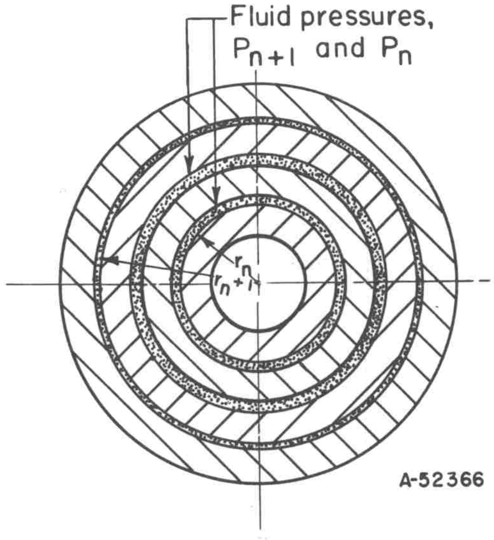

FIGURE 60. CONTROLLED FLUID-FILL CYLINDRICAL-LAYERED CONTAINER [REFERENCE (42)]

In order that each ring may have the same shear stress under static pressure, Berman finds that the same relation, Equation (30) [first found by Manning[5]], applies for the controlled fluid-fill container that also applies for the multiring container designed for static shear strength. If this result is used in a shear fatigue analysis (assuming ductile materials), then Equation (30) can be interpreted as the maximum shear stress developed during a cycle of pressure, i. e.,

$$(S)_{max} = \frac{p}{N} \frac{K^{2/N}}{(K^{2/N}-1)} \tag{70}$$

If the pressures p_n are reduced to zero, then the minimum shear stress during a cycle of pressure is zero. Therefore, the semirange and mean shear stresses are equal,

$$S_m = S_r = \frac{pK^{2/N}}{2N(K^{2/N}-1)} \tag{71a, b}$$

where S_m and S_r are defined in Equations (6a, b).

If Equation (71a, b) are substituted into the fatigue relation, Equation (9), there results

$$\sigma = \frac{5p}{2N} \frac{K^{2/N}}{(K^{2/N}-1)} \tag{72}$$

It is surprising that this result, Equation (72), is the same as Equation (40) plotted in Figure 44, the result of the shrink-fit analysis, except now the limit Equation (42) no longer applies. Therefore, now p/σ can be made as large as desired simply by increasing N. The only problem is that the required N or K may be too large to be practical. For example, assume σ = 150,000 psi (ultimate strength of a ductile steel), N = 8 and K = 16. Calculating p we find that p = 240,000 psi. Thus, it is concluded that for fatigue applications under high pressure the controlled-fluid-fill, multiring container becomes too large to be practical. Eight rings also means there are seven annuli under fluctuating pressures. (The magnitudes of these pressures are all different and are given by an equation similar to Equation (38).) Design of mechanical apparatus to supply and control all these pressures presents practical difficulties also.