was used as the base line for comparison with the other systems. A comparison of the data indicates that none of the new lubrication systems evaluated appeared to be better than castor oil and L17 lubricant. For five of the new lubricant systems the trials were stopped before extrusion breakthrough occurred. This was because either relatively excessive pressures were obtained or, in the case of Trial 346, because one pressure-recording instrument falsely indicated a high pressure. In Trials 345 and 365 extrusions were produced with pressures approximating those obtained with L17 lubricant (Trial 347). Although the extrusions produced in Trials 345 and 347 were of generally good quality, lubrication breakdown occurred as evidenced by stick-slip during runout and some areas of poor extruded surfaces. In the case of Trial 365, the combination of polyethylene glycol and L47 lubricant decreased the severity of stick-slip (as compared to castor oil in Trial 345), but did not eliminate it.

TABLE 2. EXPERIMENTAL DATA FOR COLD HYDROSTATIC EXTRUSION OF 7075 ALUMINUM ROUNDS

Die Angle	45 degrees	Stem Speed	20 ipm
Extrusion Ratio	20:1	Billet Surface Finish	60 to 100 microinches, rms

Item	Trial	Hydrostatic Fluid	Billet Lubricant	Extrusion Pressure, 1000 psi				Length of Extrusion, inches	Comments
				Breakthrough		Runout			
				Stem	Fluid	Stem	Fluid		
1	347	Castor oil	L17	162.0	152.0	144.0	130.0	65-1/2	Severe stick-slip followed by uniform Pr
2	380	Castor oil	L8	180.0	172.5	--	--	0	P_b not reached; stopped at indicated pressure
3	343	Water	L22	234.0	213.0	--	--	6	P_b not reached; die broke
4	344	Water	L46	195.0	186.0	--	--	0	P_b not reached; stopped at indicated pressure
5	346	Castor oil	L46	168.0	144.0	--	--	0	P_b not reached; stopped at indicated pressure prematurely because of false high pressure reading
6	365	Polyethylene glycol	L47	165.0	154.5	143.0	136.5	62-1/2	High P_b peak; moderate stick-slip
7	345	Castor oil	L47	165.0	156.5	141.0	130.5	44	High P_b peak; severe stick-slip
8	356	Castor oil	L51	202.0	187.5	--	--	0	P_b not reached; stopped at indicated pressure

It is expected that additional lubricants will be investigated during the next report period.

Extrusion Evaluation

Several of the 7075-0 aluminum extrusions produced during the last interim report period were examined to evaluate extruded product quality. Surface roughness and hardness measurements were determined.

As indicated in Table 3, extruded surface quality of 7075-0 aluminum rounds showed little dependency on extrusion conditions when evaluated by surface roughness measurements. The spread in surface finish obtained over the entire range of extrusion

conditions shown is small. Of particular significance is the large improvement in surface generally obtained as a result of hydrostatic extrusion. The fact that considerable variation in extrusion variables can be permitted without significantly affecting surface quality will be important in commercial application of the hydrostatic extrusion process.

TABLE 3. SURFACE ROUGHNESS OF 7075-0 ALUMINUM ROUNDS HYDROSTATICALLY EXTRUDED UNDER VARIOUS CONDITIONS

Die Angle 45 degrees
Fluid Castor oil

	Extrusion Conditions			Surface Roughness, microinches, rms	
Trial	Extrusion Ratio	Stem Speed	Lubricant	Before Extrusion	After Extrusion
249	20	20	L11	270	10-20
297	20	20	L11	300	40-90
283	20	20	L11	420-540(a)	70-120
281	20	20	L17	400-500(a)	40-70
319	40	20	L17	380-520(a)	30-60
322	60	20	L17	350-500(a)	30-60
309	20	20	L17	100-250	20-30
310	20	80	L17	100-120	20-40
318	40	20	L17	45-65	50-120
324	60	20	L17	60-100	30-50

(a) Surface grit-blasted followed by vapor-blasting.

Hardness measurements made for extrusions made at a constant extrusion ratio showed no variation in hardness regardless of lubricant, stem speed, or type of extrusion curve variations. The increase in hardness obtained with increased area reduction is shown below:

Material Condition	Reduction in Area, percent	Vickers Hardness Number
As-received	--	90
Extruded at 20:1	95.0	100
Extruded at 40:1	97.5	115
Extruded at 60:1	98.3	120