the resistances of the three zones. If we assume (1) that all wave velocities are steady, (2) that all stress amplitudes are steady, (3) that the resistivity is not time dependent, (4) that the stressed regions of the disk are in a state of one-dimensional strain, and (5) that the strains are infinitesimal;* it follows that:

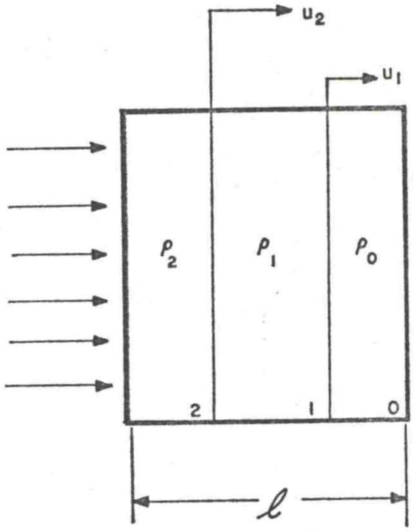

FIG. 2. Three zone resistivity model for a shock-wave loaded semiconductor. Two separate shock waves are shown as would be encountered in the stress region above the Hugoniot elastic limit.

$$AR(t) = \rho_0 l + U_1 t(\rho_1 - \rho_0) + U_2 t(\rho_2 - \rho_1), \qquad 0 < t < \frac{l}{U_1} \tag{1}$$

and

$$AR(t) = \rho_1 l + U_2 t(\rho_2 - \rho_1), \qquad \frac{l}{U_1} < t < \frac{l}{U_2} \tag{2}$$

where: A is the area of the disk; R is the resistance between the electrodes; ρ is the resistivity; U is the wave velocity; l is the thickness of the disk; t is the time and the subscripts 0, 1 and 2 refer to the various zones.

Equations (1) and (2) show that the electrical resistance between the electrodes of the specimen at any time is equal to the sum of the resistances of the zones. After all the waves have propagated out of the specimen without reflection, the resistance–time record will exhibit a final value corresponding to the impact stress. The initial and final values of the resistance are connected by a continuous line made up of segments of different slope, each segment corresponding to the propagation of a wavefront through the specimen. The initial and final values of the resistance explicitly define the change in resistivity due to the impact stress; the discontinuities in slope show the existence of multiple waves and define transit times for each wave from which the wave velocities can be calculated. This behavior is clearly shown in the typical record given in Fig. 3. Thus, resistance–time measurements can yield explicit data on the number of wavefronts and their wave velocities as well as the resistivity associated with each wave. Further, the complications resulting from wave reflections and subsequent interactions, which are inherent in free surface velocity techniques, are avoided.

Although it was originally hoped that values for resistivity would be obtained for the full stress range and thus provide quantitative data on the resistivities associated with the phase transition and the plastic range, experimental results show an e.m.f. for stress increments above the elastic limit which precludes quantitative resistivity measurements. Also, the temperature rise for large compressions is large and not accurately known such that resistivity is governed by the uncertain temperatures rather than the compression. The resistance–time measurements are sufficient, however, to provide good measurements of the various wave velocities, and quantitative resistivity data is obtained in the elastic range.

In order to determine the stress and specific volume, the particle velocity associated with each wave must be known in addition to the wave velocity. Because of symmetry, the total particle velocity imparted to the specimen disk is one-half the experimentally measured impact velocity.† In general the division of the total particle velocity

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* It is not necessary to neglect the particle velocity (strain) to develop the analysis. It has been neglected for illustrative purposes only. All reduced data include the effects of finite particle velocity.

† The instantaneous velocity of the projectile immediately prior to impact is measured to a precision of 0·5%.(8)

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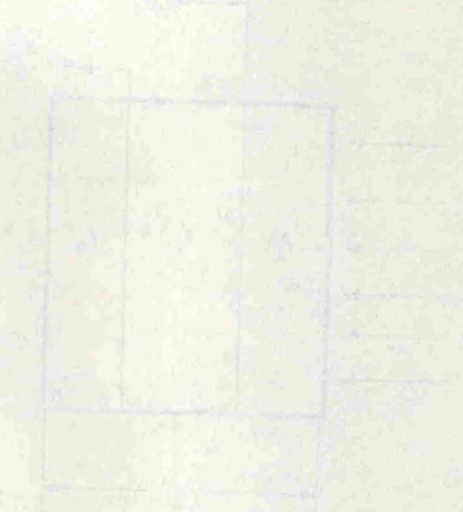

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