SECTION 4

HYDROSTATIC EXTRUSION CONTAINERS DESIGNED AND CONSTRUCTED IN THE PROGRAM

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SUMMARY OF SECTION 4

The history of container design during the course of this program essentially follows the developments described in Section 3. An early container of 3-ring construction, designed on the maximum-shear-strength failure criterion failed due to low-cycle fatigue. The liner was replaced by two shrink-fit rings to obtain a higher prestress in the bore. This container was used in the remainder of the program. Stress analyses are presented for both of those containers. In addition, this section describes the design and the construction of a container that was intended for stand-by use in the event of another fatigue failure. This container was designed on the basis of fatigue design described in Section 3.

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ANALYSIS OF THREE CONTAINERS DESIGN

The configuration of the three hydrostatic-extrusion containers described herein was basically as shown in Figure 66. The boundary conditions for the designs were:

(1) Maximum operating internal pressure on bore = 250,000 psi

(2) Maximum operating temperature = 500 F

(3) Pressure vessel ID = 2.375 inches

(4) Pressure vessel OD = 22.000 inches

(5) Axial load on vessel is negligible.

For reference purposes, the containers will be designated Containers I, II, and III in order of historical development. The design of Container I commenced in June, 1961, and was modified in January, 1965, to be redesignated Container II. As a result of the liner fatigue failure experienced with Container I, Container III was designed on the basis of a fatigue-failure criterion with the aim of obtaining a fatigue life in the order of 10^4 to 10^5 cycles. Container III was completed toward the end of the program but was not used in the hydrostatic-extrusion studies described in Sections 1 and 2.

Container I

Container I, which was designed and constructed in the previous program(47), was used in the early stages of this program. A detailed analysis of its design has been published.(47) In view of the more sophisticated analysis made in Section 3, it would be irrevelant to detail the design steps taken. However, the failure criterion used and the design interferences obtained will provide a useful background to the development of container designs.

Selection of Failure Criterion

Initially, failure of the design for Container I was interpreted as that condition where the diameter of the bore increased due to plastic yielding of the bore surface. Such a condition would have caused leakage by the previously close fitting stem that would result in an inability to compress the fluid adequately. With this in mind, three commonly applied failure criterion were examined to determine which was the most applicable.

The Rankine or maximum-normal-stress theory teaches that failure will occur when any one of the principal stresses reaches the level of the yield strength in uniaxial tension. Thus, it neglects the effects of the other two principal stresses. The Tresca or maximum-shearing-stress theory predicts yielding will occur when the difference between the maximum and minimum principal stresses reaches a level of the yield strength in simple tension. Experimental evidence suggested that this theory was on the