INTRODUCTORY REMARKS BY

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This month marks the 10th anniversary of the first supersonic flight of manned aircraft. On October 14, 1947, Major Charles Yeager flew the rocket propelled X-1 research airplane at 1.05 times the speed of sound. In the ensuing decade since that historic flight, the family of X airplanes flown by a few skilled test pilots have pushed the speed limits to more than 3 times the speed of sound, and raised flight altitudes to above 126,000 feet.

No one can question the tremendous impact on aviation of the research airplanes and their record making flights. These airplanes, which represent a team effort of the military services, industry and the NACA, explored and revealed many of the unforeseen aerodynamic problems of transonic and supersonic flight. They provided a considerable amount of information which complemented the large body of basic and applied research data obtained in wind tunnels, and the free-flight powered model techniques. Designers have relied heavily on these aerodynamic and structural research data in their successful development of the airframes for our supersonic airplanes and missiles.

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Similarly in the propulsion area, the engine designer has relied and capitalized on the large amount of data obtained in the specialized and complex facilities of the aircraft propulsion laboratory. The compressor, combustor and turbine component facilities provided the knowledge leading to substantial improvement in these individual components. Metallurgical laboratories yielded the high temperature alloys so critical to the success of the highly stressed hot parts of the engine. Supersonic tunnels provided the research data needed for the development of efficient inlets and exhaust nozzles. Altitude test facilities which simulate flight conditions of high speed and high altitude revealed and solved the problems associated with the integration of the individual components into a complete propulsion system.

These and numerous other diverse research and development facilities manned by highly skilled and creative personnel provided the scientific data, and the new ideas and concepts which made the rapid progress of aeronautics possible; progress which is typified, not only by the spectacular speeds and altitudes of the research vechicles and experimental rockets, but also by the solid performance achievements of practical military aircraft and missiles. Currently turbojet powered manned aircraft are flying at speeds about twice the speed of sound and at altitudes well above 50,000 feet. Supersonic ramjet and rocket powered missiles of the short range variety are now taking their place in the nation's arsenal of weapons. The intermediate range and intercontinental ballistic missiles have recently attained some measure of success. And, as part of the current International Geophysical Year activities the Russians have, only a few days ago, successfully established a satellite orbiting around the earth; and our country's Project Vanguard satellite is scheduled for launching this next spring.

Unquestionably, aeronautics has made considerable progress and undergone radical changes in the past decade. But what now, and what of the future? A general prophecy of more progress, of faster, higher, and farther would certainly be safe and irrefutable. All of us, however, would like and, infact, need a more specific and detailed forecast of things to come.

Unfortunately, the would-be aeronautical soothsayer faces a formidable task. His crystal ball has turned into a kaleidoscope presenting an endless variety of changing possibilities. He sees a host of promising ideas and concepts and he recognizes the urgent need for exploiting those ideas. At the same time he is all too aware of the manpower and dollar limitations of the nation's economy. Hence he must select from the many possibilities only those few offering the most significant improvement in the over-all art.

What, for example, is the future of the air-breathing engines? Turbojet? Ramjets? How much faster and higher will they effectively propel aircraft? What about high energy fuels? And what about nuclear energy? Will air-breathing engines by superseded by rockets and if so, when and for what types of applications? And what propellant combinations will be used in the rocket engines of tomorrow?

These and many other similarly perplexing questions and problems face us. The answers are neither simple nor straightforward but choices and decisions must be made and time, our most critical resource, is at a premium.

We in the flight propulsion research business are all too aware of these many perplexing questions. We consider it our responsibility to provide the data and information which will guide the necessary choices and decisions. In order to fulfill this responsibility we must conduct analytical and experimental research on a large number and variety of propulsion systems and we must carry this research far enough to explore the practical problems and possibilities as well as the potential merits of the different systems.

During today's inspection we will present a review of the research we have in progress and are planning in the various propulsion areas. A brief discussion, at this time, of future trends and problems may provide background and a framework of reference to help you interpret and integrate the various researches, facilities and techniques you will see during your tour.

Let us first consider the turbojet engines. Over a short span of years we have progressively increased the predicted speed range for this engine type, and accomplishments rapidly equalled and exceeded the prediction. Currently, as previously mentioned, the turbojet is propelling several of our military aircraft at speeds of the order of twice the speed of sound. We anticipate further development of the turbojet for application up to speeds of 3,or possibly even 4, times the speed of sound. This high Mach number turbojet will differ apprecably from today's engine and will present somewhat different problems. Its inlet diffuser and exhaust nozzle introduce particular difficulties. At one of your stops you will be given a review of these problems and of the research aimed at their solution. That stop will include an inspection of the Lewis 10' x 10-foot tunnel, our newest major facility for supersonic propulsion research.

For still higher flight speeds, say up to about 7 times the speed of sound, the ramjet engine may supplant the turbojet. In the past decade the ramjet has made great strides. It has matured from the status of a laboratory novelty to a full-fledged powerplant for supersonic missile propulsion. At hypersonic speeds the principal problems facing the ramjet engine or any alternate propulsion system, indeed the principal problems facing the entire aircraft, are those of extremely high stagnation temperature. The stagnation temperature, as you know, is the temperature the air attains as it is accelerated to flight velocity on the surfaces of the engine and aircraft. At Mach number 7 this stagnation temperature is about 4000° F. Currently the NACA is in process of modifying existing facilities and adding new equipment to provide the combination of high temperature and high velocity required for conducting research in the hypersonic region. At our Propulsion Systems Laboratory we will describe some of the hypersonic propulsion research problems and several of the associated facilities. There, also as an example of our exploratory efforts in advanced areas, we will discuss some of the problems and possible propulsion schemes for flight beyond the earth's atmosphere. Such flight is pertinent to sustained

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satellite operation which would be the expected sequel to the short duration satellite of Project Vanguard.

Advances in jet propulsion have always been critically dependent upon high temperature metallurgical developments. The extreme temperatures associated with hypersonic flight speeds obviously aggravates this dependency. A review of our work in the high temperature materials area and a discussion of some of the future possibilities for improved materials will be included in the day's itinerary.

Achieving increased speed is but one facet of the future aircraft propulsion picture. An equally important goal, particularly from the military viewpoint, is that of increased range or radius of action. A most important propulsion factor affecting range is the energy or heat content of the fuel. This laboratory, in cooperation with the military services and industry, has been exploring the possibilities of the use of the high energy boron hydrides which contain from 25 to 50 percent more heat energy than the conventional hydrocarbon fuels. We will discuss the characteristics and problems of these boron fuels at our new High Energy Fuels Facility, which will be completed and placed in operation very shortly.

The rocket engine, despite its ancient antecedents and its modern glamorous publicity, has until recent years, received but a fraction of the research and development effort accorded its air-breathing colleagues. It has, nevertheless, made distinct progress and improvement during the past 10 years. Lighter weight, larger thrust and higher efficiency units have resulted

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from the rapidly expanding efforts of the dedicated and enthusiastic fraternity of rocketeers. Whereas, not too long ago, the rocket occupied a relatively minor role in the over-all aircraft propulsion picture, it is currently assuming a more dominant position. Previously relegated to ancillary uses such as take-off assist and small missile propulsion the rocket has now claimed its birthright by achieving the status of primary propulsive unit for the large intermediate range and intercontinental ballistic missiles.

For rocket engines the heat content or specific impulse of the fuel-oxidant combination is of even greater importance to aircraft or missile range than it is for air-breathing engines. Here, significant improvement in rocket performance and missile range is anticipated through use of higher energy propellants than the currently popular hydrocarbon-oxygen combinations. The NACA has been concentrating its rocket research on the high energy propellants and is presently in process of expanding its efforts in this area. We will discuss this research at our new Rocket Laboratory which was put into operation with initial experiments 1 month ago.

A discussion of high energy fuels would be incomplete without some consideration of nuclear energy. The energy released by fission of U^{235} is about 2 million times that obtained from combustion of gasoline. This energy potential provides the possibility of increasing aircraft ranges to values that are limited only by human desire and endurance. Included in today's inspection is a discussion of several of the very difficult problems involved in utilizing nuclear energy for aircraft propulsion. We will also discuss the research being conducted on these problems.

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The NACA devotes a portion of its research efforts to the airplane operating problems area. A representative project in this area is our research aimed at aircraft jet noise reduction. We will demonstrate this work for you at our Hangar stop.

Time and space limitations prevent us from showing you more than but a small sample of our research. In an attempt to overcome in part, these limitations, at one of the inspection stops we will present motion picture abstracts of a variety of experiments being conducted in areas of the laboratory not easily accessible to large groups.

We hope that today's inspection will prove interesting and profitable, and not too tiring. We appreciate this opportunity to show you our laboratory and we will welcome any comments or suggestions you may care to send us after your visit.

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