Was enough plastic work done to generate the defect concentration asserted? At 100 kbar the elementary calculation of work of plastic deformation gives 3.9 bar cm^3/g (Fig. 6). At one atmosphere of pressure, vacancy formation energy in silver is 1.8×10^{-12} erg/vacancy (Koehler, 1969). As with vacancy resistivity, the dependence of monovacancy formation energy on pressure is not known. Using the one atmosphere value for formation energy implies an energy of formation of 11 bar cm^3/g for a monovacancy concentration of 10^{-3}. This energy is 2.8 times larger than the work of deformation calculated. An initial Hugoniot elastic limit of three or four kbar would be needed to balance work with formation energy of the vacancies, even if none of the plastic work were converted to heat. More work hardening would also help increase plastic work. Since the HEL used in calculating the plastic work was estimated from the yield stress in tension at low strain rate it could be in serious error. A number of materials have HEL's larger than values calculated from yield stress at low strain rate (Sec. III.C). In lithium fluoride the HEL after several millimeters of propagation was steady at as much as 100 times the static yield stress (Asay et al., 1972). In addition, the resolved shear stress in single crystal copper under shock loading is 20 times the quasi-static value (Jones and Mote, 1969).

A further difficulty is that a fraction of the work of deformation is dissipated as heat. In quasi-static deformation only 5 to 10% of plastic work is stored in the form of lattice imperfections (Williams, 1967). It should be noted that the fraction of stored energy which is in the form of point defects as opposed to dislocations and other imperfections may vary from 3 to 70% depending on purity, strain, and temperature of deformation (Clarebrough, Hargreaves, and Loretto, 1962). When nickel and copper are shock loaded, the stored energy is twice that obtained when the metals are quasi-statically deformed to the same strain (Leslie, 1973). Kressel and Brown's annealing study of shock-deformed and cold-rolled nickel (1967) showed point defect concentrations and dislocation densities after shocking to be much larger than for cold rolling near 0°C to the same strain value. Flow stress and hence work may have been different at the two strain rates, so that the difference in fraction of energy stored is not known. Assuming conservatively the 5 to 10% figures for stored energy fraction, an average HEL of 10 to 20 kbar in the first 20 μm of shock propagation in silver would be necessary to balance energy for a 100 kbar shock.

An aspect of shock response of solids which is relevant to the problem of energy balance is stress relaxation in elastic-plastic solids. For a stress relaxing solid it has been hypothesized that initial elastic stress in the solid at the face where the shock enters the material is equal to the total stress acting on the face, provided that the loading wave has a very fast rise time (Asay et al., 1972). This means very high initial stresses on the dislocations in their glide planes. As the shock propagates into the material, the elastic stress relaxes with time and distance to a steady state level