COLD HYDROSTATIC EXTRUSION OF TUBING

The mandrel tooling arrangement designed for the initial trials of hydrostatic extrusion of tubing is shown schematically in Figure 6. The mandrel is a floating rather than fixed type. It anchored at its top end by a guide which rests directly on the billet top and fits the liner bore closely. Although not shown in Figure 6, the guide contains flats on its OD surface to permit free flow of the hydrostatic fluid medium. As the billet extrudes, the mandrel and guide move with it. The tubing is extruded over a moving mandrel, and the latter is tapered slightly to reduce frictional drag on the tubing. The mandrel can be made a fixed type by placing a tube spacer between the guide and the top flat surface of the die. This arrangement may be investigated later if necessary.

Tubing was produced from both 7075 Al and AISI 4340. The experimental data are given in Table 6. 7075 Al tubing was extruded to the following sizes at ratios of 3.77 and 12.2:1 at stem speeds up to 20 ipm:

	Tube Size, inches		
Ratio	OD	ID	Wall
3.77:1	1.107	0.750	0.178
12.2:1	0.875	0.750	0.063

At a stem speed of 20 ipm, stick-slip was prevented at the lower ratio only. Tubing of excellent surface quality was produced under these conditions. At a ratio of 12.2:1, stick-slip persisted at the stem speed of 20 ipm but tubing of fair surface quality was still produced as seen in Figure 5. The lathe machine marks orginally on the billet are evident on the tube surface, indicating that lubrication during the "slip" portion of stick-slip was sufficiently good to preserve the pattern. If undesirable, such patterns can probably be prevented or minimized by changing the original billet surface finish or modifying the die design.

About 10 inches of AISI 4340 tubing of high surface quality was produced at an extrusion ratio of 3.77:1. The runout pressure was uniform at first, indicating that lubrication was good. Toward the end of the stroke, the runout pressure began to rise continuously without any evidence of stick-slip. Examination of the extrusion afterward revealed that the pressure rise was due to excessive frictional drag of the tubing over the bottom portion of mandrel. Part of the frictional drag may have been due to the simultaneous thermal contraction of the tubing and thermal expansion of the mandrel. To prevent or minimize this problem, the taper on the mandrel will be increased to provide greater clearance between it and the extruded tubing.

FUTURE WORK

During the next interim report period evaluation of extrusion trials made during this report period will be continued. These efforts will include quantitative measurement of extruded surface quality as well as determination of mechanical properties where appropriate. Also, it is expected that hot extrusion trials will be started, and efforts will continue in preparing for experimental work with other extrusion shapes and materials.

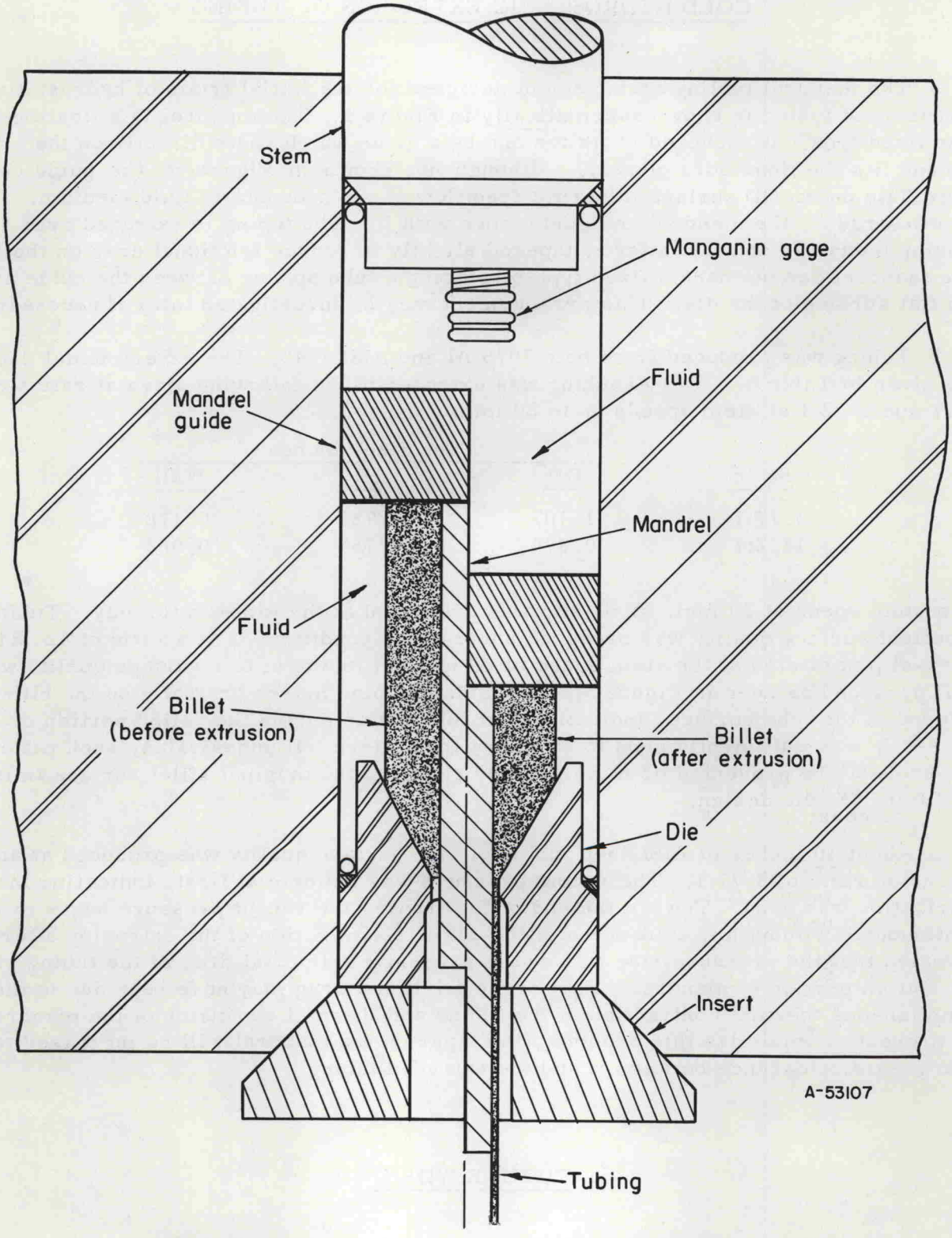

FIGURE 6. MANDREL TOOLING ARRANGEMENT FOR HYDROSTATIC EXTRUSION OF TUBING