explosive-metal assembly previously described[24] and illustrated in Fig. 1. In this figure the essential parts are shown, including the positions of the foil specimen which are secured in holding plates by press-fitted dowels. Commercial grade 70/30 brass was used for all metal parts of the assembly. A duPont sheet explosive plane wave generator was used to initiate the top surface, AA', of the explosive. The forces of the explosion accelerated the driver plate in a planar fashion so that the specimen assembly surface, BB', was impacted simultaneously, thereby producing a planar shock compressive wave.

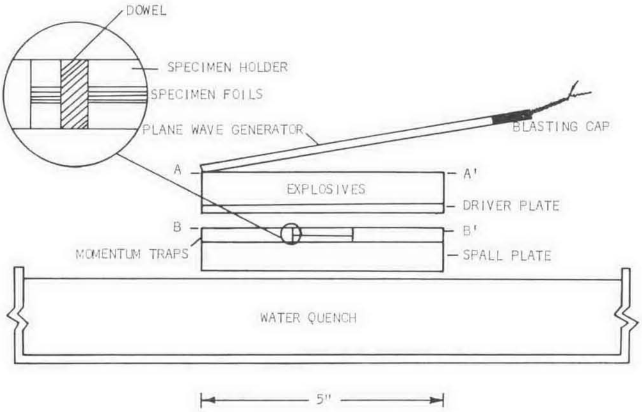

FIG. 1. Experimental apparatus for explosive-shock-deforming metal specimens.

The magnitude of the induced pressure depended on the velocity of impact and was estimated from Hugoniot compressibility data.[25] Momentum traps and spall plates were used to prevent undesirable lateral relief and reflected waves from reaching the specimen. Thus the specimens were subject to a planar compressive wave having one-dimensional strain only:

$$\epsilon_x \neq 0, \qquad \epsilon_y = \epsilon_z = 0 \tag{1}$$

where x is the propagation direction of the shock wave and normal to the specimen surfaces. Fowles[26] has shown that for an elastic, perfectly plastic solid, the one-dimensional strain condition gives rise to a triaxial stress state σ_x, σ_y, σ_z characterized by

$$\begin{aligned} \sigma_x &= P + \tfrac{2}{3} Y_0 \\ \sigma_y = \sigma_z &= P - \tfrac{1}{3} Y_0 \end{aligned} \tag{2}$$

The applied stress during impact consists of a hydrostatic component of stress P plus an additional factor on the order of Y_0, the yield stress of the material as determined in simple tension. In the present work, specimens of pure copper, Cu–6 wt.% Zn, Cu–10 wt.% Zn, and Cu–20 wt% Zn were subjected to a shock wave with P of 55 kilobars. Those of Cu–30 wt.% Zn were shock-deformed with P of 50 kilobars. The duration of the shock wave was approximately 2.0×10^{-6} sec in each case. The specimens were recovered in water at room temperature.

Shock-loaded specimens were prepared for transmission electron microscopy by electrothinning in a solution of 35% nitric acid and 65% methanol at -30°C and a current density of 0.5A cm^{-2}. The microstructures were observed by using an Hitachi HU–11A electron microscope operated at 100 kV.

Results and Discussion

The results of the present study of the dislocation configurations produced in copper and α brasses are shown in Fig. 2 and 3. Specifically, Fig. 2 shows the formation of a cell structure in pure copper after deformation to 55 kilobars Some of the α brasses of relatively high SFE also exhibited a cell structure as shown in Fig. 3*a* and 3*b*—namely; those copper alloys having compositions of 6 and 10 wt.% Zn. Brasses of low SFE such as Cu–20 wt.% Zn and Cu–30 wt.% Zn are shown in Fig. 3*c* and 3*d* to exhibit coplanar dislocations. We can see clearly in Fig. 3 that, under shock deformation conditions, a variation in the SFE produces a variation in the dislocation structure. Furthermore, these substructures are quite similar to those produced in the series of α brasses deformed slowly in simple tension as reported by Thomas.[11] In fact, the shock-induced structures observed here are essentially those that would be expected on the basis of

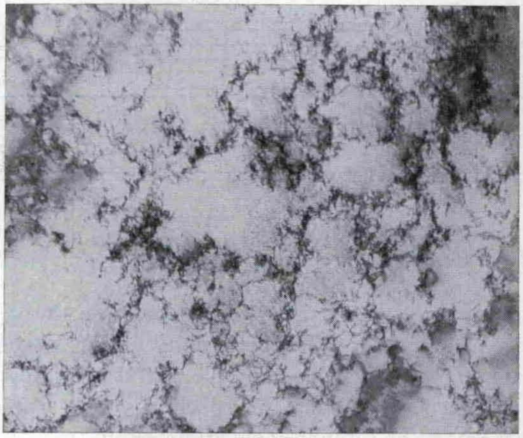

FIG. 2. An electron micrograph showing a dislocation cell structure in pure copper after shock deformation to 55 kilobars. Magnification 34,000 × (reduced 50 %).