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EXPERIMENTAL TECHNIQUES II

INTRODUCTION

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Recent developments in rocket and missile technology have made possible hypersonic vehicles such as intercontinental ballistic missiles, satellites and space probes. During the entry of these hypersonic vehicles into the planetary atmospheres, numerous environmental problems in the areas of fluid dynamics and physics of high temperature gases are encountered. The equilibrium temperature in the stagnation region will be greater than 6500 K for flight Mach numbers exceeding 20. The air at these high temperatures can no longer be considered a simple mixture of nitrogen and oxygen molecules; instead, it will dissociate, ionize and experience chemical reactions between some of the constituents. Many of the conventional experimental tools for obtaining aerodynamic information, such as supersonic and hypersonic wind tunnels, have become inadequate for investigating the real-gas effects. In recent years many new experimental techniques were developed to simulate some of the extreme conditions encountered by the hypersonic vehicles. The capabilities and the results for some of these new facilities will be discussed in the following papers.

The use of a shock tube to study the high temperature gases behind a normal shock wave ahead of a body has been pioneered by S. C. Lin and his associates. In the shock tube the flow Mach number after the shock wave is always relatively low, but the gas is heated to high temperatures and is an ideal method for the study of the properties of gases at high temperatures. This author has summarized some of the aerophysic results that have been obtained by the use of shock tube technique.

The free flight ballistic range for research in the physics of hypersonic flight is described by A. C. Charters, who has made many original contributions in this field. With the

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ballistic range it is possible to simulate the flight Mach number and the corresponding temperature simultaneously in the laboratory at reasonably high ambient pressures. It has been possible to produce a maximum velocity of 31,500 fps with a small model by the accelerated reservoir gun. Some of the methods for obtaining the desired aerodynamic information and the heat transfer results are discussed.

To simulate the high enthalpy gas surrounding a hypersonic vehicle during re-entry, the air arc plasma generator has been developed at various laboratories. W. R. Warren and his associates have been developing arc facilities for testing materials suitable for protecting the nose cones against high heat transfer rates. The recent developments, operational ranges, and some of the results for the heat protecting materials are discussed.

By attaching a diverging nozzle to a shock tube, it is possible to generate high enthalpy hypersonic flows in the test section. This modified shock tube is referred to as a shock tunnel. A. Hertzberg and his associates have been pioneers in the development of the shock tunnel to investigate the hypersonic flow problems at high stagnation temperatures. The authors review the development of the shock tunnel and necessary instrumentation required to obtain data in short time. In the paper, simulation of hypersonic flight phenomena in the shock tunnel is discussed in detail, and some of the high temperature results from the shock tunnel are presented and discussed.