HYDROSTATIC EXTRUSION STUDIES

Fabrication of the redesigned container assembly was subcontracted to National Forge Company of Irvine, Pennsylvania. The container, scheduled to be completed by the week of September 6, was delivered about eight weeks later on November 10, 1965. Examination of the container on arrival at Battelle revealed some small nicks and gouges on the top end face of the liner component. To avoid the possibility of these defects acting as stress raisers, the top end face of the container assembly was surface ground to remove them.

Subsequently, the hydrostatic extrusion tooling was assembled in Battelle's 700-ton vertical hydraulic press and the fluid and stem pressure measuring instruments were calibrated. At this point, unfortunately, the time remaining in the present quarterly period was enough to scarcely begin the hydrostatic extrusion study scheduled for the second series of experiments. The objective of this series was to continue the study of the critical process variables (Part I of Phase I). Although a few trials were conducted, the numbers so far were too few to ascertain definite effects of the variables studied. Thus, reporting of the results of these trials has been postponed until the next interim quarterly report.

ANALYSIS OF SEVERAL HIGH-PRESSURE CONTAINER DESIGN CONCEPTS

An analytical study of several high-pressure container design concepts has been completed. Theoretical solutions were derived for the various designs. The analyses for maximum pressure capability, residual stresses, and required shrink-fit interferences were programmed for calculation on Battelle's CDC 3400 computer.

A detailed report of the study could not be finished in time for this interim report because the description of the analyses is fairly long and because there are many significant findings to be discussed. However, the results of immediate interest are available and are presented in this report. A complete and detailed description of the analyses will be included in the next interim report.

SCOPE OF ANALYSIS

The purpose of this study is to determine the maximum pressure capability of several designs of vessels for containing fluids at the pressures encountered in hydrostatic extrusion and other hydrostatic forming processes. Containment of bore fluid pressures up to 450,000 psi at room temperature and at temperatures of 500 F and 1000 F is considered.

Four types of pressure vessel designs were analyzed in detail. These are:

(1) Multi-ring container,
(2) Ring-segment container,
(3) Ring-fluid-segment container, and
(4) Pin-segment container.

The four cylindrical containers are shown in Figure 1. A wire-wrapped (strip-wound) vessel and a controlled fluid-fill, cylindrical-layered container were also considered, but only briefly.

The multi-ring container was one of the first design modifications of the monoblock thick-walled cylinder*. An initial compressive stress at the bore is achieved by shrink-fit assembly of successive cylinders each manufactured to provide an interference fit with its mating cylinder. The multi-ring container has been analyzed on the basis of static shear strength by Manning[1, 2, 3]†.

The ring-segment container with one outer ring was patented by Poulter[4] in 1951. One intent of this design is to reduce the pressure acting upon the outer ring by using a segmented cylinder to redistribute the pressure at a larger diameter. However, the inner cylinder is always subject to the bore pressure. The external diameter of the vessel necessarily increases with increasing segment size.

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*The monoblock thick-wall cylinder is the simplest type of pressure container. However, for the very high-pressure levels considered in this study it is a relatively inefficient design.

† References listed at end of report.