SOME PROPERTIES OF COMPRESSIONAL WAVES IN LENNARD-JONES AND DEVONSHIRE LIQUIDS

II. SHOCK WAVE

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Summary

This paper describes some theoretical calculations of the thermodynamic changes which occur when a condensed substance is compressed by a shock wave from an explosion. It is assumed that the material is a simple molecular fluid (or a plastic solid) obeying Lennard-Jones and Devonshire's equation of state.

The calculations have been applied to single and colliding shock waves, to shocks generated in a precompressed material, and to the adiabatic expansion of a material from a shocked state. The results are in good qualitative agreement with the experimental data where these exist. In addition they suggest possible ways of extending the scope and usefulness of shock wave experiments.

I. Introduction

In Part I of this series (David and Hamann 1961) we computed the speed of sound in liquids obeying Lennard-Jones and Devonshire's (1937) equation of state. The present paper describes similar calculations of the properties of strong shock waves.

The purpose of the work has been to predict the kinds of conditions which may exist in compressional waves launched by explosions. It is known that if a high explosive is detonated in contact with an inert solid or liquid it drives a steep-fronted shock wave into the material and that the pressure behind the shock front may be as great as a million atmospheres for a few millionths of a second. It is possible to measure the pressure, the density, and even some of the chemical properties of shocked materials (see, for instance, Hamann 1960*a*). But no means has yet been devised for measuring the transient temperature. Instead this is estimated by combining a postulated equation of state with the Rankine-Hugoniot shock relations (see, for instance, Hirschfelder, Curtiss, and Bird 1954 ; Hamann 1960*a*). In the present calculations we have employed Lennard-Jones and Devonshire's (LJD) equation of state in this way. We have used it to calculate (i) the properties of plane shock waves in classical monatomic liquids ; (ii) the corresponding properties in a "quantal" liquid ; (iii) the conditions after adiabatic expansion from a shocked state ; (iv) the conditions

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