An improvement in the die seal arrangement was made during this interim period. Figure 1 shows the present seal arrangement which consists of a beryllium-copper seal-ring and a rubber O-ring.

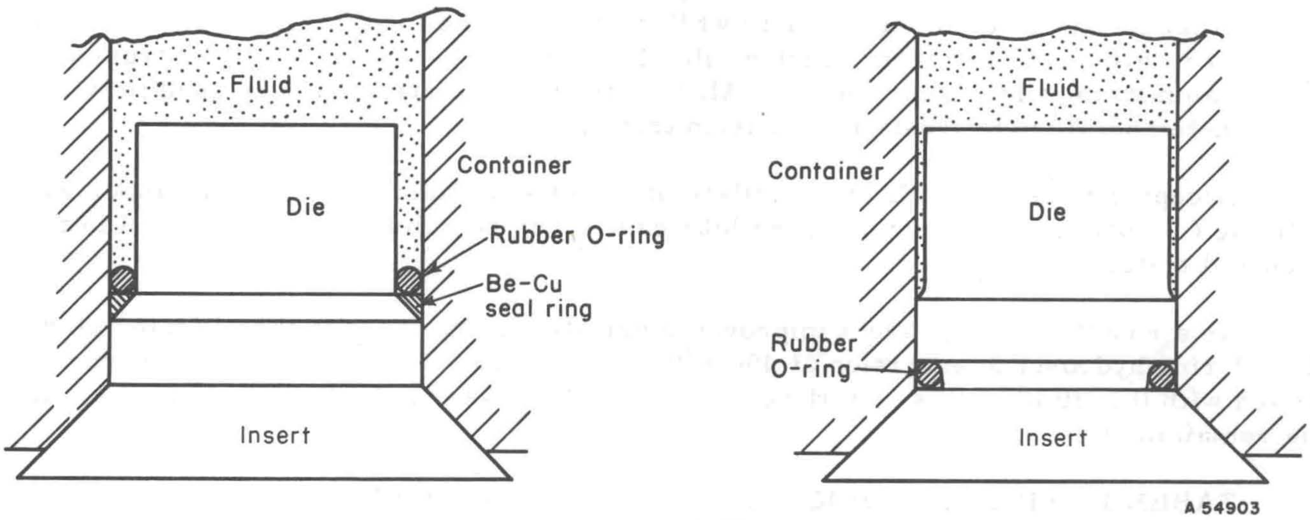

FIGURE 1. DIE SEAL ARRANGEMENTS EVALUATED IN HYDROSTATIC EXTRUSION

The new seal arrangement consists of a single rubber O-ring located at the base of the die. This arrangement is similar in principle to that used at the High Pressure Laboratory, ASEA, Sweden. The advancement is essentially an economic one since sealing was never a problem with the previous arrangement. The new arrangement eliminates need for a metallic seal ring and reduces the die machining costs somewhat. Sealing with this design was achieved in several trials up to about 180,000 psi, the maximum attempted thus far.

Materials

Except for the TZM Molybdenum alloy, the billet materials used during this report are described in Interim Report Numbers I and VI[1,5]. Wrought TZM bar stock was obtained in the following conditions:

Condition	Heat Treatment	Hardness, DPH
Stress relieved	1 hr at 2350 F	276
Recrystallized	1 hr at 2900 F	196

The chemical composition of the stock was reported to be:

Ti - 0.42

Zr - 0.10

C - 0.023

Others - 0.007

Mo - balance

Lubricants, Coatings, and Fluids

Table 1 lists billet lubricants used during the last quarterly period. Lubricant 52 was modified to L53 by adding 20 wt % molybdenum disulphide. This in turn was modified further to L54 by the addition of 10 wt % graphite. The modifications were made in an effort to produce a lubricant which would eliminate stick-slip during the extrusion of 7075-0 aluminum at low stem speeds. All the other lubricants have been used previously in room-temperature hydrostatic extrusion trials.

Except for one billet all of the billets of Ti-6Al-4V titanium alloy were anodized with the C3 coating before applying the lubricant. The remaining billet was used in the uncoated state.

As a result of the apparent improved lubrication achieved with the silicate ester fluid during hydrostatic extrusion at 400 F[6], some room-temperature trials were conducted with this fluid in this report period. Castor oil was used as the fluid medium in the remaining trials.

TABLE 1. BILLET LUBRICANTS USED FOR HYDROSTATIC EXTRUSION DURING THIS INTERIM REPORT PERIOD

Lubricant	Source	Description	Billet Material Treated
L17	Battelle	20 wt % MoS_2 in Castor Wax	7075-0 Al, Ti-6Al-4V, TZM, 4340
L31	Commercial	Fluorocarbon Telomer	7075-0 Al, 4340, Ti-6Al-4V
L33	Battelle	55 wt % MoS_2 and 6 wt % graphite in sodium silicate	7075-0 Al, Ti-6Al-4V
L38	Commercial	PTFE lacquer	7075-0 Al, 4340, Ti-6Al-4V, TZM, Be
L52	Commercial	Stearyl stearate	7075-0 Al
L53	Commercial & Battelle	20 wt % MoS_2 in stearyl stearate	7075-0 Al, 4340
L54	Commercial & Battelle	20 wt % MoS_2 and 10 wt % graphite in stearyl stearate	7075-0 Al

CHARACTERISTICS OF PRESSURE-DISPLACEMENT CURVES

In reporting the results of trials conducted so far, a written description of the characteristics of the pressure-displacement curve obtained during extrusion has been used. To simplify matters, the types of curves obtained will now be described by using typical representative diagrams of the curves. It has been found that the extrusion pressure-displacement curves can be classified into families as shown in Figure 2, page 25. The figure is placed at the end of the text on a foldout page for ready reference