

# *On the Propagation and Decay of Spherical Blast Waves*

T. Y. THOMAS

**1. Introduction.** The following article<sup>1</sup> contains the results of the application of our recent work on *compatibility conditions*<sup>2</sup> to the problem of the propagation of spherical blast waves. As customary in treating a problem of this character it is assumed that the gas is devoid of viscosity and thermal conductivity; since the flow is spherically symmetric it is therefore governed by the equations

$$(1.1) \quad \rho \frac{\partial v}{\partial t} + \frac{\partial p}{\partial r} + \rho v \frac{\partial v}{\partial r} = 0 \quad (\text{equation of motion}),$$

$$(1.2) \quad \frac{\partial \rho}{\partial t} + v \frac{\partial \rho}{\partial r} + \rho \frac{\partial v}{\partial r} + \frac{2\rho v}{r} = 0 \quad (\text{equation of continuity}),$$

$$(1.3) \quad \frac{\partial p}{\partial t} + v \frac{\partial p}{\partial r} + \gamma p \frac{\partial v}{\partial r} + \frac{2\gamma p v}{r} = 0 \quad (\text{entropy condition}),$$

where  $r$  denotes the distance from the center of symmetry  $O$  and  $p$ ,  $\rho$ ,  $v$  and  $t$  are, of course, the pressure, density, velocity and time with  $p$ ,  $\rho$  and  $v$  functions of  $r$  and  $t$ . The first two equations (1.1) and (1.2) require no additional comment. Equation (1.3), in conjunction with (1.2), expresses the requirement that the quantity  $p/\rho^\gamma$ , where  $\gamma$  is the gas constant, remains unchanged following the motion of the fluid particles.

In this problem we are concerned with a spherical region, having its center at the point  $O$ , which is expanding into a gas at rest. Within this sphere the equations (1.1), (1.2) and (1.3) are satisfied. The boundary  $r = R(t)$  of the sphere is a surface of discontinuity or *shock* where abrupt changes in the quantities  $p$ ,  $\rho$  and  $v$  occur as determined by the well known shock conditions. Denoting by  $p_0$  and  $\rho_0$  the values of the pressure and density in the undisturbed gas and by  $\bar{p}$ ,  $\bar{\rho}$  and  $\bar{v}$  the values of the pressure, density and velocity immediately behind the moving shock front we can express the shock conditions in the form<sup>3</sup>

<sup>1</sup> Prepared under Contract N6onr 18005, Indiana University NR 041-037.

<sup>2</sup> *Extended compatibility conditions for the study of surfaces of discontinuity in continuum mechanics*, Jour. Math. and Mech. **6** (1957) pp. 311-322.

<sup>3</sup> See, T. Y. Thomas, *The fundamental hydrodynamical equations and shock conditions for gases*, Math. Mag. **22** (1949) pp. 169-189. Also, *The distribution of singular shock directions*, Jour. of Math. and Physics **28** (1949) p. 164.