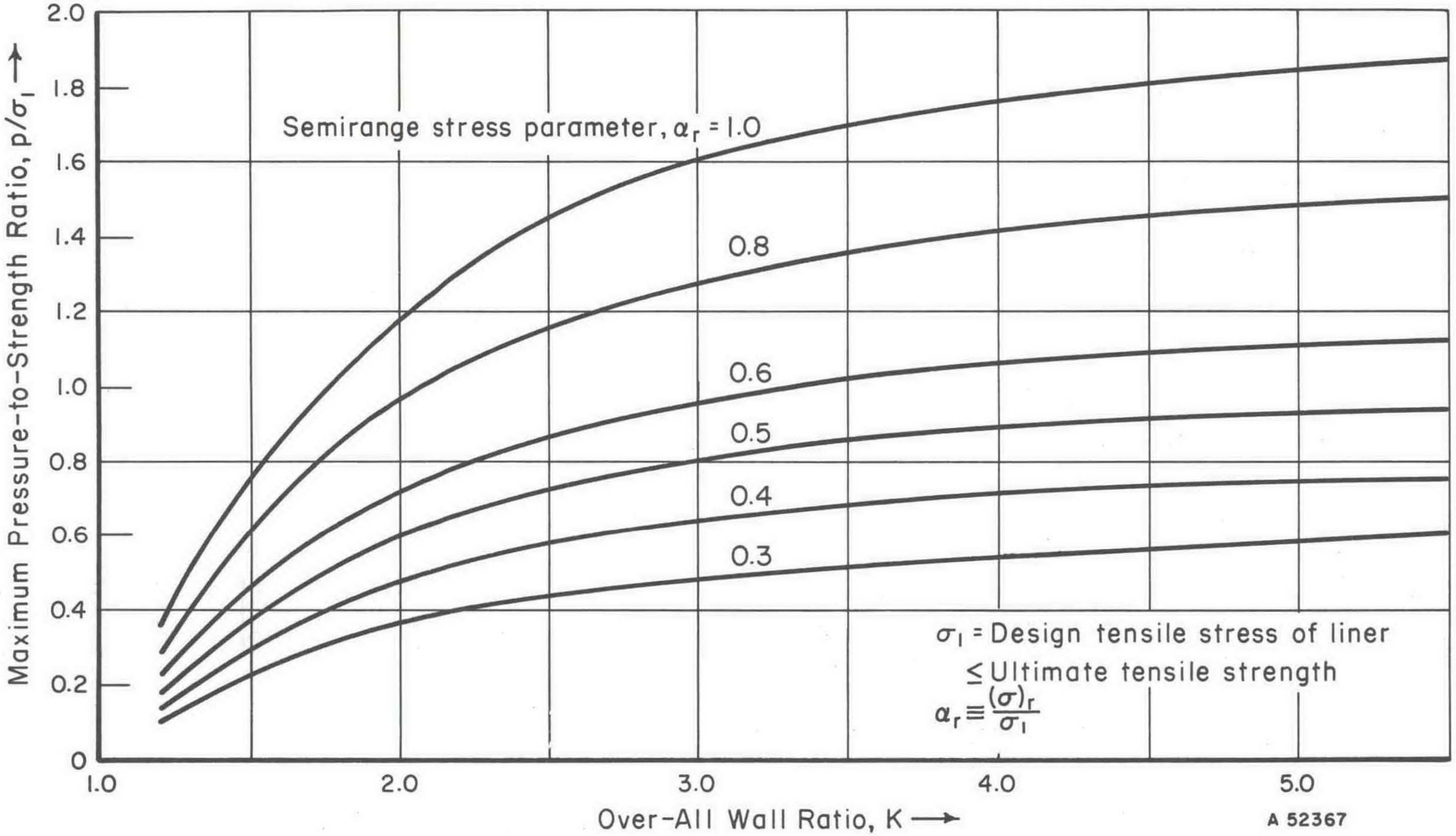

FIGURE 5. MAXIMUM PRESSURE-TO-STRENGTH RATIO IN MULTI-RING CONTAINER WITH HIGH-STRENGTH LINER BASED ON THE FATIGUE TENSILE STRENGTH OF LINER

Ring-Segment Container

The ring-segment container is also assumed to have a high-strength liner and relatively more ductile outer cylinders. The segment strength is assumed adequate. Its pressure-to-strength ratio p/σ_1 is plotted in Figure 6 for various k_1. From this figure it is evident that the ring-segment container cannot withstand as great a pressure as the multi-ring container if the over-all size is the same. This result is believed due to the fact that the segments do not offer any support to the liner – they are "floating" members between the liner and the third component, another ring. The effect is more pronounced as the segment size is increased; that is, the bore pressure capability decreases with increasing segment size. The detrimental effect of insufficient segment support to the liner can be reduced by using a high modulus material, such as tungsten carbide, for the segment material. However, in spite of this, it has been found that the reduction is not sufficient to increase the pressure capability of the ring-segment container to that of the multi-ring container for the same over-all wall ratio.

If the size and number of components of the ring-segment container are made large enough, then the pressure-to-strength ratio of this design can be made to approach that of the multi-ring container. Thus, its maximum cyclic pressure is 300,000 psi for 10^4 to 10^5 cycles life based upon an ultimate tensile strength of 300,000 psi for the liner.

Ring-Fluid-Segment Container

A high-strength liner and relatively more ductile outer cylinders are also assumed for the ring-fluid segment container. The functional dependence of the pressure-to-strength ratio of this container on the geometrical parameters is more complicated than for the other containers – mainly because of the additional parameter, the fluid support pressure, p_3. For example, Figure 7 shows that p/σ_1 decreases with segment size (k_2) for small K' but increases with segment size for larger K' ($K' \equiv k_1 k_2 k_3 = r_3/r_o$). This is an advantage over the ring-segment container (Figure 6) in which increasing segment size always has a detrimental effect. The pressure-to-strength ratio is also increased by increasing the support pressure p_3 as shown in Figure 8. (σ_1 and σ_3 are the design tensile stresses of the liner, $n = 1$, and the support cylinder, $n = 3$). With the high ratios shown, it is theoretically possible to have bore pressures as high as 1,000,000 psi in ring-fluid-segment container. However, practical limitations which are discussed later, considerably reduce the pressure capability of this design.

Pin-Segment Container

The analysis of the pin-segment container assumes a high-strength liner and lower strength, more ductile pins and segments. It is also assumed that any manufactured interference is taken up during assembly by slack between pins and holes. Therefore, the residual pressure between liner and segments is zero at room temperature but not zero at temperature if the coefficient of thermal expansion of the liner, α_1, is greater than that of the segments, α_2. In the analysis, it assumed that $\alpha_1 \geq \alpha_2$.