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ABSTRACT

Delta-stabilized plutonium, which is a soft gummy material similar to annealed copper, is difficult, if not impossible, to thread using conventional taps and dies or thread-cutting techniques. This report describes a successful "plunge" threading technique and a surface preparation method which permits assembly of threaded delta-stabilized parts without galling.

INTRODUCTION

Plutonium is easily stabilized in the delta phase by the addition of 1 wt % gallium or aluminum.[(1)] In contrast to unalloyed plutonium which has a hardness of ~275 DPH and machining characteristics similar to cast iron, the delta-stabilized material has a hardness of ~40 DPH and machines like annealed copper. The delta-stabilized material is preferred to unalloyed plutonium for many applications because it is stable at all temperatures below 450°C and can be rolled, drawn, or extruded at ambient temperature. Unalloyed plutonium undergoes a 9 % volume change at 117°C[(2)] at which point it transforms from the alpha to the beta phase, and fabrication operations are generally limited to casting and machining.

As would be expected, difficulties were encountered in attempting to thread the soft delta-stabilized material using conventional thread-cutting tools. This report presents a tool design developed for cutting threads in delta-stabilized plutonium and a procedure for conditioning the threads so that external and internal threaded parts may be mated without galling.

DEVELOPMENT WORK

a. Conventional Cutting

Attempts to cut threads in the soft delta-stabilized plutonium using a standard 60° included-angle tool with the compound slide set at 30° were unsuccessful. In this method the tool was fed using the compound slide, and only one side of the thread was cut. The plutonium turnings, which tore as they were removed, slid across the tool and tended to weld to the other side of the thread. This produced gouges in the threads. These conditions occurred with cuts of from 0.0025 to 0.015 in. on the diameter, with or without lubricants. The tearing effect is illustrated in Fig. 1 by the rough edge on one side of the turnings as the diameter of a delta-stabilized ingot was cut. Threading with taps and dies was equally unsuccessful. The gummy chips loaded the taps and dies and produced severe galling.

b. Plunge Cutting

Threads were successfully cut in delta-stabilized plutonium by using a plunge technique. In this method the compound slide was set at 90° to the rod and the 60° included-angle tool was fed straight into the rod so that

Fig. 1. Delta-stabilized plutonium turnings showing sharp saw-tooth edge.

an equal amount of material was removed from each side of the V-shaped thread. With this type of cut, turning edges curled slightly and the turning moved straight out from the rod as shown in Fig. 2.

Cuts of from 0.0025 to 0.015 in. on the diameter were successfully taken; however, a lubricant such as Mobil Oil Co. Gargoyle DTE-Light was required. The male thread being cut in Fig. 2 is a standard 1 5/8 in.-16 Class 2.[3] Figure 3 shows the mating female thread being cut. Initial cuts of 0.010 to 0.015 in. on the diameter, with a finished cut of 0.0025 in., were taken using a spindle speed of about 60 rpm. The threaded

Fig. 2. External threading of delta-stabilized plutonium using plunge feeding.

Fig. 3. Internal threading of delta-stabilized plutonium using plunge feeding.

delta-stabilized plutonium parts were inspected using conventional thread gauges and steel standard threaded rings or plugs as shown in Fig. 4.

ASSEMBLY OF THREADED PARTS

Severe galling resulted when threaded delta-stabilized parts were assembled. Liberal use of lubricants during assembly reduced the galling, but was objectionable because organic or water-base residues remaining in the threaded grooves react with plutonium and form hydrides or oxides. Not only are the hydrides and suboxides pyrophoric, but the increased volume of the compounds can fracture the threads.

Fig. 4. Inspection of 1 5/8 in.-16 threaded delta-stabilized plutonium rod using steel gauge.

The procedure developed for assembling delta-stabilized threaded parts was as follows: Powdered molybdenum or tungsten disulfide was worked into the soft threads using a pointed phenolic rod as the parts were rotated in a lathe. This gave a case-hardening effect to the threads plus good lubrication which eliminated galling during assembly. Figure 5 shows an assembled 1 5/8 in.-16 Class 2 threaded delta-stabilized plutonium unit which meets standard thread tolerances.

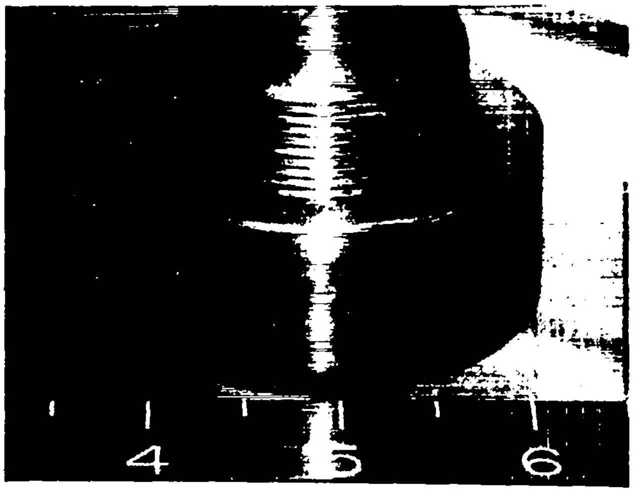

Fig. 5. Partially assembled 1 5/8 in. -16 threaded delta-stabilized plutonium components.

CONCLUSIONS

Soft delta-stabilized plutonium can be threaded by the method described. Treatment of threaded parts with dry molybdenum or tungsten disulfide gives a case-hardening effect plus good lubrication which permits assembly without galling.

Although not tested, an alternate thread cutting method using the plunge feeding technique with a milling cutter ground to the same 60° included angle as the V-shaped tool probably would be satisfactory.

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