Suitable reinforcement processes have been naturally thought of, in the industry. The big chemical reactors are actually built by winding under tension strong bands around a thinwalled cylinder, the material of which is selected for its good resistance to corrosion, although its mechanical resistance is rather low.

BRIDGMAN [1936] has thought out a method for progressively reinforcing the resistance of cylinders, which is applicable to high pressure apparatuses. The cylinder is given a slight outside conicity. It is then progressively forced into another cylinder, which has a slight inside conicity. In the original disposition the thrust resulting from the pressure, to which the inner face of the cylinder head is submitted, progressively presses both cylinders one against another. At the upper cylinder head, the pressure is equilibrated by a piston. In an other disposition, invented by BRIDGMAN [1940] and utilized by DAVID and HAMANN [1956] up to 45 kb two cylinders are used for reinforcing the inner one. The cylinders are progressively pressed one against the other by means of a press.

With a view to crushing solid samples up to 100 kb and more, the pistons and cylinders are reinforced especially in the "Belt" apparatus, designed by HALL [1960]. A description of the Belt apparatus as well as of other apparatuses of various types can be found in a article, written by BUNDY and inserted in the text of a treatise, published by WENTORF [1962].

(c) When the external pressure is practically nil, as it is generally the case, the stresses are such, that following inequalities can be written : $\sigma_t > \sigma_z > \sigma_r$, so that $\tau = \frac{1}{2}(\sigma_t - \sigma_r)$ is "ipso facto" the greatest shear stress.

(d) If walls having different inner radii whereas the k ratio remains the same, are submitted to the same pressures p_1 and p_2, they will present the same stress configuration at places, defined by the same l. This important principle of similarity excludes every scale effect in stress configurations, where the elasticity laws apply, it being however understood, that the walls are made of a perfectly homogenous material, that their geometry is a perfect one and that Hooke's law is applicable to this material.

When a pressure is applied to the inner side only of a cylinder ($p_2 = 0$), when said pressure is mesured by means of a pressure balance and when the outer and even the inner deformation is measured by means of strain gauges, measuring microstrains, it has been found, that the stress-strain curve slightly deviates from the straight line, which is typical of Hooke's law graphical representation, owing to a crystalline microplasticity which appears very soon and develops within a very short time. Now, the stresses at the bore ($l = 1$) are numerically the greatest. Assuming that the macroscopic overstraining depends on the stresses, such an overstraining (plasticity) will first appear at the bore. This phenomenon can easily be observed, because the inside and outside deformations, as far as steel grades with low carbon content are concerned, suddenly develop and because their stabilization takes some time.

The question of determining whether this overstraining is affected by a scale effect is more difficult and delicate to settle out once and for all. If this phenomenon depends on the sole stresses, there is no scale effect, because the principle of similarity is in this case applicable but if it also depends on the shear stress gradient, a scale effect may appear, because the shear stress gradient $d\tau/d(lr_1) = (d\tau/dl)\, r_1^{-1}$ varies with the inner radius. This problem has been studied by DEFFET and LIALINE [1959] and LIALINE [1959].

4. The Elastic Energy of a Thick-Walled Cylinder

Let us consider a small cube of material, of which the edge is equal to the unit of length and which is oriented, so that the principal stresses σ_1, σ_2 and σ_3 act on its faces. When the edges are increased by $d\,\varepsilon_1$, $d\,\varepsilon_2$ and $d\,\varepsilon_3$, the elastic energy of the cube, namely the energy per unit of volume is increased by dW

$$dW = \sigma_1 d\varepsilon_1 + \sigma_2 d\varepsilon_2 + \sigma_3 d\varepsilon_3.$$

By applying Hooke's law, which leads to equations, similar to eqs. (4a-c), dW can be expressed as follows

$$dW = \frac{1}{2E}\, d\,(\sigma_1^2 + \sigma_2^2 + \sigma_3^2) - \frac{\nu}{E}\, d\,(\sigma_1\sigma_2 + \sigma_2\sigma_3 + \sigma_3\sigma_1).$$

By superimposing upon the stresses acting on the cube a certain hydrostatic state, characterized by three principal stresses equal to $-\sigma$, one submits the cube to the combined stresses : $s_1 = \sigma_1 - \sigma$, $s_2 = \sigma_2 - \sigma$, $s_3 = \sigma_3 - \sigma$. In this case the energy is increased by dW, expressed by following equation, taking into account that $\sigma_1 = s_1 + \sigma$, $\sigma_2 = s_2 + \sigma$, $\sigma_3 = s_3 + \sigma$

$$d\,W = \frac{1}{2E}\, d\,(s_1^2 + s_2^2 + s_3^2) - \frac{\nu}{E}\, d\,(s_1 s_2 + s_2 s_3 + s_3 s_1)$$

$$+ \frac{3\,(1 - 2\,\nu)}{2E}\, d\sigma^2 + \frac{1 - 2\,\nu}{E}\, d\,(s_1 + s_2 + s_3)\,\sigma.$$

It is clear, that the term $(\frac{3}{2}E)\,(1 - 2\,\nu)\, d\sigma^2$ represents the work