It is worthwhile to point out that the breakthrough pressure on restarting after stopping was, in both cases, about 43,000 psi or 32 percent higher than the pressure required for initial breakthrough. Also, it is significant that severe stick-slip occurred during runout, whereas no stick-slip occurred during runout of the first billet.

TABLE XXXV. EXPERIMENTAL DATA OBTAINED IN THE INVESTIGATION OF TANDEM EXTRUSION AT 80 F

Material - 7075-0 aluminum
Extrusion Ratio - 20:1
Stem Speed - 20 ipm

Billet Diameter - 1-3/4 inches
Fluid - Castor oil
Billet Lubricant - L53

Trial	Joint Design	Operation	Fluid Extrusion Pressure, 1000 psi		Type of Curve(a)	Length of Extrusion
			Breakthrough	Runout		
453	A	Extrusion stopped	138	122	B2	72
		Restarted after loading	177	122	C2	56
454	B	Extrusion stopped	134	122	B2	100
		Restarted after loading	179	120	D2	20
472	-	Extrusion stopped	135	121	B2	65
		Restarted after 10 sec.	172	122	D2	10

(a) See Figure 26.

This phenomenon was investigated further in Trial 472, which was conducted to determine the effect of stopping and restarting on pressure requirements during the extrusion of a single billet. Thus, on restarting 10 seconds after stopping, similar high breakthrough pressures and stick-slip occurred.

This behavior was probably due to lubrication breakdown although the precise mechanism is not clear. On depressurization of the fluid, the residual temperature at the die-billet interface (developed before stopping) may be high enough to cause a sharp viscosity drop and/or unfavorable chemical change in the lubricant system. Repressurization may not necessarily renew the same state of lubrication which existed during initial extrusion. Other factors may be that:

(1) The change in surface characteristics of the billet at the billet-die interface may have reduced the contribution of "squeeze" lubrication during re-extrusion.

(2) Sufficient work hardening of the billet nose occurred, in spite of adiabatic heating, that higher pressures were required for re-extrusion.

An alternative to the tandem technique which would eliminate waste of billet material would be to reduce the fluid pressure to the ambient pressure level at the point of final emergence of the extrusion from the die. This would be very difficult to achieve by press-control of the stem motion but may be achieved by a carefully designed plug which followed the billet. The plug design would vary with extrusion conditions and billet extrusion properties.

The tandem extrusion technique using the counterbore joint "A" was utilized in the extrusion of short billets of sintered aluminum product (SAP) which is described in Section 1. There was insufficient length of SAP billet on which to machine a 45 degree nose. The short billets were sandwiched between two billets of 7075-0 aluminum one of which formed the nose of the sandwich. Successful extrusions were obtained of the whole of the sandwiched billet at ratios of 10:1 and 20:1. The pressure-displacement curve indicated the position of the joint by a ripple in the runout pressure followed by a slightly lower runout pressure level. The interruption and lowering in the pressure curve was mainly due to a slight difference in mechanical properties of the two materials.