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HONEYWELL

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FOURTH QUARTERLY PROGRESS REPORT

For Period July 1, 1967 to October 1, 1967

STERILIZABLE WIDE ANGLE GAS BEARING GYRO FGG334S

California Institute of Technology
Jet Propulsion Laboratory
Contract No. 951529

HONEYWELL | Aerospace Division

This work was performed for the Jet Propulsion Laboratory, California Institute of Technology, sponsored by the National Aeronautics and Space Administration under Contract NAS7-100.

Request for copies of this report should be referred to:

National Aeronautics and Space Administration
Office of Scientific and Technical Information
Washington 25, D. C.

Attention: AFSS-A

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Contract Number 951529

Fourth Quarterly Progress Report
For Period July 1, 1967 to October 1, 1967

STERILIZABLE WIDE ANGLE GAS BEARING GYRO FGG334S

This work was performed for the Jet Propulsion Laboratory, California Institute of Technology, sponsored by the National Aeronautics and Space Agency under Contract NAS 7-100.

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ABSTRACT

This document is the fourth Quarterly Progress Report, covering the period 1 July 1967 to 1 October 1967, for the Wide Angle Gas Bearing Gyroscope FGG344S, submitted in accordance with contract No. 951529. This report defines progress to date, technical problems encountered and a proposed new delivery schedule.

CONTENTS

SECTION I
GENERAL

This fourth quarterly report is submitted in accordance with Contract No. 951529, Mod. 1, Task Order No. RD-38, and is for the period from 1 July 1967 to 1 October 1967. Work progress and present status are discussed in Section II, technical problems encountered are discussed in Section III, and future plans are outlined in Section IV.

SECTION II
WORK PROGRESS

- Five spinmotors have been built and tested to contractural vibration and shock requirements.
- Five gimbal assemblies (less spinmotors) have been completed.
- Other gyro sub-assemblies are 100 percent complete
- Two gyros were built and tested
- Testing was terminated on both gyros when the spinmotors failed to start after 30 hours operation

Gyro No. 1 was disassembled and the gimbal cover removed; the spinmotor rotor was observed to be "locked up".

Gyro No. 2 is scheduled for teardown.

SECTION III
TECHNICAL PROBLEMS

BACKGROUND OF THE GAS BEARING STARTING PROBLEM

The problems encountered with two gyros and one spinmotor during this quarterly period are:

- Two gyros failed to start normally (minimum starting volts increased from 16 to over 32 volts) after less than 30 hours in a sealed gyroscope.
- The above symptom was duplicated in less time at the spinmotor assembly level, in the normal hydrogen environment, and without drying of the gas by drying agents.
- The spinmotor high starting voltage tends to improve with length of time non-operating and temperature changes such that near normal starting voltage could be recovered.
- A liquid is sometimes observed (through the translucent ceramic) to accompany the hard starting during spinmotor testing.

The problem with the FGG334S gyros encountered during this quarterly period is attributed to condensation of vapors within the gas bearing. Water is considered the principal constituant of the vapor or condensate; however, the possibility of other constituants has not been eliminated by the investigation.

Condensation will most probably occur within a gas bearing when the design favors high "G" capability (high pressure rise within the gas bearing) at the same time as low power (low temperature rise). In other words, if the sealed gimbal environment is nearly vapor saturated and circulation of the gas through the bearing is present, then vapor will condense to a liquid in the bearing if the pressure rise is large compared to the temperature rise (vapor condenses from gas with increasing pressure or lowering of temperature). These conditions of high "G"-low power have been emphasized in the FGG334S design to an extent not previously undertaken, thus causing an unanticipated severe bearing starting problem.

PREVIOUS EXPERIENCE WITH THE PROBLEM

A similar problem has been encountered on previous Honeywell spinmotors such as the 16 PIGA. The problem was solved by drying of parts and fill gas. Thirty-three units have achieved 10,000 hours of normal operating life to this date.

The problem has also been observed on the GG159 and GG282 programs where the solution consisted of dry gas and pumped gas flow by the hydrodynamic bearings. Five hundred gyros of several configurations fall into this category. A process similar to that used for the 16 PIGA devices (dry piece parts and fill gas) has been incorporated into the design of the FGG334S gyros. The gross "pumped gas flow through the bearing" design used for GG159 and GG282 gyros is not normally compatible with the lower electrical power and higher "G" capability requirements of the FGG334S program. After defining the problem of gas bearing starting as one of apparent vapor condensation, a thrust vented configuration which is compatible with the contract requirements was developed. This is shown in Figure 1 where the thrust bearing groove lengths are different to provide an axial pressure difference.

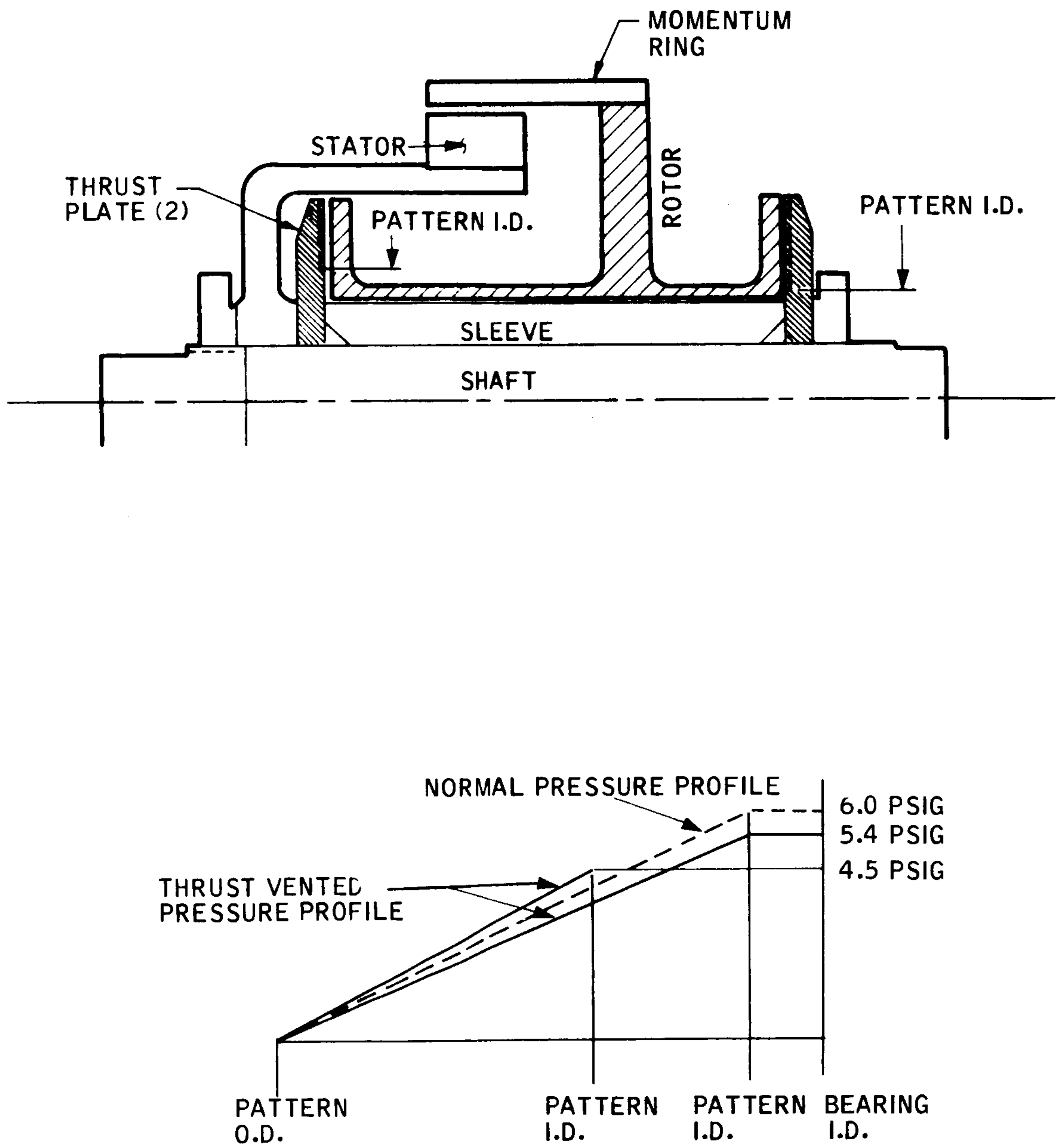

Figure 1. GG334S Vented Thrust Bearings

MECHANISM FOR CONDENSATION OF VAPORS IN A GAS BEARING

The theorized mechanism whereby condensation occurs in a gas bearing depends on near vapor saturation of the gas which is sealed within the gimbal. Complete elimination of vapor physically or dissolved in the piece parts of the gimbal is considered as one element of the the theory although very low levels have apparently been achieved in some cases, such as the 16 PIGA program.

An evaporation process from piece parts is assumed to continue until a saturated condition occurs at some temperature and pressure. An estimate of the time required for complete stabilization is not attempted at this time.

Inside the gas bearing, condensation occurs due to the higher pressures (20 psig) and lower temperatures (10°F) than occur near the stator where gas vapor saturation is assumed to occur.

Figure 2 shows this cycle occurring in two motors, one with and one without the starting problem.

SUMMARY

The technical approach to the solution is:

- Continue use of desiccant in drying of fill gas.
- Incorporate thrust vent feature.
- Incorporate long-term leaking of all piece parts, assemblies and fixtures prior to filling the gimbal with hydrogen.

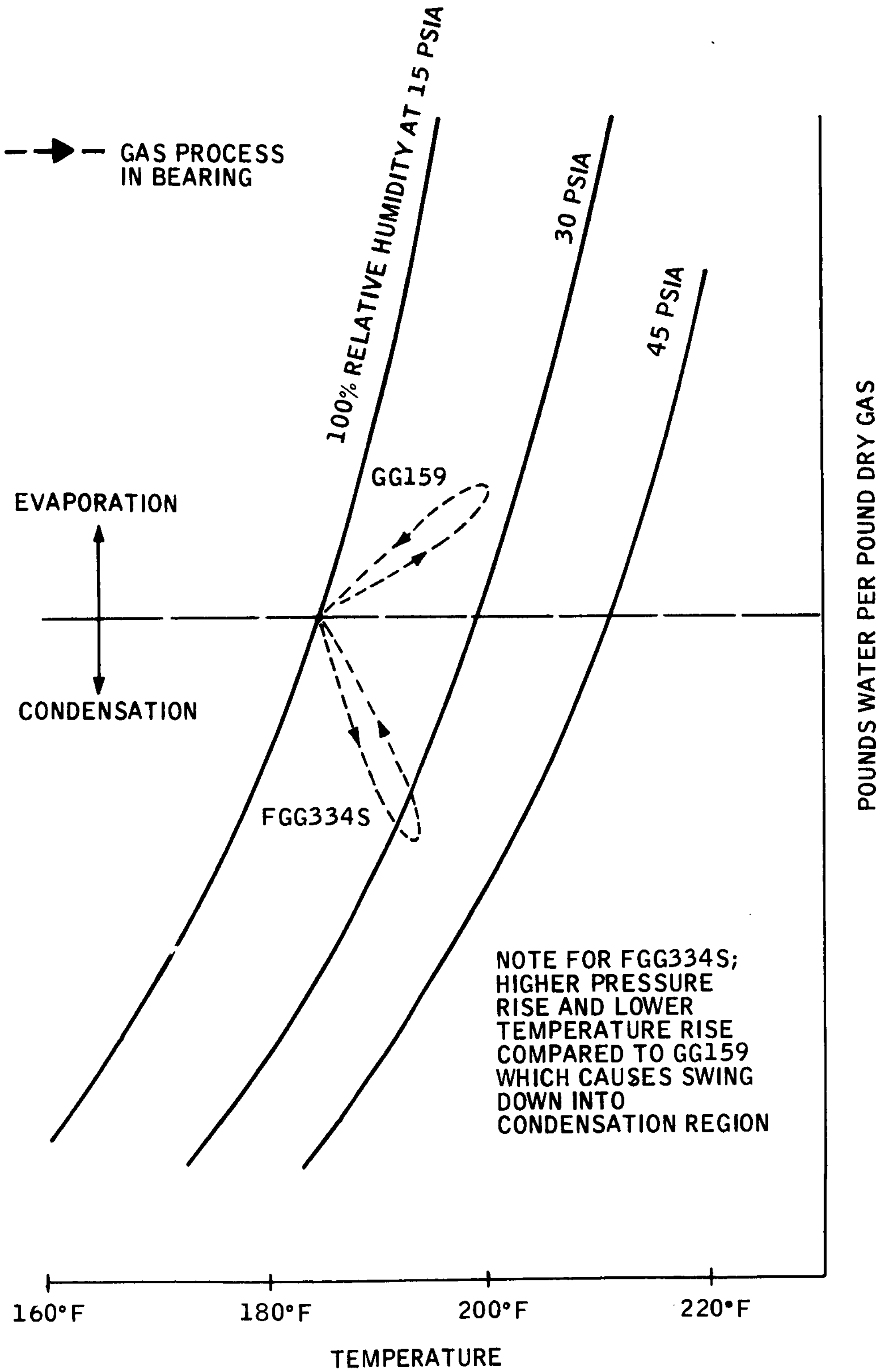

Figure 2. Typical Psychrometric Chart

SECTION IV
FUTURE PLANS

- The spinmotors will incorporate the thrust vent feature.
- The spinmotor assemblies will be subjected to 100 hours min. at 300°F with a constant dry nitrogen purge to carry off vaporized contaminants.
- The motor will be "run in" for 200 hours prior to the final assembly of the gyroscope.
- A progress report will be issued to Jet Propulsion Laboratories every two weeks starting 27 October 1967.
- The proposed new delivery schedule is:

  One gyroscope 24 November 1967

  One gyroscope 1 December 1967

  One gyroscope 8 December 1967

  Two gyroscopes 15 February 1968