2. Design Calculations

Two design approaches are appropriate. In the first case, the stresses at each interface may be preset and the interferences required to achieve these stresses may be calculated. In the other case, interferences may be estimated, the stresses calculated and the interferences adjusted as necessary in successive iterations. The 1 x 10^6 psi die body was calculated in this way on the basis of previous experience with similar designs. The stresses were acceptable on the first try and no iterations were necessary. A second apparatus was designed to provide a maximum working pressure of 3 x 10^6 psi (200 kilobar). In this case, the calculations after four iterations gave acceptable stresses which are shown below. Both the die body itself and the punches required this support and calculations were made for both.

The quantities calculated are contact pressure p (radial) and tensile and compressive stress f_t and f_c (circumferential) at each interface. These quantities are given by

$$p = \frac{E\delta}{b} \quad \frac{(b^2 - a^2)(c^2 - b^2)}{2b^2(c^2 - a^2)} \tag{1}$$

$$f_t = \frac{b^2 p}{c^2 - b^2} \left(1 + \frac{c^2}{2}\right) \tag{2}$$

$$f_c = \frac{b^2 p}{b^2 - a^2} \left(1 + \frac{a^2}{2}\right) \tag{3}$$

where

- p = contact pressure at ring
- E = Young's Modulus
- δ = interference between rings
- c = outside radius of assembly
- b = outside radius of ring being pushed in
- a = inside radius of ring being pushed in
- f_t = tensile stress
- f_c = compressive stress

3. Assembly and Test

The geometry is shown in Figure 1. Typical calculations for the 1 X 10^6 psi cell are given in Appendix A. The results for a punch assembly are summarized in Table I for the 1 x 10^6 psi and Table II for the die assembly of the 3 x 10^6 psi apparatus which shows the stresses in the final assembly in both the loaded and unloaded condition.

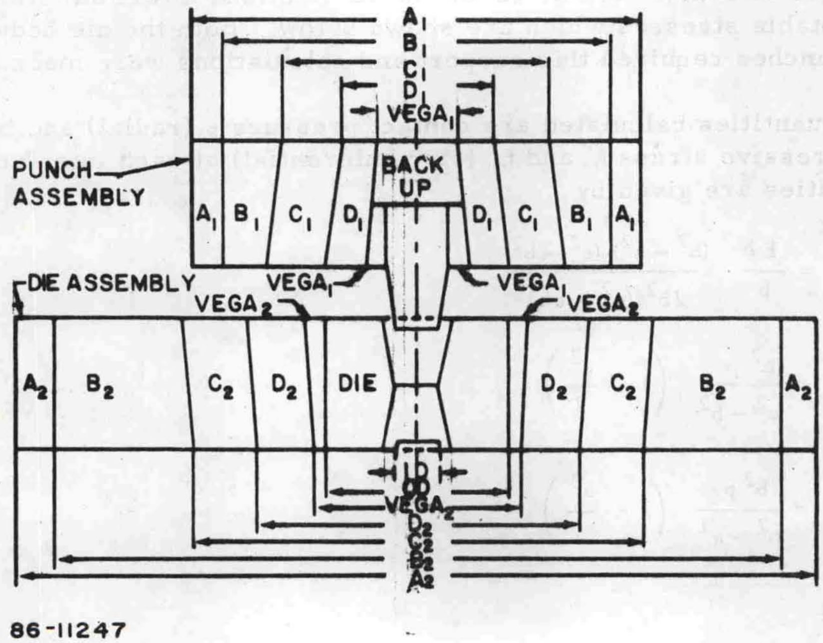

Figure 1 DIE OR PUNCH GEOMETRY