Threading and Assembly of Soft Delta-Stabilized Plutonium Parts
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Price: Printed Copy $3.00; Microfiche $0.65
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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 con-
trast to unalloyed plutonium which has a hardness of
\( \sim 275 \) DPH and machining characteristics similar to
cast iron, the delta-stabilized material has a hardness
of \( \sim 40 \) DPH and machines like annealed copper. The
delta-stabilized material is preferred to unalloyed plu-
tonium 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 fabrica-
tion 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 condition-
ing 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 un-
successful. 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
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. 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 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 sub-oxides pyrophoric, but the increased volume of the compounds can fracture the threads.
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.

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.

REFERENCES


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