librium but is also metastable from considerations of homogeneous equilibrium.

This is suggested as the reason why viscosity bears a relation to the previous thermal history and why anomalous heat capacity effects are observed in the annealing range.

Resistance to motion and reorientation is a function of viscosity so we should expect anomalous effects in highly viscous substances quenched from high temperatures. In fact we might expect a possible increase of compressibility with pressure since the system is in a state which is up on the right limb of the energy curve plotted in Fig. 2 and should be under internal tension.

Bridgman[9] observes anomalous effects in the compressibilities of quartz glass and of basalt glass but he suggests a different explanation for these behaviors. The results of Birch and Dow,[10] however, support the conclusion arrived at here because at higher temperatures, where rearrangements for a more stable configuration will take place more readily, they find the "abnormal" observed increase of compressibility with pressure becomes less pronounced and eventually disappears.

### Unidirectional Pressure

If, instead of a hydrostatic pressure, a unidirectional pressure load $\pi$ is applied to the system no external constraints will exist in the plane at right angles, resulting in an unbalanced energy distribution in the system. The spacing $r$ along the line of thrust decreases by an amount $r-r_0$ and the strain energy increases, climbing up the left limb of the $\phi$ function plotted in Fig. 2.

It is possible to set up hypothetical unsymmetric arrangements of attractive and repulsive forces such that on contraction of the longitudinal elements the effect laterally is an increased net attraction with consequent contraction of these elements also. Such a condition yields a negative Poisson's ratio, $\sigma$, the ratio of lateral elastic extension to longitudinal elastic contraction under compression. A few examples of this phenomenon exist, but in general $\sigma$ is positive and varies in magnitude between 0.25 and 0.50. As a rule then, the symmetry will be such that, as the longitudinal elements are contracted, the effective lateral $r$ for Eq. (1) decreases and thus the system extends in the plane at right angles to the compression. The effective left limb of the strain energy curve $\phi$ of Fig. 2 moves to the right a distance $\sigma(r_\pi-r_0)$. When this extension reaches the value $(r_m-r_0)$, the strain energy increasing to $\phi_m$, the system becomes unstable and, on further extension, ruptures by moving into the region of no stress. This "brittle" potential rupture, observationally called breaking along tension cracks, will occur across surfaces that tend to parallel the axis of compressive thrust.

The ideal "potential" rupture condition, according to this presentation, is given by

$$r_\pi - r_0 = (r_0 - r_m)/\sigma \tag{5}$$

and the elastic or potential strength by

$$(F_\pi) = A r_\pi^{-n} - B r_\pi^{-m}. \tag{6}$$

Thus the elastic strength in compression should be $1/\sigma$, or roughly three, times the elastic strength in tension. In general there is evidence of more or less "plasticity" in compressional and tensional test pieces of steel. Glass hard tool steel, in which a minimum of plasticity is observable, has a compressive strength of about 30 kilobars but even here there is some evidence of shear in the rupture. Direct comparisons for potential rupture cannot therefore be made but the tensile strength of this steel is not very different from the expected value. Such tests should be carried out at low temperatures.

In considering the effect of hydrostatic pressure alone we had only one region available to the system, i.e., the entire region was subjected to the hydrostatic pressure $p$. Here, however, there are two regions available to our system—one subjected to compressive stress $\pi$ and one to zero compressive stress. The system therefore, if free of internal and external constraint, will move into and occupy the region of lower energy. If then, before the lateral strain energy can attain the value $\phi_m$, the longitudinal energy has increased to a value such that its thermodynamic potential becomes equal to that of the liquid for

[9] P. W. Bridgman, Am. J. Sci. 237, 7–18 (1939).

[10] F. Birch and R. B. Dow, Bull. Geol. Soc. Am. 47, 1235–1256 (1936).