

**BRIEF SUMMARY OF UNREFLECTED AND UNMODERATED CYLINDRICAL  
CRITICAL EXPERIMENTS WITH ORALLOY AT OAK RIDGE**

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# **BRIEF SUMMARY OF UNREFLECTED AND UNMODERATED CYLINDRICAL CRITICAL EXPERIMENTS WITH ORALLOY AT OAK RIDGE**

## **ABSTRACT**

This report lists and briefly describes ~50 critical and ~20 subcritical experiments with unreflected and unmoderated uranium (93.2 wt%  $^{235}\text{U}$ ) metal that could easily be incorporated into the International Handbook of Evaluated Criticality Safety Benchmark Experiments. Photographs of several assemblies are included.

## **1. INTRODUCTION**

A variety of critical assemblies were constructed at the Oak Ridge Critical Experiments Facility in the 1960s and 1970s with highly enriched uranium, unmoderated and unreflected.\* Many of these have been reported in the literature but not in as much detail as exists. Sufficient information about the material and assemblies exist that they could serve as benchmarks for verifying calculational methods. In addition to providing basic criticality safety data of interest to the Oak Ridge Y-12 Plant, interaction effects, height to diameter effects, and complex geometry effects were evaluated. The complex geometry experiments were designed to test the geometry capability of 05R and KENO. These experiments used the same materials in a wide variety of geometries and could be documented as benchmark data. In addition to delayed critical configurations, the prompt neutron decay constant was obtained from Rossi- $\alpha$  and pulsed neutron measurements both at delayed criticality and subcritical. The subcriticality can be estimated from the prompt neutron decay constants. For some subcritical experiments, inverse kinetics rod drop experiments were also performed.  $^{252}\text{Cf}$ -source-driven noise analysis measurements were also performed for subcritical single 7-in.-OD cylinders and two 7-in. diameter interacting cylinders. Thus, for some experiments, subcritical reactivity could be obtained by three methods. Isotopic analyses, dimensional inspection results, and impurity contents are precisely known.

This report just lists the measurements that were performed and presents some photographs of some of the many of the critical assemblies in their disassembled condition.

## **2. EXPERIMENTAL CONFIGURATIONS**

The list of experiments performed is given in Table 1. The same Oralloy parts (annular rings and cylindrical discs) were used for all assemblies except for two: the GROTESQUE configuration and the material of the parallelepiped in another configuration.

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\* The many references for this work (because of the size of this list) have been left out of this report but are generally known and mainly in Journals of the American Nuclear Society and American Nuclear Society meeting transactions.

**Table 1. List of Experimental Configurations**

Assemblies	Delayed Critical <sup>a</sup>		Subcritical	
	Geometry	Prompt Decay	Prompt Decay	<sup>252</sup> Cf Noise
<b>Single Right</b>				
<b><u>Circular Cylinders</u></b>				
7-in.-OD	Y(1)	Y	Y(6) <sup>b</sup>	Y(8)
9-in.-OD	Y(1)	Y		
11-in.-OD	Y(1)	Y	Y(3) <sup>b</sup>	
13-in.-OD	Y(1)	Y		
15-in.-OD	Y(1)	Y	Y(4) <sup>b</sup>	
<b><u>Cylindrical Annuli</u></b>				
13-in.-OD; 7-in.ID	Y(1)	Y		
15-in.-OD; 7-in.ID	Y(1)	Y		
15-in.-OD; 9-in.ID	Y(1)	Y		
<b><u>Two Interacting Cylinders<sup>c</sup></u></b>				
7-in.-OD, Variable Spacing	Y(6)	Y	Y	Y(13)
11-in.-OD, Variable Spacing (0-51cm)	Y(14)	Y	Y	
15-in.-OD, Variable Spacing (0-140cm)	Y(9)	Y		
<b><u>Three Interacting Cylinders</u></b>				
15-in.-OD, Variable Spacing	Y(8)	Y(8)		
<b><u>Complex Geometry</u></b>				
Cylinder Inside Annulus	Y(1)	--		
Parallelipiped Inside Annulus <sup>d</sup>	Y(2)	--		
GROTESQUE <sup>e</sup>	Y(2)	--		

<sup>a</sup>Y signifies an experiment was performed and the number in parentheses is the number of different configurations that were assembled. No entry indicates no experiment.

<sup>b</sup>For some of these system inverse kinetics rod drop experiments were performed.

<sup>c</sup>For some of these assemblies, the fission rate was measured along the axis with Oralloid metal discs.

<sup>d</sup>Two configurations of parallelipiped.

<sup>e</sup>D. Irving's name and description of this assembly. These were two configurations of this system: one with five major parts and the other with nine.

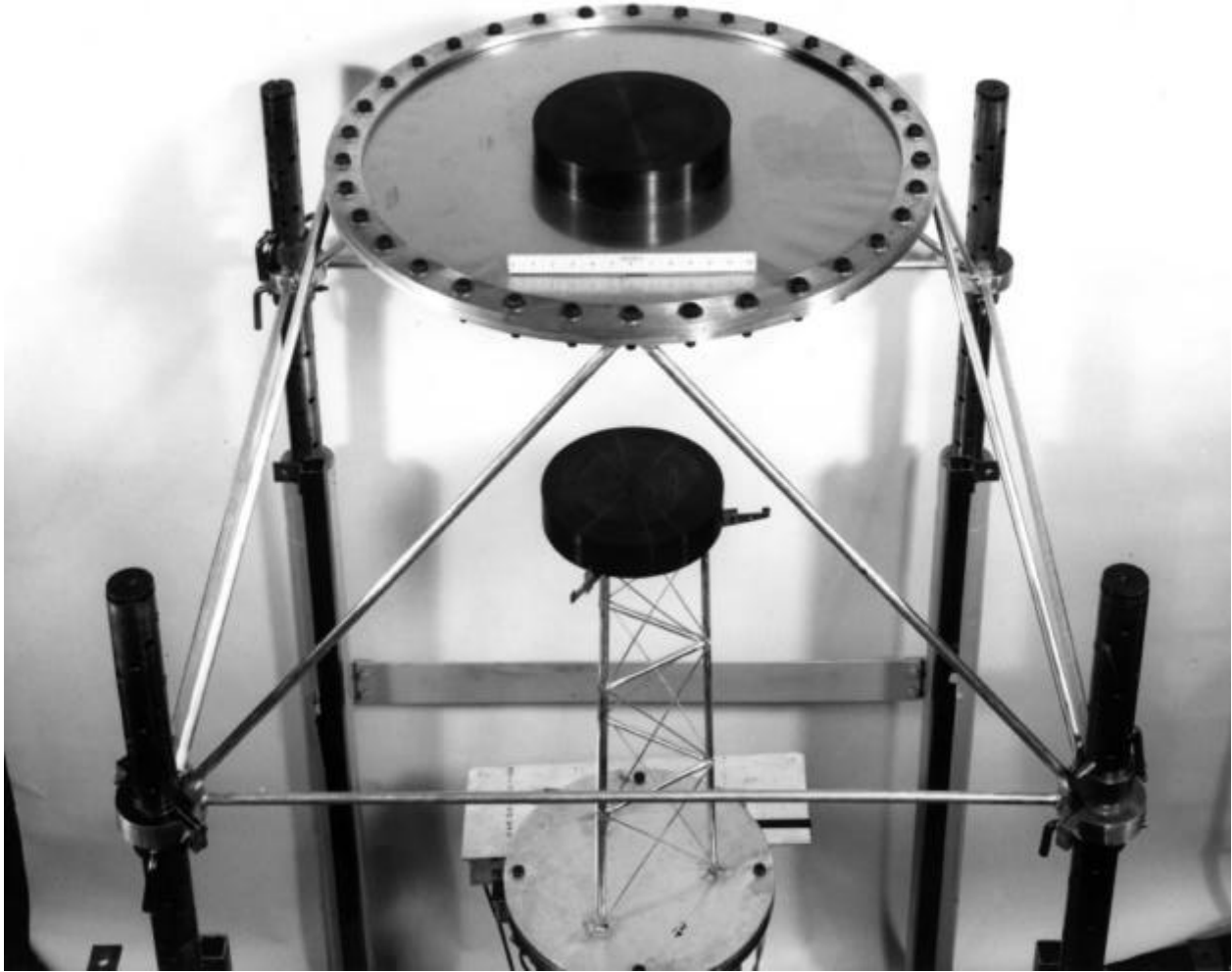


### **3. PHOTOGRAPHS OF SEVERAL ASSEMBLIES**

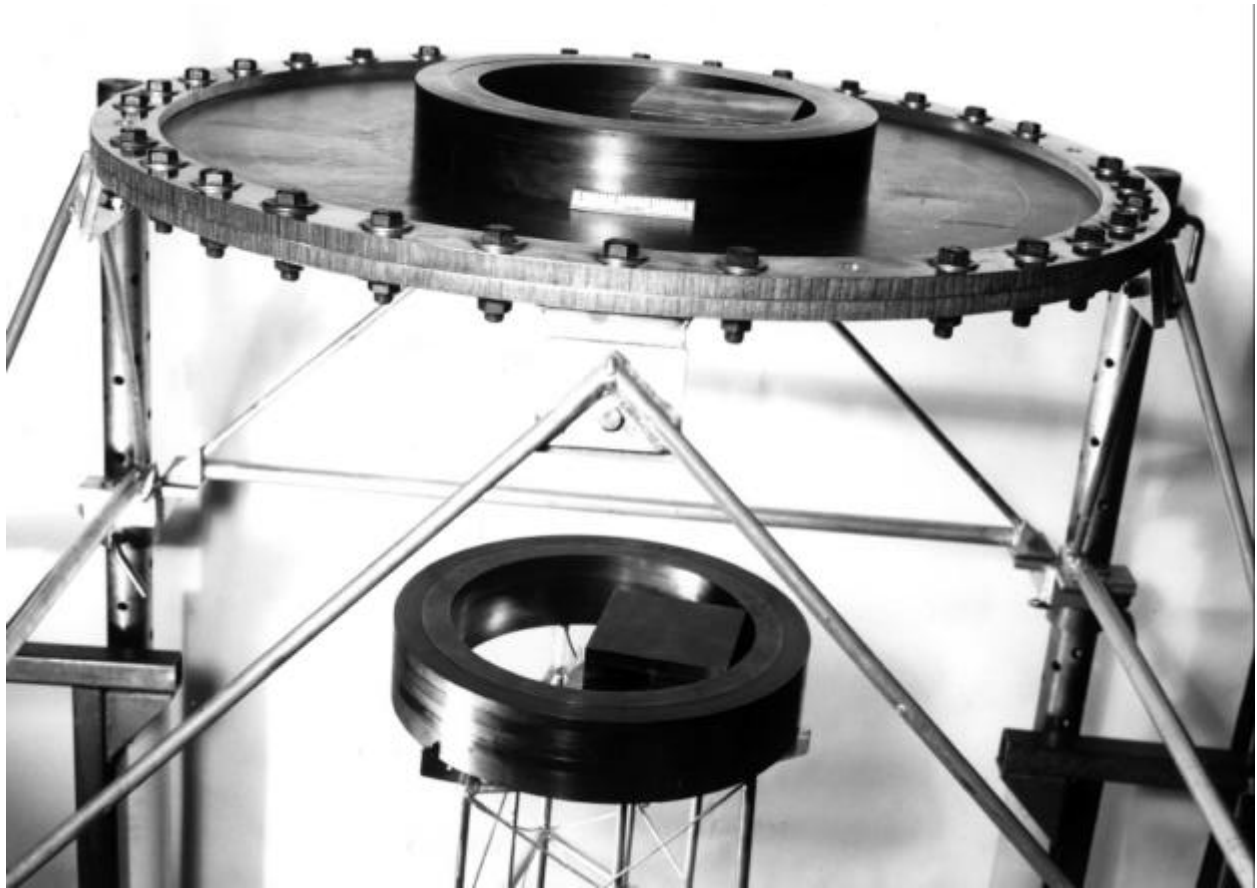
Various photographs of several of these delayed critical assemblies listed in Table 1 are given in Figs. 1-6 in their disassembled state. Photographs of two interacting cylinders, three interacting cylinder, solid cylinders, an annulus with solid cylinder inside, an annulus with parallelepiped inside, and a very complicated geometry are given. The latter three were built to test geometry capability of O5R and KENO.

### **4. RECOMMENDATIONS**

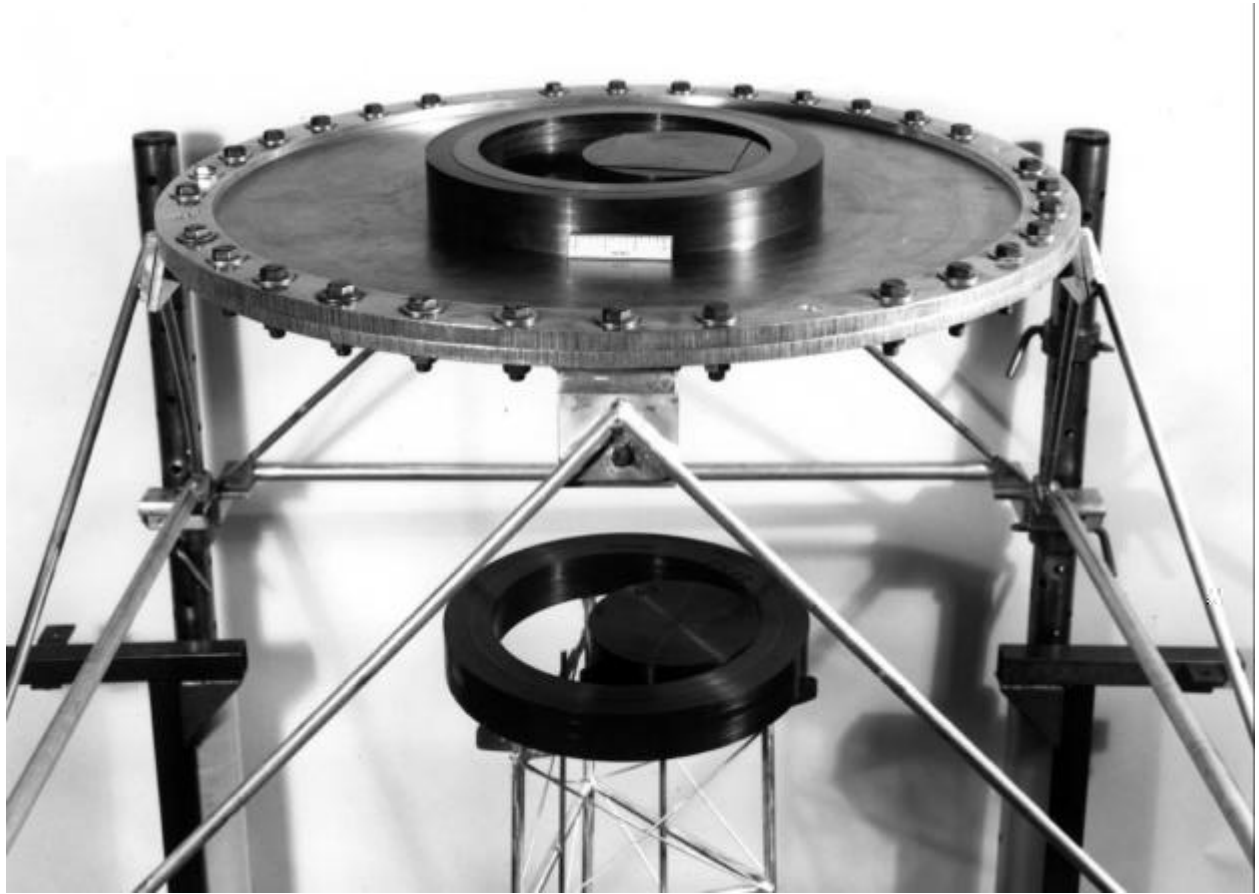
All of these delayed critical experiments could be evaluated for incorporation into the International Handbook of Evaluated Criticality Safety Benchmark Experiments. The same annular rings and discs of Oralloid were used for all but two of these experiments.



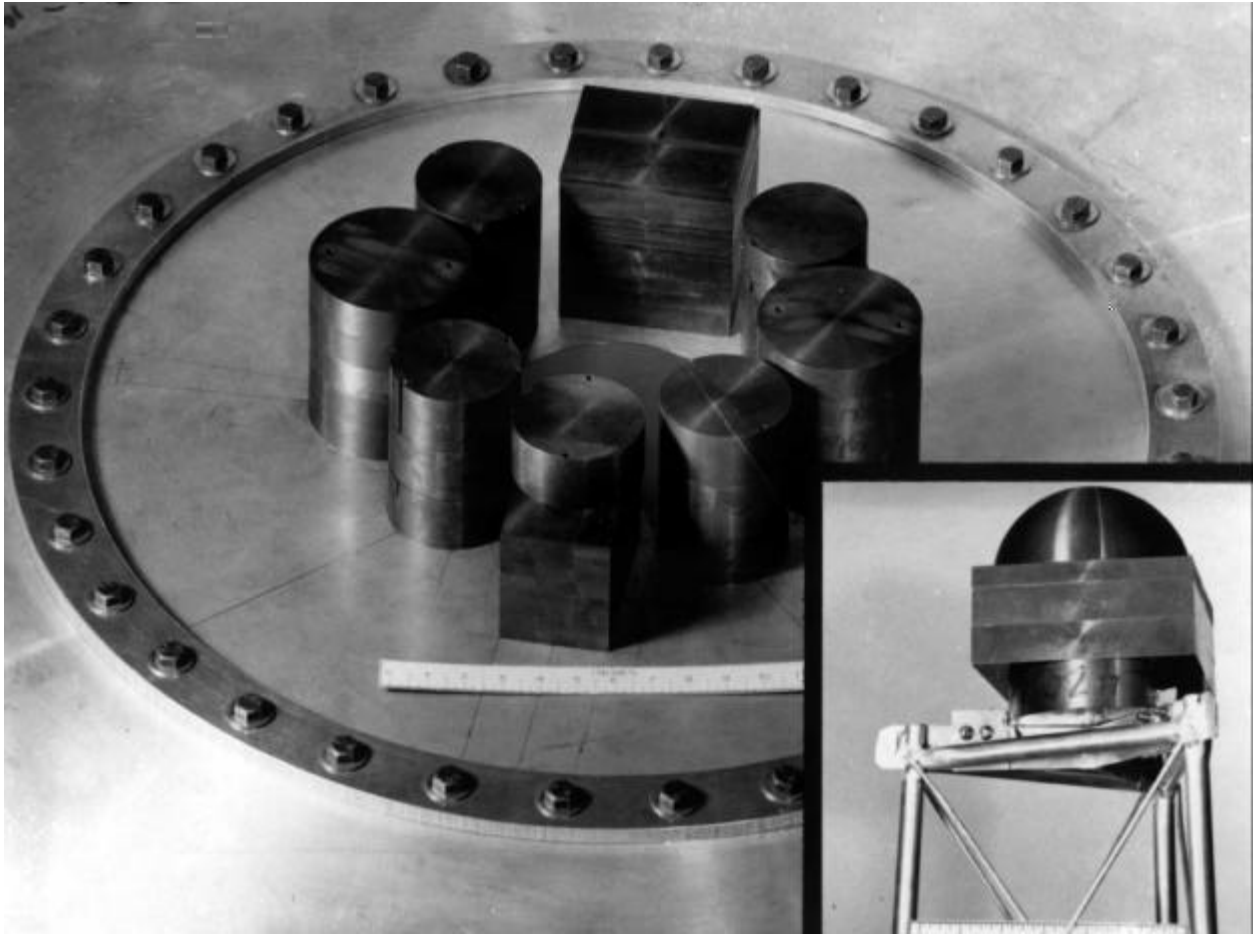
**Figure 1. Solid Uranium Oralloid Cylinder.**



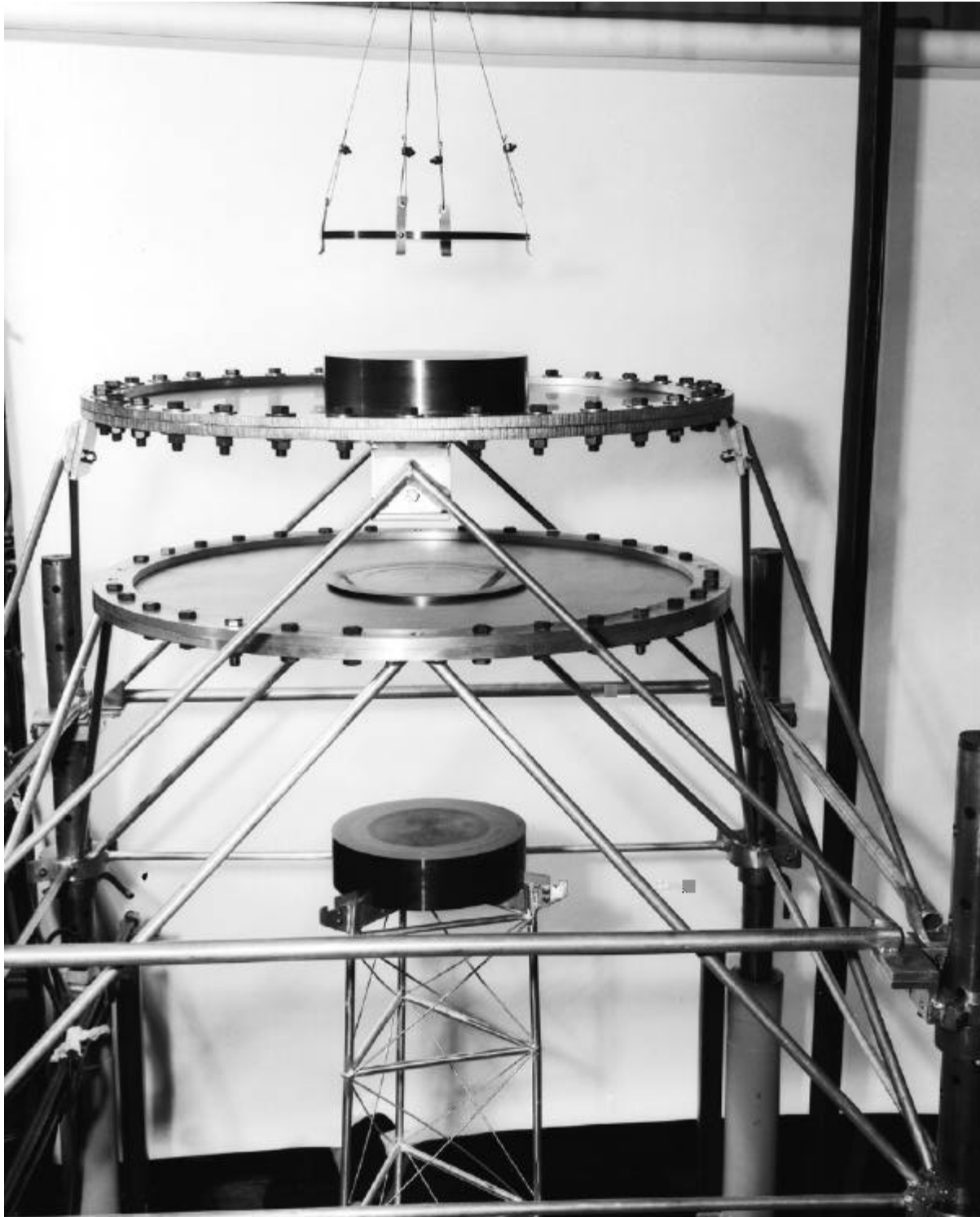
**Figure 2. Oralloy Annulus with Parallelepiped (Geometry Capability of O5R and KENO).**



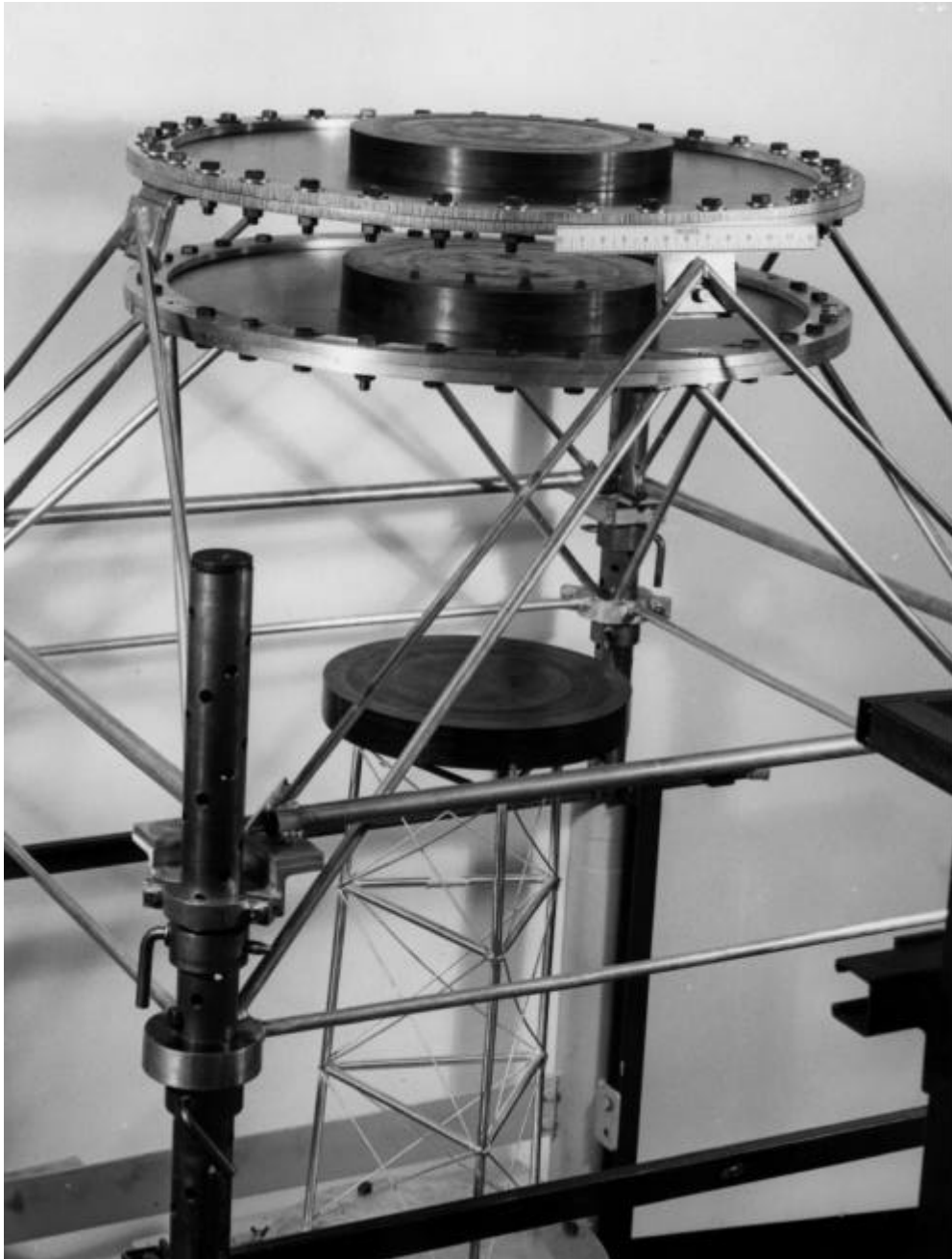
**Figure 3. Oralloy Annulus with Cylinder (Geometry Capability of O5R and KENO).**



**Figure 4. GROTESQUE with nine major parts (Geometry Capability of O5R and KENO).**



**Figure 5. Two Interacting Cylinders of Oralloy (Varying Outside Diameter).**



**Figure 6. Three Interacting Cylinders of Oralloy (15-in.O.D. Cylinders Shown).**

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