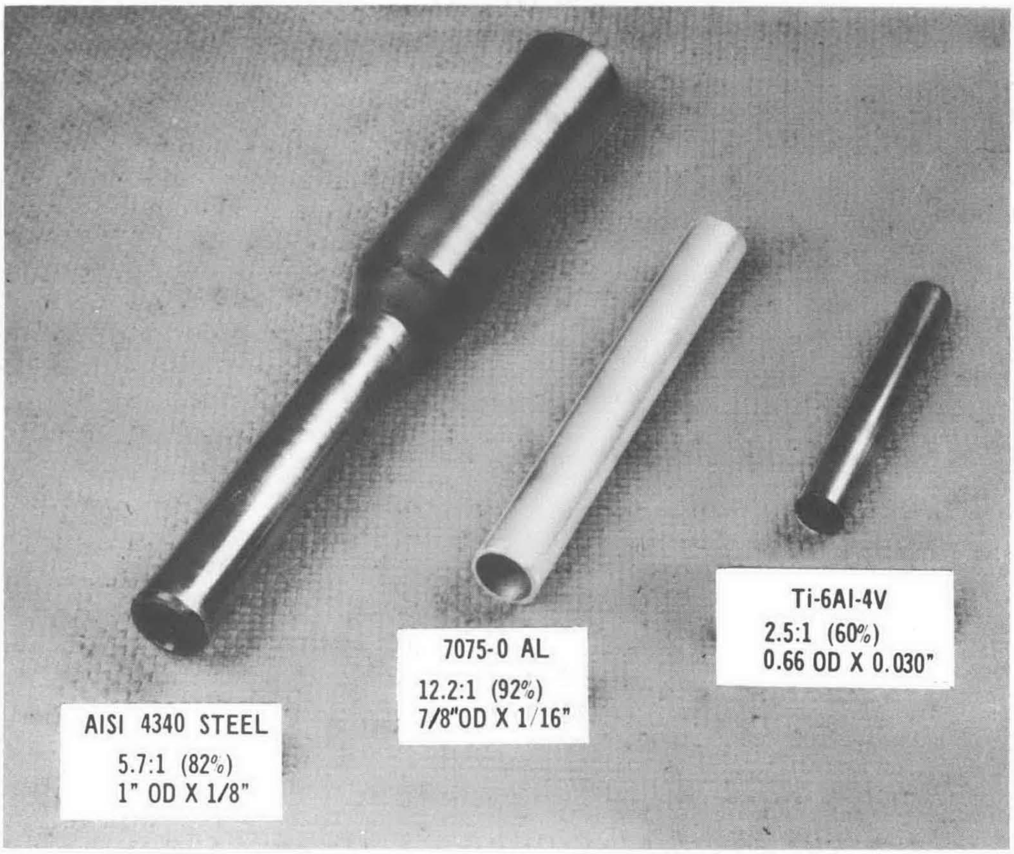

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FIGURE 3. HYDROSTATICALLY EXTRUDED TUBING FROM THREE ALLOYS

Data given refers to extrusion ratio, percent reduction, and extruded tube dimensions.

III

EQUIPMENT AND PROCEDURE

Extrusion Tooling

The operational requirements of the hydrostatic extrusion tooling designed and built in the previous program at Battelle[1] were that it withstand internal fluid pressures up to 250,000 psi at temperatures up to 500 F. The extrusion tooling was designed for use in a 700-ton capacity vertical hydraulic press at Battelle. It is shown installed in the press in Figure 4. The general details of the tooling design are shown in the cross-sectional view in Figure 5. The container assembly, consisting of four concentric shrunk-fit rings, is seated on a tapered insert. The extrusion die is located entirely within the bore of the liner and rests directly on the insert.

The columns bolted to the container flange are used to raise and lower the container assembly for inserting and removing the die and billet between extrusion runs. The columns are connected beneath the press platen to a die cushion actuated by an auxiliary double-acting hydraulic system.

The over-all size of the tooling can be judged from the nominal dimensions of the following basic components:

Component	ID, inches	OD, inches	Length, inches
Stem	--	2-3/8	13
Liner	2-3/8	--	20
Container	13-3/8	22	24-7/8

The outside diameter of the container flange is 30-1/4 inches. Billets up to 2-1/4 inches in diameter and 16 inches long can be accommodated within the liner bore.

The design of the container assembly was altered slightly during the course of the program and the details are given in Section 4 of the report along with the complete stress analysis of the tooling and description of the tool materials.

The Hydrostatic Extrusion Operational Sequence

Details of the hydrostatic-extrusion operation are shown in Figure 6. The nose of the billet is tapered to mate precisely with the die-entry surface to prevent fluid leakage. No forcing or wedging of the billet is necessary to obtain a seal. At the start of a typical run, the nose of the billet is dipped into the fluid medium to be used and placed in the die opening. This is done so that the nose will be exposed to the same fluid environment as the rest of the billet. The billet and die are then placed and aligned on the tapered insert as shown in Figure 5. The container assembly is lowered and seated against the tapered insert with a hold-down force to insure alignment and lateral stability. Although a hold-down force of 100 tons (the maximum available on the press) was found to be adequate, it is likely that a much lower force (perhaps in the order of 25 to 50 tons) would