2. Micrometer split-ball gage. - A Small-hole gage combined with a micrometer would be better than the above device but is not available.
3. Special "Go-not go" gage. - For measurement, a graduated series of gages would have to be used and measurement would be slow. The gaging tip would have to have a narrow portion to permit insertion past constricted regions.
4. Supersonic. - It seemed that an instrument such as the Reflectoscope might be used to measure plate spacings thru the use of progressive filling of the channels with a sound-transmitting fluid. Investigation showed this method to be impractical.
5. Miniature flexible hydraulic reservoir and capillary manometer. - This device would not be simple to construct.
6. Wax-coated probe. - This device would be useful in obtaining minimum spacing to a given probing depth.
7. Pneumatic gages. - A gage of this type was constructed. The probing element consists of a small flattened metal tube sealed at one end and bearing a small orifice drilled thru one wall near the

tip. The metal tube is connected to a manometer by means of rubber tubing. The air supply line is equipped with a water seal which limits the pressure in the gaging system. As a flat surface is moved toward the orifice the back pressure increases and the manometer can be thus calibrated in terms of plate spacing. Measurements can be obtained if the probe surface opposite the orifice is kept in close contact with the active plate. It was difficult to maintain this close contact during deep probing without the aid of a small leaf-type spring. Also, the wide variations in plate spacing that existed during the development period required the use of several probes.

Considering the limitations of the above devices it seemed that the gaging would be best handled by a special cam-type gage.

CAM-TYPE GAGE

During a review of various gaging methods the use of a bent wire probe was discussed in which the degree of freedom in rotation might be related to plate spacing.[1] This was followed by the suggestion that a cam-type probe approximately elliptical in section might be more satisfactory.[2] In this case the effective range of the instrument would lie between a dimension slightly greater than the small cam dimension and slightly less than the large cam dimension. This would correspond to a total rotational angle varying from slightly greater than 0° to slightly less than 180°.

An instrument of this type (Fig. 2) was then designed[3] and constructed. It consists of several parts as follows:

1. Base block.
2. Horizontal adjustment block with pairs of horizontal and vertical guide rods.
3. Vertical adjustment block and set-screw.
4. Cam probe, pointer and scale.

The fuel assembly is centered on the wooden base block as shown. The base block contains two brass guide tubes for the steel horizontal rods. The vertical adjustment block (lucite) bears the cam probe and scale. The probe rod position is set by two bushings, one of which carries the pointer. The pointer range is limited by two pins set in the block. The present gage has in addition, an adjustable clip which locks the pointer in the vertical position during probe insertion.

The pointer is set at right angles to the long cam dimension. The weight of the pointer then brings it to a definite scale position to the right and left of vertical, according the spacing being measured. The theoretical range is set by the long and short cam dimensions. The ideal range is slightly narrower since rotational freedom is small near the lower limit and since wedging may occur near the upper limit.

The ideal cam is symmetrical and of such a shape as to give reasonably uniform scale calibration. The proper cam size and shape is approximated fairly readily by manual shaping with a file and fine emery cloth. The initial probe cam was made of copper to facilitate shaping.

Photo Neg. # 3991

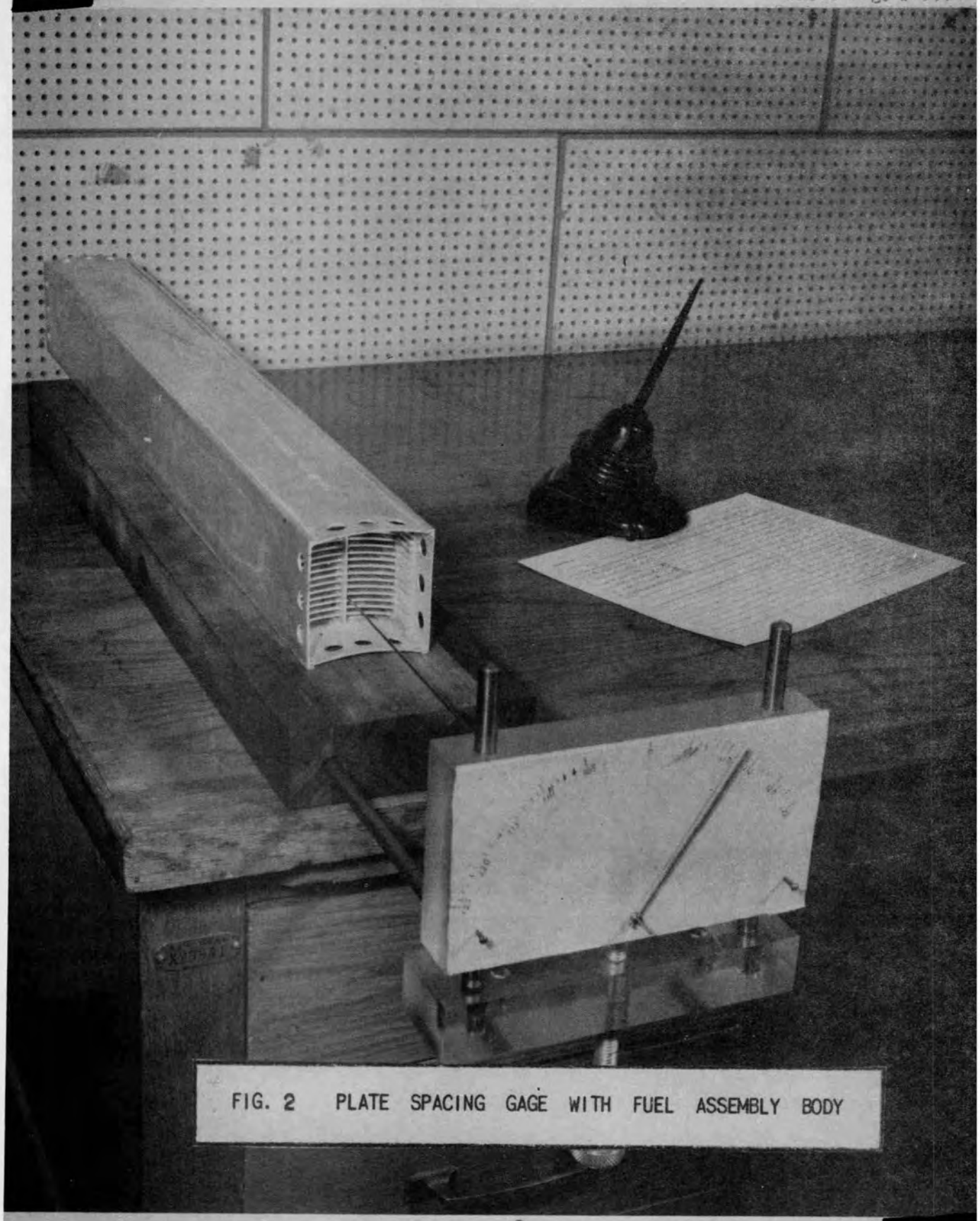

FIG. 2 PLATE SPACING GAGE WITH FUEL ASSEMBLY BODY

The present cam (Fig. 1) is made of stainless steel soldered to a thin stainless steel rod, and has greater wear resistance. The gage is calibrated by a micrometer mounted vertically on Johansson blocks. The micrometer spacing values are marked on a polar coordinate paper scale for both left and right pointer positions. During actual measurements the two values are averaged if the readings are not identical. Initially the angle readings were taken and converted to spacing values by means of calibration curves. Errors due to plate curvature or moderate cam displacement from the plate center-line were found negligible. The probe length is kept constant for a given calibration and the torsional effect is thereby compensated.

The above gage has proven very satisfactory for plate spacing measurements. Readings are possible at the rate of 68 (4 for each of 17 spaces) in about 30 minutes.

ACKNOWLEDGEMENTS:

The authors express their appreciation for assistance received as follows:

H. Seaman	- construction of gage.
F. W. Drosten and J. N. Hix	- pointer lock and minor gage modifications.
E. C. Miller	- editorial suggestions.

REFERENCES:

(1) J. A. Kyger; verbal communication, January 28, 1947

(2) F. Kerze; Notebook, January 28, 1947

(3) W. H. Wilson; Technical Division Section IV Report for Period Ending August 31, 1947; (C.F. 47-9-322); page 12.