INTRODUCTION

The examination of the response of a solid body to a deforming force can be separated into three parts: elasticity-spontaneously reversible deformation; anelasticity-time dependent reversible deformation; and plastic flow-irreversible deformation. Although several investigators have examined the viscoelastic behavior of dental amalgam,[1,2] there has been no definitive study of its purely elastic response to external forces. This three part series of papers will examine this elastic behavior, separated from the flow characteristics, of amalgam.

The early measurements of the elastic constants of amalgam, using tensile measurements produced values which are now seen to be much too low.[3] These measurements were made at sufficiently low strain rates that the amalgam samples were probably able to flow during the experiments. Since ultrasonic techniques measure the elastic response at extremely high strain rates compared to the rate of flow in amalgam, the purely elastic behavior can be studied.[4,5]

Dental amalgam can be considered a quasi-isotropic, quasi-homogeneous material since it is a random, polycrystalline mixture of several phases. Although an isotropic material requires only two independent elastic constants to describe its elastic behavior, the four quantities, bulk, shear and Young's moduli and Poisson's ratio, are generally used. These elastic constants can be determined by measuring the velocities of propagation of ultrasonic waves in samples whose lengths are long compared to the wavelength of the radiation. In elastic, isotropic media there are only two solutions to the equations of motion[6] - a pure longitudinal wave and a pure shear wave. These two velocities can be expressed in terms of the bulk and shear moduli as follows: