up and down, its dimensions become unstable and its seals untight, so that it is finally destroyed. MACRAE [1930] has demonstrated, that a cylinder can be stabilized by submitting it to a progressive "autofrettage" combined with restoring heat treatments.

The simplified theory, which may be applied, as far as small deformations and a yield without hardening are concerned, has no far reaching consequences. It does not say anything about the ultimate pressure p_{1u}, to which a cylinder is submitted before bursting. MANNING [1945 and 1957] has elaborated a theory, which is so complete, that it is not only capable of correctly predetermining the p_{1u} value but also of following the evolution of the stresses developed in the wall from the very small strains up to greatest ones. Manning's theory is based on 3 hypotheses :

(a) There is no scale effect; stresses and strains only depend upon the k ratio.

(b) There is no axial strain, or better, this strain is negligible when it is compared with the others.

(c) The relation between the shear stress and the shear strain in the deformed cylindrical wall is the same as in a torsion test rod.

Hypothesis (a) entitles us to consider a cylinder, of which the inside radius is equal to 1 and the outside radius, to k. Hypothesis (b) combined with the fact, experimentally well established, that the density of the material remains constant, when the material yields, amounts to writing following relation

$$\pi(r+u)^2 - \pi(1+u_1)^2 = \pi r^2 - \pi \quad \text{or} \quad u(2r+u) = u_1(2+u_1). \tag{26}$$

This equation expresses the fact, that the mass comprised between both circles is the same before and after deformation, the inner circle selected being this one of the bore. Eq. (2), adapted to great radial displacements and in which $\sigma_t - \sigma_r$ has been replaced by 2τ may be written as follows

$$2\tau = (r+u)\frac{d\sigma_r}{d(r+u)} \quad \text{or} \quad -\int dp = 2\int \frac{\tau}{r+u}\, d(r+u). \tag{27}$$

The integrals are to be calculated between limits, which will be determined later on. Table 3 can be now completed and its first column contains all the radii, which are to be taken into account. The second column contains the displacements of these radii and begins with u_1, the value of which is arbitrarily chosen equal to the unit of length; following values have been calculated by making use of eq. (26). The third column contains the deformed radii and the forth column the ratios u/r.

We could define a shear strain, as MANNING [1945] did, and utilize the classical values $\varepsilon_t = u/r$ and ε_r. But it is perhaps preferable to improve

TABLE 3

	u/r	$2\log\left(1+\frac{u}{r}\right)=\gamma$	τ
0	1.0000	1.3863	12.5
7	0.8652	1.2469	12.5
[illegible]	0.7759	1.1280	12.3
5	0.6659	1.0207	12.1
[illegible]	0.5908	0.9285	11.8
3	0.5274	0.8471	11.5