TABLE XXXIII. SELECTED EXPERIMENTAL DATA FOR HYDRAW OF BERYLLIUM WIRE

Die angle - 45 degrees (included)
Die material - Tungsten carbide
Fluid - Acidless stearine
Reduction ratio - 2.5:1
Area reduction - 60 percent
O-Ring seal arrangement - 1 PTFE + 1 Rubber

Beryllium wire starting diameter - 0.0196 inch
Wire lubricant - L38
Draw speed - 34 fpm
All wire payed out from free vertical coil
Wire points prepared by chemical etching

Trial	Temperature, F	Stem Pressure (P'), 1000 psi[a]	Draw Stress, 1000 psi: Breakthrough	Draw Stress, 1000 psi: Runout (D)	P' + D, 1000 psi	Length of Wire, feet	Comments
			Beryllium - Ingot Origin				
1021[b,c]	500	156	13.6	13.6	170.0	1	Wire exited at very slow speed
1022[c]	500	108	14.5	14.5	122.5	1	Wire exited at very slow speed
1027	500	128	16.8	16.8	144.8	1	Wire exited at very slow speed
1028	500	134	10.4	2.5	136.5	11	
1032	550	131	10.4	2.5	133.5	22	
1035	530	135	13.3	1.6	136.6	2	Wire tangled in container
			Beryllium - Powder Metallurgy Origin				
1033	550	126	10.4	10.4	136.4	25	Wire exited at very slow speed; after producing 2 ft, P' + D was increased to 237, at which time the remainder of the wire was freely extruded
1034	530	126	10.4	10.4	136.4	2	Wire exited at very slow speed

(a) Fluid pressure gage was out of order.
(b) HYDRAW trials for beryllium wire start at No. 1001.
(c) Fluid was polyphenyl ether; die and feeder were cold during loading.

requirements for a 60 percent reduction indicated that reductions up to 80 percent were possible within the pressure capacity of the container. Should these predictions be correct, it is anticipated that a maximum of 4 successive reductions would be required to reduce wire from 0.020-inch diameter down to the target diameter of 0.001 inch.

The Starting Wire

Beryllium wire of a nominal starting diameter of 0.020 inch was evaluated. It originated from two sources, each having a different processing history:

(1) Ingot wire supplied by the Beryllium Corporation. This originated from a cast ingot which was hot extruded (at 1800 F in a steel jacket) to 3/8-inch rod and then drawn down to 0.020 inch in a nickel sheath at 700-800 F. The nickel sheath was removed and the wire was annealed at 1300 F for 1/2 hours.

(2) Powder-metallurgy wire supplied by the Brush Beryllium Company produced from hot-pressed powder block. In this case, the wire was drawn without a nickel sheath but still at 700-800 F. The powder-metallurgy wire was annealed at 1250 F for 1 hour.

Experimental Developments

Thirty-nine trials were conducted in the HYDRAW of beryllium wire, mainly with the ingot material. Some of these are not reported because they represented trials where experimental procedures were investigated. Initially, copper and Nichrome A wire were used to test the dies and HYDRAW equipment before any attempts were made with beryllium. In some of the trials with beryllium wire, failure to produce wire was due to one of several causes. In each case a better understanding of the techniques required for handling fine beryllium wire and the associated tooling was obtained. The areas where improvements in technique were obtained are:

(1) Method of pointing

(2) Method of coiling

(3) Wire lubrication

(4) Stem and die sealing for 500 F trials

(5) Die design and construction

(6) Handling the wire and hot die during loading in the hot containers.

Method of Pointing. Initially, pointed lengths of wire were prepared long enough to be wrapped round the coiling reel after being passed through the die. This was about 6 feet. Problems encountered here were mainly due to an uneven etching rate by an ammonium bifluoride (NH_4F_2H) solution over the 6-foot length. These were overcome by etching a much shorter point, about 1 foot long. After passing this short point through