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Manufacturing Process Development to Produce Depleted Uranium Wire for EBAM Feedstock

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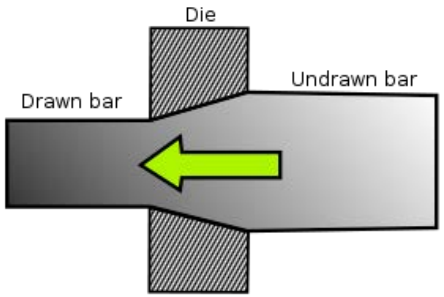
Production of Depleted Uranium Wire

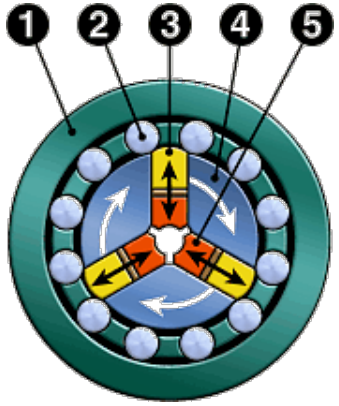
Wire produced from depleted uranium (DU) is needed as feedstock for the Electron-Beam Additive Manufacturing (EBAM) process.

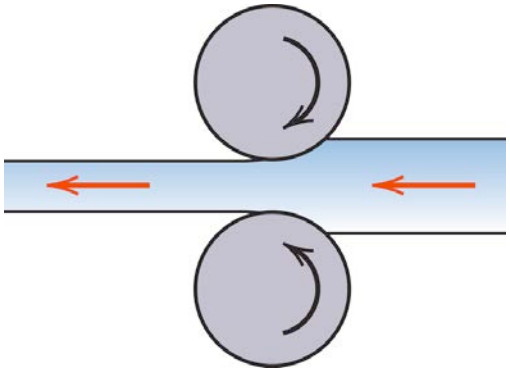
- Goal: long lengths of DU wire with round or rectangular cross section, nominally 1.5 mm (0.060 inches)

Fabrication options

- wire drawing
- swaging
- rolling: grooved rolls; grooveless (smooth rolls)







Previous Work

Los Alamos National Laboratory

- Previous work at LANL used swaging and wire drawing to produce small quantities of DU wire
  - R. E. Anderson, J. M. Taub, and D. T. Doll, “Fabrication of Uranium Wire”, LAMS 967, October 1949
  - E. L. Brundige, G. S. Hanks, and J. M. Taub, “Fabrication of Uranium Welding Rod”, LA-2225, September 1958
  - used Ag and/or Cu plating on surfaces, to improve lubrication effectiveness, and to prevent oxidation

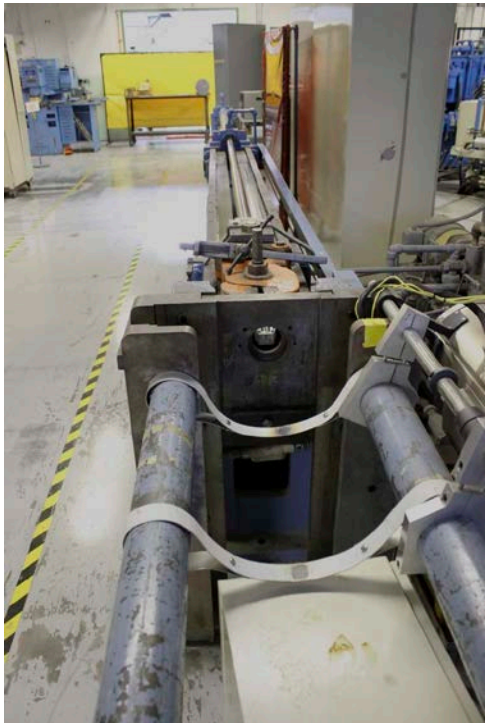
Y-12 National Security Complex

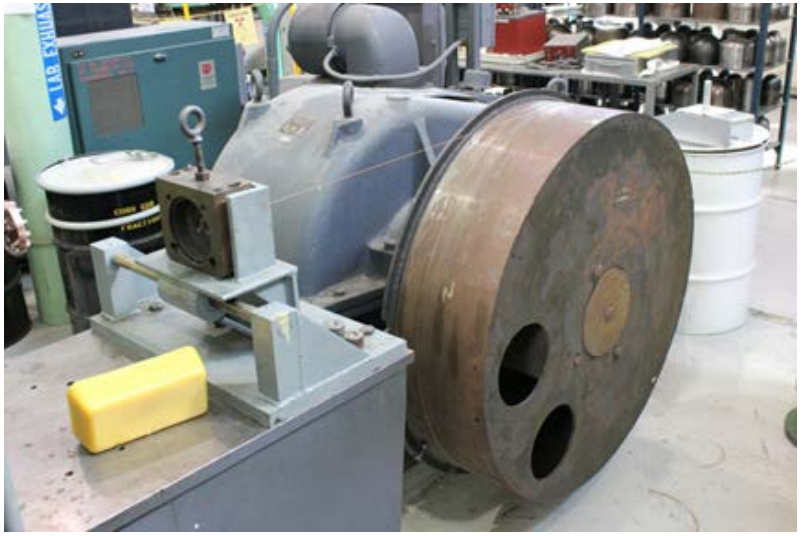
- Swaging is used to produce short lengths of stock at Y-12

Swaging Equipment in MST-6

- dies from 1.250 to 0.012 in. (31.8 to 0.3 mm)
- located inside Radiological Controlled Area (RCA)

Wire Drawing Equipment in MST-6





- hydraulic drawbench, 10 foot stroke
- take-up reel on Waterbury Farrel rolling mill
- dies from 1.250 to 0.010 inches (31.8 to 0.25 mm)
- not inside RCA

Swage and Draw Options

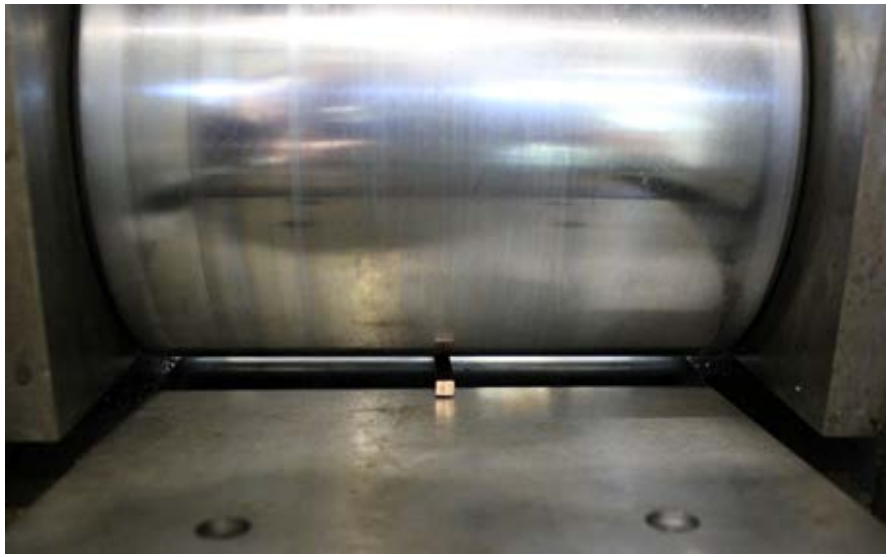
- some existing equipment in MST-6
- some inside RCA, some not in RCA
- only suitable for low volume production
- labor intensive
- difficult, physically demanding process (swaging)
- circular cross section
- limited lengths, long footprint for drawbench
- use of take-up reel requires coiling of stock

Alternatives to Swaging or Drawing: Rolling

Grooveless Rolling

Grooveless rolling (with smooth rolls) can be used for initial reductions of bar stock.

- square wrought bar
- rotate 90° after each rolling pass
- some spread, some extension



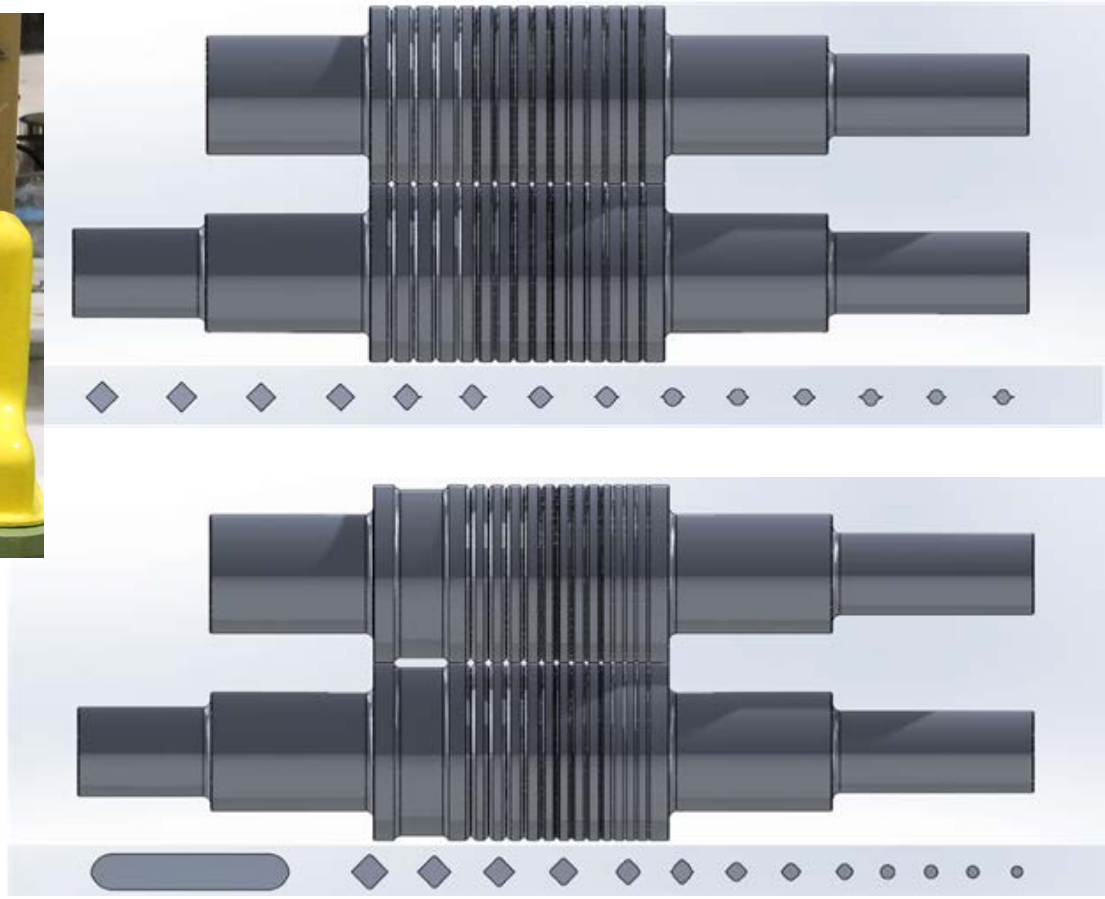
Grooveless Rolling Trials

- useful initial reductions in area can be achieved with grooveless rolling
- even with careful rolling schedules and in-feed guides, large reductions lead to ends of rods becoming off-square, skewed
- may need out-feed guides to prevent distortion

Rolling with Grooved Rolls

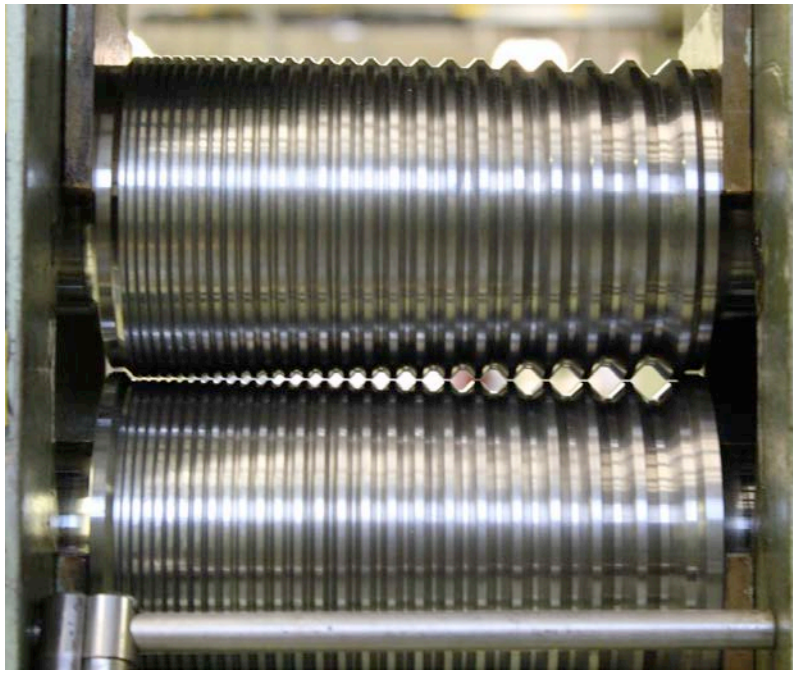
- use rolls with grooves of appropriate cross section to control spread, cross section of rolled stock
- need to design groove geometry, reduction of area per pass
- cost for fabrication of grooved rolls
- production of flash or fins must be avoided
- selection of lubricant
- application of lubrication during forming
- removal of lubricant after forming
- ability to coil thinner material

Stanat Dual-Stand Mini Mill

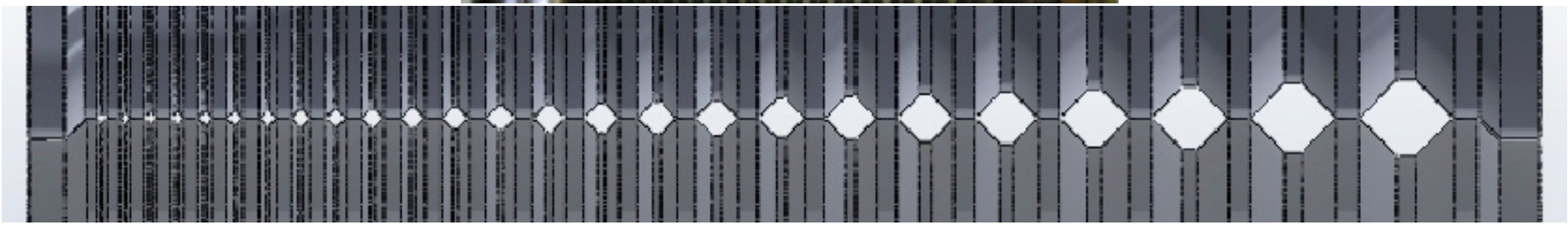


- 14 + 13 = 27 grooves
- 0.120 to 0.050 inches (3.0 to 1.3 mm)

MDM Rolling Mill with Flat-Bottom Vee Grooves



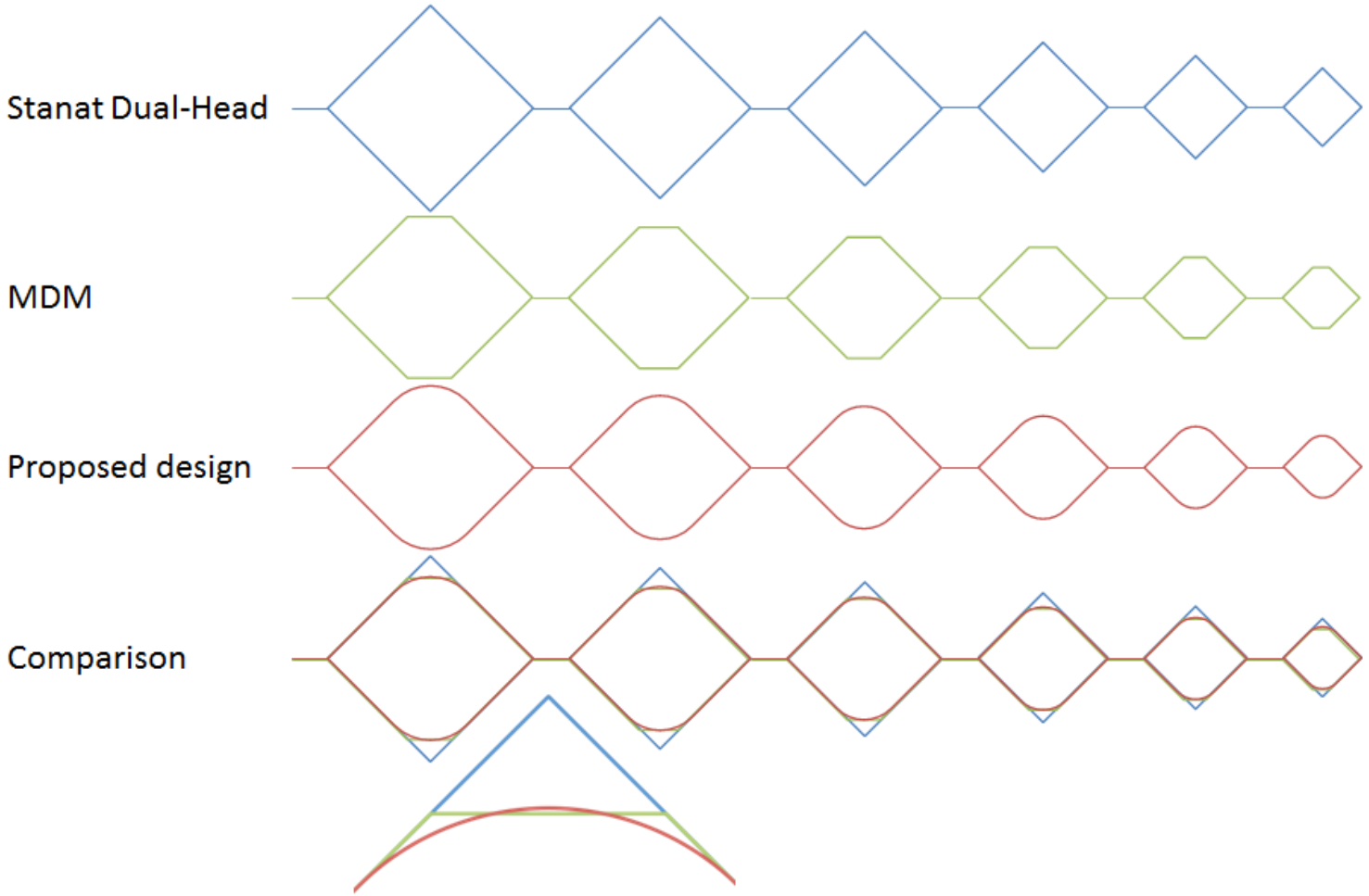
- 25 grooves
- 9 to 1 mm (0.35 to 0.04 inches)



Initial Wire Production Trials

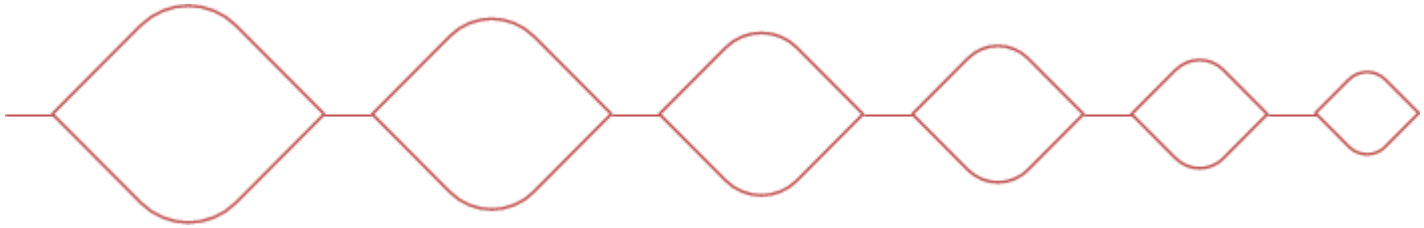
1: square copper bar, 12.5 mm square (0.492")
2: after grooveless rolling to 3.8 mm square (0.150") and trimming to length
3: bar from 2 reduced using grooved rolling to 2 mm (0.080")
4: round copper wire reduced to 1.5 mm (0.040") diameter by successive wire drawing

Roll Groove Design



Proposed Method for Producing DU Wire

- rolling with grooved rolls
- refurbished Stanat 2-high rolling mill
- 6-inch diameter by 10-inches wide rolls, heated (~250°C)
- round-bottom vee grooves: modified square
- groove radius = 30 % of groove width (square width)
- 12.5 % reduction of area per pass
- 41 passes to reduce 1-inch square bar to 0.060-inch wire (square)
- 4 sets of rolls: 1 smooth, 3 grooved



Production of DU Wire: Current Status

1. Rolling methods, rather than swaging or drawing, are preferable for production of intermediate quantities of DU wire.
2. Trials with grooveless rolling have shown that it is suitable for initial reductions of large stock.
3. Initial trials with grooved rolling have been successful, for non-rad materials.
4. A refurbished rolling mill has been ordered.
5. Modified square grooves (square round-bottom vee grooves) with 12.5 % reduction of area per pass have been selected for the reduction process.