KEYNOTE ADDRESS

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It is a pleasure to attend a conference of this type and be able to say a few words about the lubrication problems. These problems certainly are, in my opinion, very vital to the Air Force and may best be resolved by free discussions of this kind between representatives of science, industry, and the military services.

We, of the services, urgently need the aid of industry in accomplishing our mission. Judging from past meetings and the fine attendance at this meeting, it is evident that there is a high degree of industry interest in future Air Force lubrication problems. I have always been gratified by the amount of industry participation in this area. Your continued support will guarantee our objectives.

I would like to quickly review some of the progress in lubrication that has been made since the last conference almost two years ago. We now have lubricants that are capable of operating satisfactorily in the 400°F temperature range with good low-temperature capabilities. More advanced lubricants have been developed that are stable to 700°F. Studies which are allied with lubricant development have been initiated in many areas, some of the more important ones being gear and bearing fatigue and load carrying ability, face riding seal capability, up to 450°F engine testing, and so on. A composite view of all these areas demonstrates the capabilities of new fluids. These developments permit the Air Force to look forward with confidence to meeting the lubrication requirements of the early B-70 weapons system and its follow-on versions.

Beyond the B-70, we can look at various applications that will pose very stringent lubrication requirements. Take the V/STOL aircraft for instance. Here we see a high-speed aircraft which, due to its unique take-off and landing characteristics, will require weight design of the highest order. Thus, because of speed, we will need high-temperature lubricants and, because of light-weight design, we will need high gear and bearing load carrying ability.

Another possible application to consider is a recoverable satellite where a gas turbine engine may be used for power and control after re-entry into the atmosphere. With the extreme stagnation temperatures accumulated during the re-entry maneuver, again high-temperature lubricants would be required. A sister application would be recoverable boosters. There are other applications which can be considered, but I will not take the time to go into these now. The point I want to make is that gas turbine lubricant needs do not end with the B-70, but will continue for a good many years.

A few years ago, missile and space vehicle power plant lubrication occupied very little of our research and development effort. Since the days of Sputnik, however, a vast change has taken place. Our R & D efforts in connection with rocket engine and flight power lubrication for missiles and space vehicles have demanded that we find the answer to a number of entirely new or relatively unexplored concepts of lubrication.

For example, rocket engines impose lubricant-propellant compatibility problems and, as the propellants for future engines become more exotic and reactive, the compatibility problems become more severe and difficult. Through research programs and cooperative testing programs with industry, a standardized method will soon be available for determining the compatibility of lubricants with liquid oxygen. We must expand this effort to include other propellant-lubricant compatibility studies.

One way of avoiding the hazard from the lubricant-oxidant compatibility problem is to eliminate the turbopump lubrication system and utilize the propellants themselves to lubricate the gears and bearings. This technique appears to be very promising in several hardware development programs. We are also sponsoring work not only to determine the lubricating performance of "work-horse" propellants (10X & RP-1) in gears and bearings, but also propellants such as liquid hydrogen, nitrogen tetroxide, hydrazine, UDMH, etc.

The flight vehicle power equipment for high Mach ramjets and space vehicles creates the most severe and unusual lubrication requirements.

For example, long duration power generation equipment for space applications dictates the use of working fluid bearing lubrication. Programs are now being conducted to determine the lubrication characteristics of several working fluids such as liquid potassium and liquid rubidium in bearings with the objective of one-year maintenance-free operation. In order to avoid sealing problems, the success of long duration power equipment is so dependent on the success of a lubrication technique which utilizes the working fluid in the system, that a novel alternate approach has been initiated to determine the lubricating capability of the working fluid vapors in bearings. This technique, if successful, would have the added advantage of low power loss and minimum wear operation. Although vapor bearing lubrication will involve much higher temperatures than the liquid metal approach, moderately successful gas bearing operation at temperatures up to 1500°F have been attained using an inert gas.

In systems such as SLAM (a supersonic low altitude missile powered by nuclear ramjet) where aerodynamic heating may prohibit the use of conventional oils, the technique of lubricating ball bearings with powdered solid lubricants entrained in a gas is offering good possibilities. This technique has been reasonably successful in test rig operation at temperatures up to 1200°F.

As more emphasis will undoubtedly be placed on missiles and space vehicle propulsion systems, we can look forward to a corresponding increase in the quantity and scope of research programs needed to meet the associated lubrication requirements. For the next three days, the technical papers and discussions of this symposium will provide a mutual interchange of information in far greater detail.

In closing, I should like to impress upon you gentlemen that the Air Force alone cannot hope to solve the problems of lubrication nor sponsor all the research required to attain that goal. Private industry's assistance and participation are urgently needed. What we seek are major breakthroughs all along the line to enable optimum performance weapon systems to be built.

I am confident that we in the Air Force can count on your cooperation.