physical fields. Section 3 is recommended for those readers principally interested in the effects of strain on the band structure of semiconductors; while Sections 1 and 2 are recommended to those readers principally interested in shock wave compression measurements and high pressure phase diagrams.

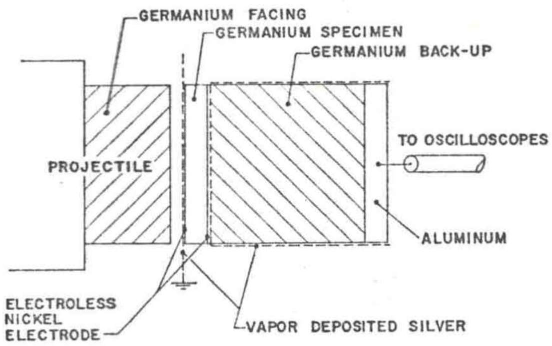

FIG. 1. Schematic drawing of the specimen and impacting projectile.

SECTION I
EXPERIMENTAL CONSIDERATIONS

Experimental arrangement

Shock loading is accomplished by impacting large diameter-to-thickness ratio disks of germanium upon each other in order to ensure a state of uniaxial strain in all but the periphery of the disks for the duration of the experiment. As shown in Fig. 1, one disk, mounted on the face of a projectile, is accelerated to high velocity by means of a compressed gas gun[(4)] and is impacted in vacuum upon the specimen disk mounted on the end of the gun. Angular misalignment between the impacting surfaces is about 5×10^{-4} rad.* Germanium backup disks are carefully mated to the rear of the specimen. The thicknesses of the impact and backup disks are chosen so that the stress waves propagate through and out of the specimen disk without reflection until, finally, the specimen is stressed uniformly to the impact value for a brief interval preceding the arrival of unloading waves.

The disks, 38 mm in dia., are cut from single crystals of high purity, n-type germanium of nominal 50 Ω-cm resistivity and are oriented with their faces parallel to a (111) crystal plane.[(6)] Intrinsic behavior at atmospheric pressure was confirmed by the measured n-type carrier concentration of 10^{14} cm^{-3}, and resistivity–temperature measurements from 20 to 75°C. The dislocation density was measured to be nominally 6×10^3/cm^2. Depending on the particular experiments, the thicknesses of the specimen disks are 3·2, 4·0 and 8·0 mm.

The resistance–time history resulting from stress waves propagating through the specimen is obtained under constant current conditions. Voltage–time measurements across the thickness of the specimen disk are recorded with a Tektronix 545 oscilloscope. The constant current of 1·00 A is applied to the specimen disk about 500 nsec before impact to prevent resistive heating of the disk. The typical signal level prior to impact is 0·4 V.

Both faces of the disk are entirely electroless nickel plated to provide ohmic electrodes.[(7)] The impact surface electrode of the specimen is also coated with vapor deposited silver and maintained at ground potential. The backup disk assembly, entirely vapor coated with silver, serves as the circuit lead to the other electrode. As will be shown in the analysis, the resistance change induced by the stress can be read directly from each record. Thus, contact resistance is effectively canceled out unless this contact resistance changes with stress. Since the electrodes are located at known positions, any change of contact resistance with stress would be shown as a change at the specific time that the stress reaches an electrode. No such changes were observed in the stress region below the elastic limit. It is estimated that the resistivity measurement is accurate to $\pm 10\%$.

Expected resistance–time behavior

For impact stresses in the range of several hundred kb, multiple waves have previously been observed in germanium which indicate the presence of slope discontinuities, or cusps, in the stress–volume relation.[(1)] To obtain an analytical description of the expected resistance–time behavior, consider a semiconductor disk in which two stress waves of different amplitude and different wave velocity are propagating. As shown in Fig. 2, the disk is divided into zones of different resistivity at any instant of time. The total resistances between the electrodes is then the sum of

* Some of the techniques involved in a gun experiment are discussed in Refs. 4 and 5.