

FIG. 3 HYPOTHETICAL ISOCHRONOUS SHEAR STRESS-SHEAR STRAIN CURVES DRAWN FROM TORSION CREEP CURVES

basically that proposed by Manning [9] allows for the dimensional changes associated with large strains. In this section, the approach is extended for use with time-dependent conditions

From a family of torsion creep curves, which include the initial plastic shear strains, a series of imaginary shear stress-shear strain curves can be constructed for various times. Figure 3 shows a hypothetical set of some such curves. If it is assumed that, no matter how the shear stress in a cylinder wall may vary with time, at a given time there is a unique relationship between stress and strain, then it is possible, using the Crossland or Manning type of analysis, to predict a series of isochronous pressure-expansion curves for a thick-walled cylinder of any desired diameter ratio. Hypothetical pressure expansion curves for different times are shown in Fig. 4. From these the diametral creep curves of cylinders with different internal pressures are deduced easily. The horizontal line AB in Fig. 4 for a particular pressure gives the initial plastic strain at time  $t = 0$ , while BC, BD, etc. give the creep strains at times  $t_1$ ,  $t_2$ , etc.

Similar approaches to this have been suggested by Coffin, Shepler, and Cherniak [6] and by Parker [10],

but both these do not make any allowance for dimensional changes.

## TESTING MACHINES AND MATERIAL

The torsion creep specimens used for this work were of thin-walled tubular form with a bore diameter of 0.750 in. and a wall thickness of 0.050 in. Shear strain was measured on a 5-in. parallel gauge length. The thick-walled cylinders had a diameter ratio of 2 with the outer diameter 2 in., and the tension creep specimens were of the standard N.P.L. design with an initial cross-sectional area of 0.1 in.<sup>2</sup> and a 2-in. gauge length. The testing machines have all been fully described in Refs. [1], [11], and [12], respectively, so no further details will be given here.

The material, a wrought carbon steel, was supplied by English Steel Corporation Ltd. in the form of a bar 15 in. in diameter and 74 in. in length. This had been trepanned from the center of a large forging for a chemical reaction vessel. Before delivery, English Steel Corporation Ltd. performed ultrasonic tests on the material, as well as sulphur-printing the end faces to check for segregation. As a result of these tests, some defective material was removed

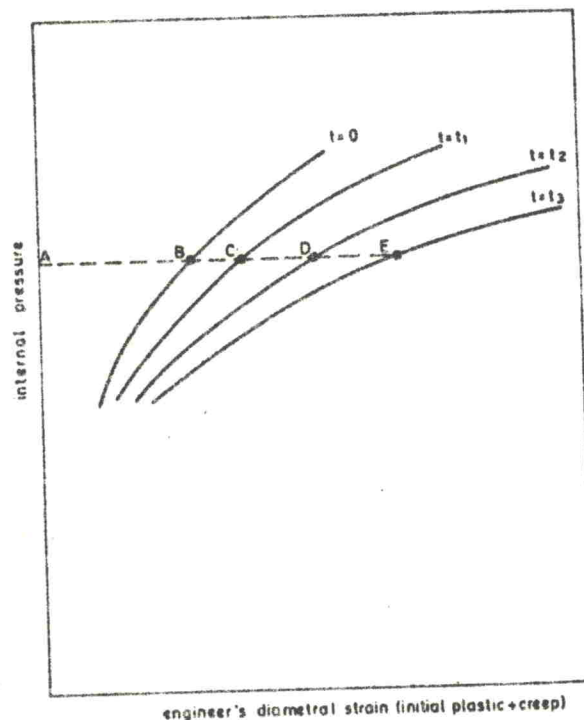


FIG. 4 HYPOTHETICAL ISOCHRONOUS PRESSURE-EXPANSION CURVES FOR THICK-WALLED CYLINDER