for the creep design of thick-walled closed-ended cylinders containing high internal pressures. Most theoretical investigations to date have used tension data, but the authors have shown [1] that there is a considerable error involved with this form of data even at quite moderate strains due to the increase of stress that accompanies the changing cross-sectional area of the test specimens. In the same paper, they have also discussed the experimental advantages and disadvantages in torsion creep testing over tension creep testing.

Under plastic or creep conditions the state of stress in the walls of a thick-walled cylinder, subjected to internal pressure, is one of a pure shear stress with a superimposed hydrostatic stress. Experimental evidence of this is that the axial strain in such a vessel, if not zero, is certainly of negligible magnitude compared with the circumferential strain. Figure 1 shows a scouting creep test that has been carried out on an EN 25 steel cylinder with a test pressure of 26 ton-ft/in.^{2} at 350° and it is seen that the axial strain is of a negligible proportion. Consequently, if the hydrostatic stress has no significant effect on creep, as seems probable, then pure shear stress data can be applied directly to the design of cylinders. If constant load tension creep data are used, it is necessary to derive constant stress creep data. One is immediately faced with the problem of deciding upon an effective stress criterion instrumental in causing creep, in order to correlate the uniaxial data with the complex stress system in a thick-walled cylinder, e.g., von Mises or Tresca criteria.

The object of this paper is to report torsion, constant load tension, and cylinder creep data obtained for a 0.18 percent C steel at 400°C and to attempt to correlate the experimental cylinder data with the torsion creep data using various theoretical approaches. For comparison purposes, the cylinder data will also be correlated with the tension data using the Bailey theory described later.

THEORETICAL ANALYSES

This section deals with the various theories that the authors have to date used for the prediction of creep in thick-walled cylinders.

The three principal deviatoric stresses in a cylinder wall are

$$\sigma'_\theta = \sigma_\theta - \left(\frac{\sigma_\theta + \sigma_r + \sigma_z}{3}\right)$$

$$\sigma'_r = \sigma_r - \left(\frac{\sigma_\theta + \sigma_r + \sigma_z}{3}\right) \tag{1}$$

$$\sigma'_z = \sigma_z - \left(\frac{\sigma_\theta + \sigma_r + \sigma_z}{3}\right)$$

On the assumption of zero axial strain, then the axial deviatoric stress is zero:

$$\sigma'_z = \sigma_z - \left(\frac{\sigma_\theta + \sigma_r + \sigma_z}{3}\right) = 0$$

Thus,

$$\sigma_z = \frac{\sigma_\theta + \sigma_r}{2} \tag{2}$$

Substituting this into Eqs. (1) gives

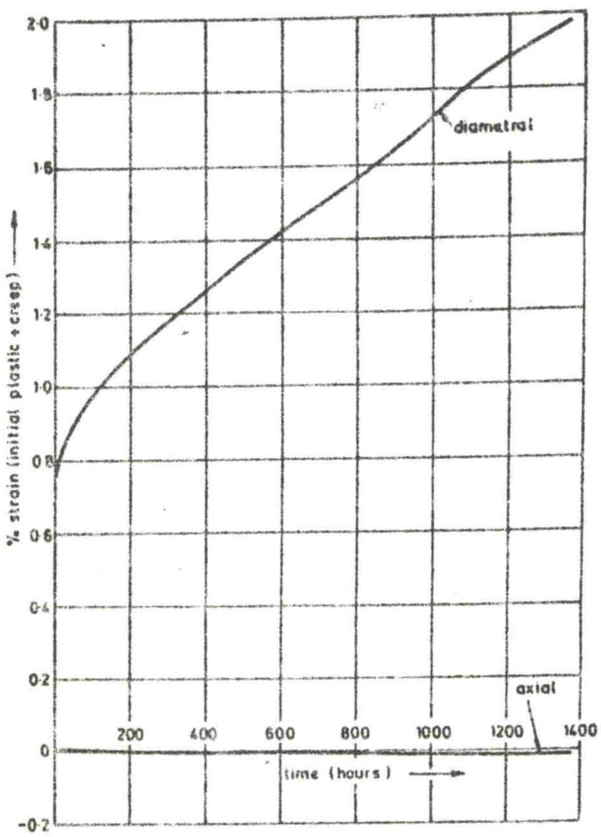

FIG. 1 PRESSURE CREEP TEST ON EN 25 STEEL CYLINDER (K=1.67), TEST PRESSURE 26 tonf/in^2, TEST TEMPERATURE 350°C