## SYNOPSIS

The thesis is concerned with a macroscopic and non-relativistic study of certain flow problems in the dynamics of inviscid, non-heat conducting, compressible fluids of infinite electrical conductivity. In all it comprises six chapters. Chapter I presents an introduction to the thesis. Chapter II - V deal with certain problems of shock waves and flows for which the gas under consideration is assumed to be in thermodynamical or chemical equilibrium. Chapter VI is devoted to the study of some flows where the non-equilibrium effects of the state of the gas play an important role. The contents of the various chapters are outlined below.

Chapter I. INTRODUCTION AND THE SCOPE OF THE PRESENT WORK: In this chapter a brief historical review of the development of the theory of magnetofluiddynamics and a resume of some of its fundamental notions is given. This is followed by a survey of works on hydromagnetic flows, waves and shocks, relevant to the present work.

Chapter II. EXTENDED COMPATIBILITY CONDITIONS FOR THE SINGULAR SURFACES IN THREE-DIMENSIONAL UNSTEADY MAGNETOGAS-DYNAMICS: The existence of an arbitrary singular surface (shock wave) $\Sigma$ in the flow field of three-dimensional unsteady magnetogasdynamics is postulated such that, across $\Sigma$, the physical quantities, and hence their space-time derivatives are discontinuous and have finite jumps. The formulae for the determination of these jumps in the quantities, their first and second order space-time derivatives are derived and are expressed (for the quantities only) in a form which is suitable for numerical computation. This form can offer answers to some of the questions for which the analyses of the existing works in this direction failed. Further, the explicit and simultaneous determination of jumps in the first and second order space-time derivatives avoids the classification of the compatibility conditions into two different categories i.e. 'kinematical' and 'geometrical' conditions. Also, the jumps in the current vector and the vorticity vector (which have hitherto been left undetermined in the literature) could be written very easily.

Chapter III. PROPAGATION AND ATTENUATION OF A CYLINDRICAL BLAST WAVE: Using the compatibility conditions, the expressions for the first and second order space-time derivatives of the physical quantities behind the cylindrical blast wave are obtained when it propagates into a conducting gas at rest and is subjected to both axial and polar magnetic fields. Further, by using an 'energy hypothesis' an algebraic equation for the blast wave velocity $G$ is determined. The explicit value of $G$ in terms of the radius of the blast and the known atmospheric conditions could be easily given for the case in which the ratio of the specific heats $\gamma = 2$ . This value of $G$ is used for finding the behaviour of the blast when its radius is indefinitely increased. It comes out from this discussion that, irrespective of the strength of the magnetic field, such a blast wave decays to an effective sonic wave when its radius tends to infinity.

Chapter IV. STEADY THREE DIMENSIONAL RADIAL FLOW: In this chapter, a question is posed as to the existence of a certain steady, radial flow that may be devoid of the usual 'limiting region' and the 'ambiguity' in the flow field. In an attempt to answer this an example of steady three-dimensional radial flow of a gas in the presence of both the toroidal and poloidal components of the magnetic field is considered. This problem admits exact solution expressible in a simple closed form and contains a few remarkable features. In particular, it is shown that for indefinitely large value of the magnetic parameter $\overset{*}{M}$ , the flow field does not possess any 'limit region' and the 'ambiguity' is automatically resolved. But for small values of $\overset{*}{M}$ , the flow field is still ambiguous and the viscosity and heat conduction may play a role as significant as those of inertia and electromagnetic forces.

Chapter V. PLANE STEADY FLOW OVER AN INFINITE WAVE-SHAPED WALL: Small disturbance solutions are obtained under the conditions that the main stream velocity and the external magnetic field are in the same plane and the gas is in thermodynamical equilibrium. For the case of 'aligned fields' the solution of the problem is determined by the method analogous to the Ackert theory of gasdynamics, while for the 'crossed fields' the problem is reduced to that of an equivalent incompressible one. The drag is determined both for subsonic and supersonic cases.

<u>Chapter VI</u>. NON-EQUILIBRIUM FLOWS: After introducing the concept of chemical reactions in the mechanics of electrically conducting compressible fluids, certain flow problems are treated, in which the chemistry of the fluid plays a significant role. In particular, the following problems are studied:

1) One-dimensional longitudinal wave propagation in a reacting mixture
2) Absorption and Dispersion of weak disturbances
3) Flow past an infinite wave-shaped wall
4) Supersonic flow round a sharp corner.

The chemistry of the fluid is brought in through the vibrational or chemical non-equilibrium state of the gas.

The solution of the first problem is obtained by using the analysis of the corresponding equilibrium flow case and contains some remarkable features regarding its stability, boundary layer existence etc. Problem 2, brings out the regions in which the non-equilibrium effects may dominate. The problem 3 is a supplement to the work of Chapter V and gives valuable information as to the drag existence, wave angle of disturbance and the role of frozen speed of sound. The solution of the last problem is obtained when the free stream is parallel to the external magnetic field. The point of interest that emerges from this discussion is the impossibility of such a flow for certain values of the magnetic parameter.