Solutions and Applications

Specialty Bearings

RBC's specialty bearings supply engineered solutions to today's toughest bearing applications

RBC BEARINGS

Industrial Tectonics Bearings

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Industrial Tectonics Bearing Corporation (ITB), a wholly-owned subsidiary of RBC Bearings, is an aerospace bearing manufacturer with over fifty years of design and manufacturing experience. We design, manufacture, and refurbish high-precision custom aerospace bearings, as well as a complete line of BACB and Mil-Spec airframe control bearings.

ITB opened its facility in Rancho Dominguez, CA in 1955 to manufacture bearings for the aerospace, nuclear, and other high-technology industries. This facility currently designs and produces high-precision ball and roller bearings for applications such as:

- Electro-optical targeting and vision systems
- Missiles and precision guided munitions
- Gas turbine engines
- Helicopter transmissions
- Helicopter main and tail rotors

ITB is located in a 72,000 square foot building with approximately 52,000 square feet dedicated to manufacturing, testing, and assembling bearings. The facility is HVAC controlled to provide for the appropriate manufacturing environment. Within the facility there is a Class 10,000 clean room with Class 100 workstations. The facility is divided into manufacturing cells with each area dedicated to specific product lines.

ITB became a certified FAA repair station in 1993. Through our state-of-the-art manufacturing cell, we can restore bearing internal clearances, active surface, and mounting dimensions to the original OEM drawing requirements.

Our quality program is in compliance with AS-9100, ISO-9001 and Boeing BQMS. In addition, heat treat & NDT are certified to NADCAP & various OEM approvals. The following are just a few of the companies the have approved ITB's quality systems either by review, survey, or audit: Boeing Rocketdyne Propulsion & Power, Boeing Helicopter, Lockheed Martin, Raytheon Systems, Bell Helicopter Textron, Northstar (Derlan) Aerospace Company, GE Aircraft Engines, Honeywell (AlliedSignal) Aerospace Company, Kaman Aerospace Corporation, Space Systems/Loral, SPAR Aerospace, General Dynamics Air Systems Defense, and MD Helicopter.

The following pages illustrate how ITB has assisted manufacturers in solving difficult bearing application problems, by making use of our considerable technical, design, and manufacturing experience. Each application defines the problem encountered and provides a solution that resulted in the optimal bearing design for the application.

Our engineering support activities vary widely from basic design recommendations to application research in our laboratories, to the cooperative development of totally new bearing concepts.

We welcome your inquiry and look forward to assisting you with your special bearing and application needs.

Table of Contents

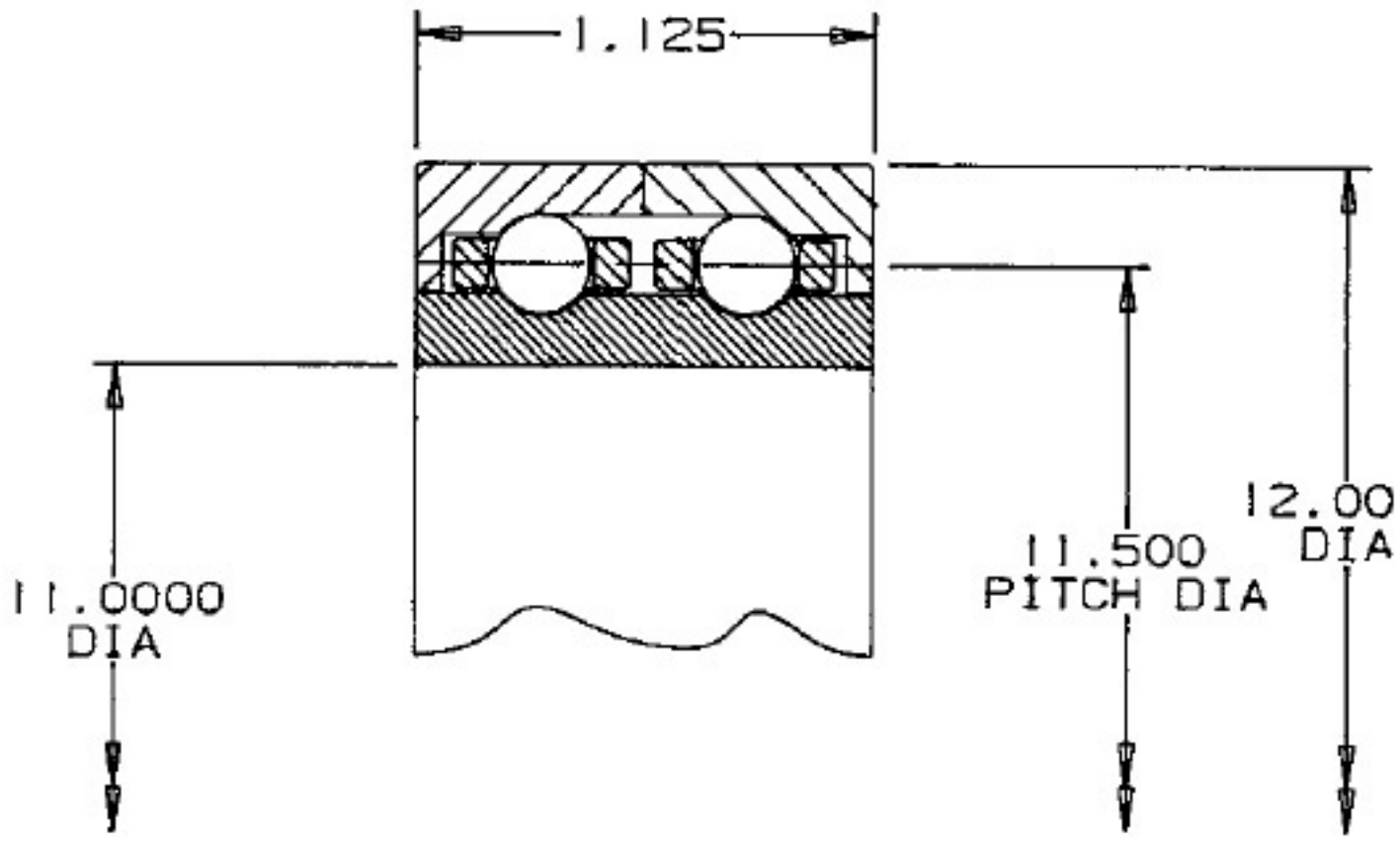
Space Application/Gimbal

Client Problem

A large diameter, thin section bearing pair operating in the vacuum of space required not only high accuracy, but also low torque and high stiffness over the full range of expected thermal conditions.

ITB Bearing Solution

Special attention was devoted to controlling the internal bearing geometry. All characteristics including run-out, contact angle, preload, stiffness and torque were measured in fixtures simulating actual working hardware; special grease plating was applied during bearing assembly in the cleanroom.



Optical Precision Bearings

Client Problem

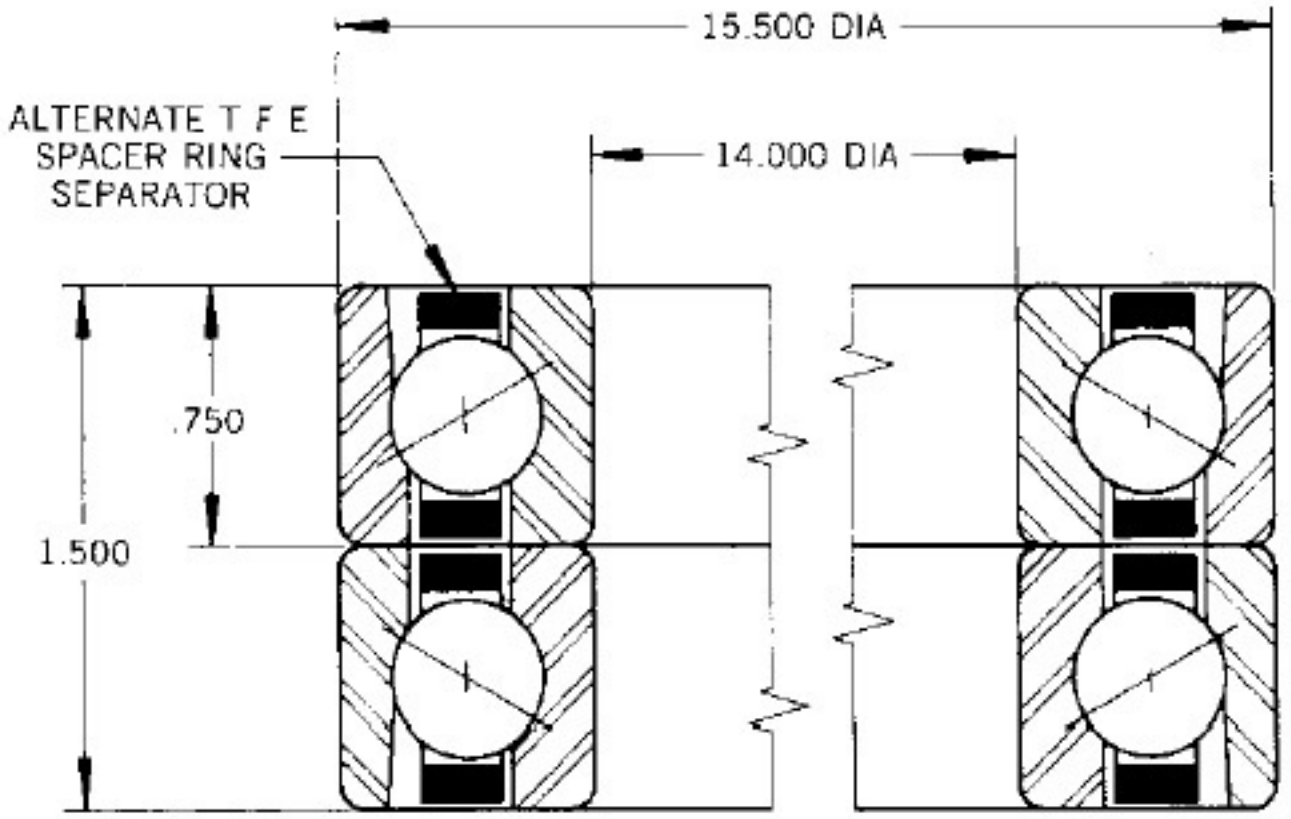
Support a 14" diameter rotating tube which contained lenses. Minimal radial runout was required to prevent distortion of the image by the lenses. Bearings should be low in torque and corrosion resistant, pre-lubricated, suitable for a vacuum operation.

ITB Bearing Solution

Duplex DB pair of bearings, preloaded, were manufactured of AISI-440-C corrosion resistant steel.

The runouts were held as follows: radial runout, inner, .0002 T.I.R.; outer, .0003 T.I.R.; axial runout, inner, .0002 T.I.R.; outer, .0003 T.I.R. The separator consisted of TFE rings around alternate balls for low starting and running torque.

Bearings were lubricated with a special lubricant and then centrifuged to remove the excess oil.



Ball Bearings for Vacuum Operation

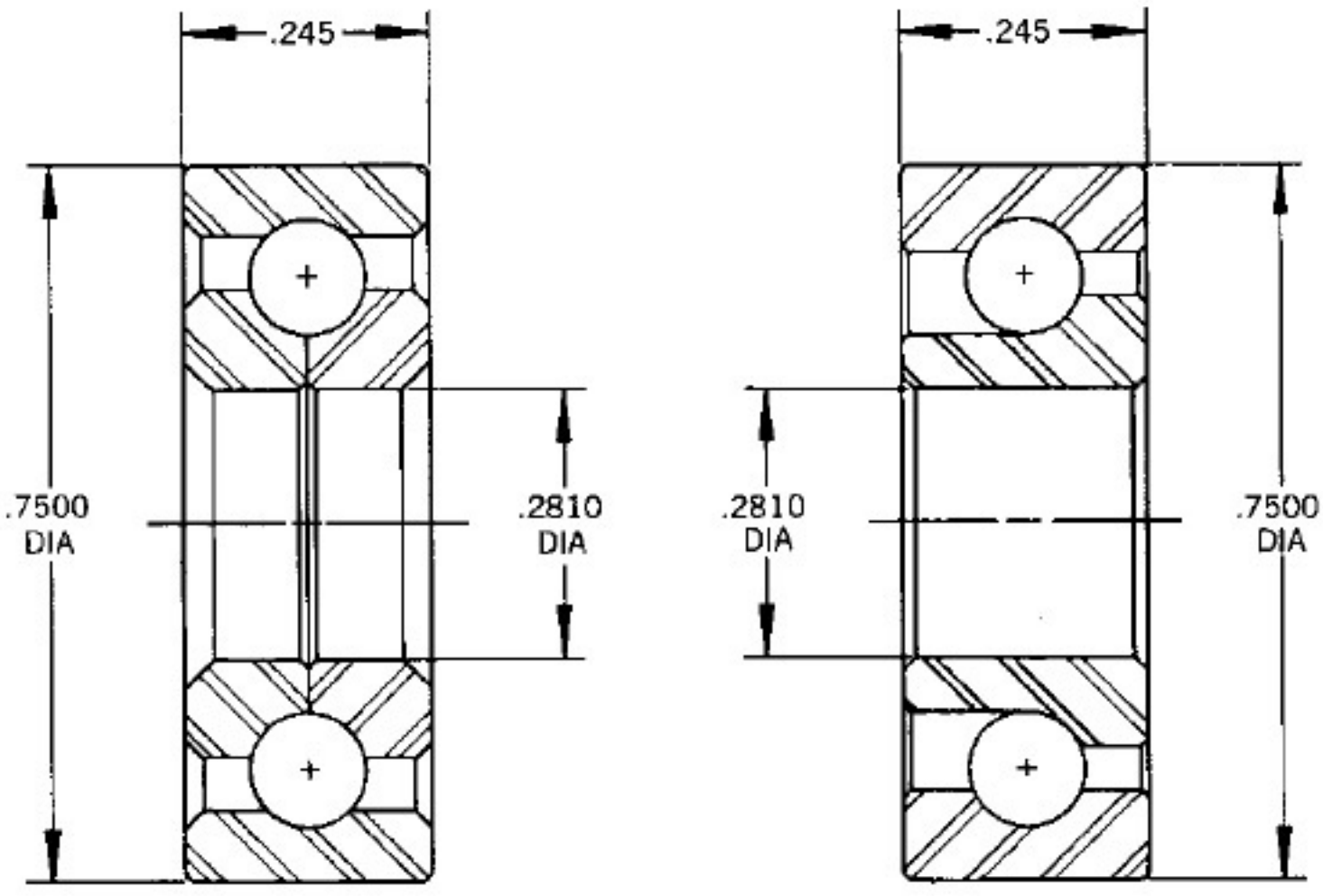
Client Problem

High speed ball bearings, to run at temperatures to 1000°F.

ITB Bearing Solution

The bearings were made of T-5 tool steel which has high hardness and wear resistance at 1000°F. The bearings contain a full complement of balls and no separator.

The lubricant was an ultra-thin layer of silver deposited on the balls. The angular contact bearings were manufactured without snap which could abrade the silver on the balls.



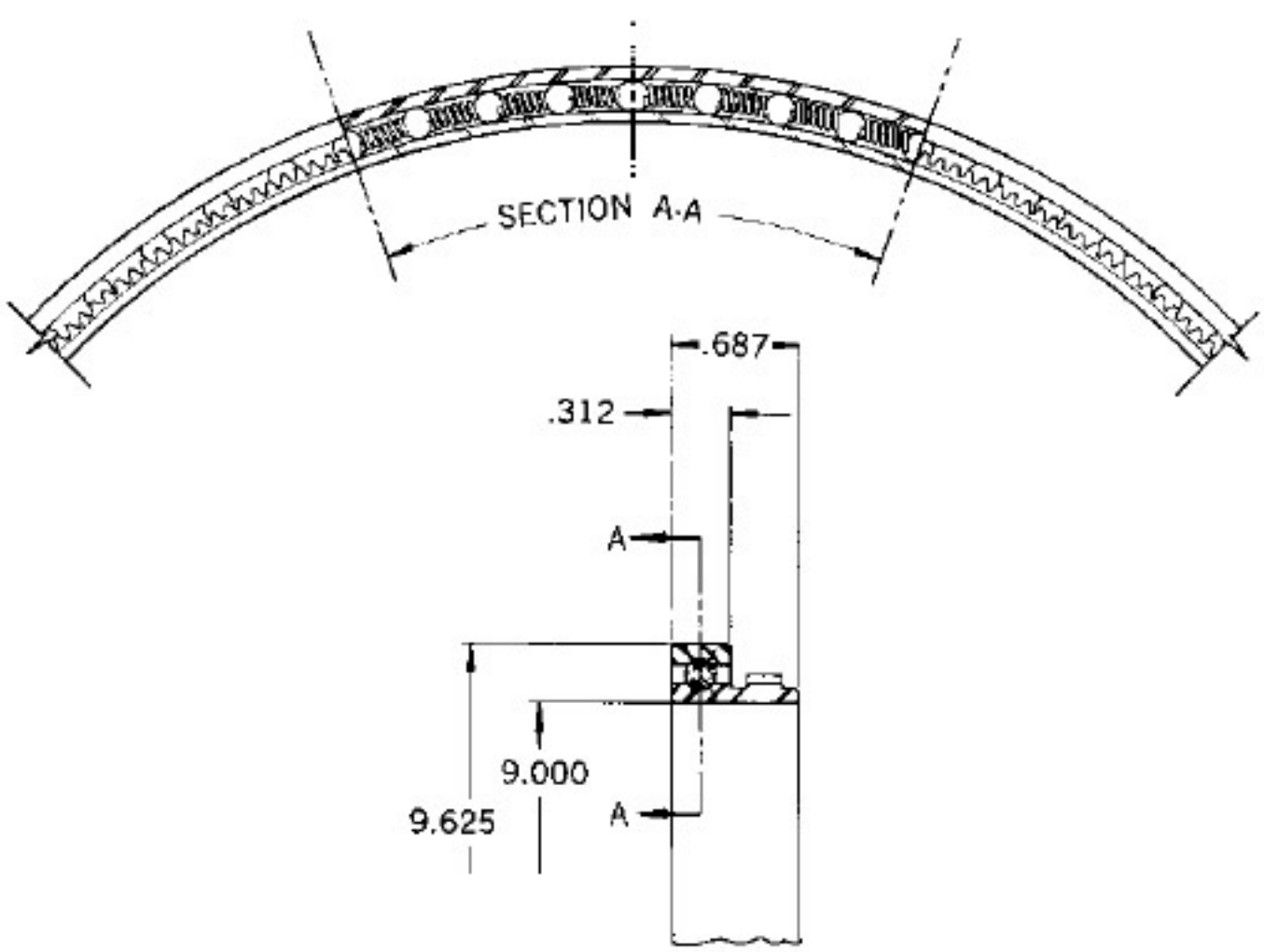
Thin Section Geared Bearing

Client Problem

A radar antenna drive had only limited space available for its support bearings.

ITB Bearing Solution

The thin section bearing utilizes coil springs as spacers between the balls instead of a conventional separator to reduce weight and lower bearing torque. The inner race of the bearing was extended and the gear was cut on this extended portion of the inner race. The incorporation of the gear into the inner race eliminated the necessity of a shaft clamping mechanism, etc., which would be required if the gear were separate from the bearing. Integrating the gear profile into the inner race increased the accuracy of the gear to bearing concentricity. The outer race and balls were manufactured from AISI-440-C; the inner race was made from AISI-8620, carburized and hardened in the raceway area to Rc 58-60.



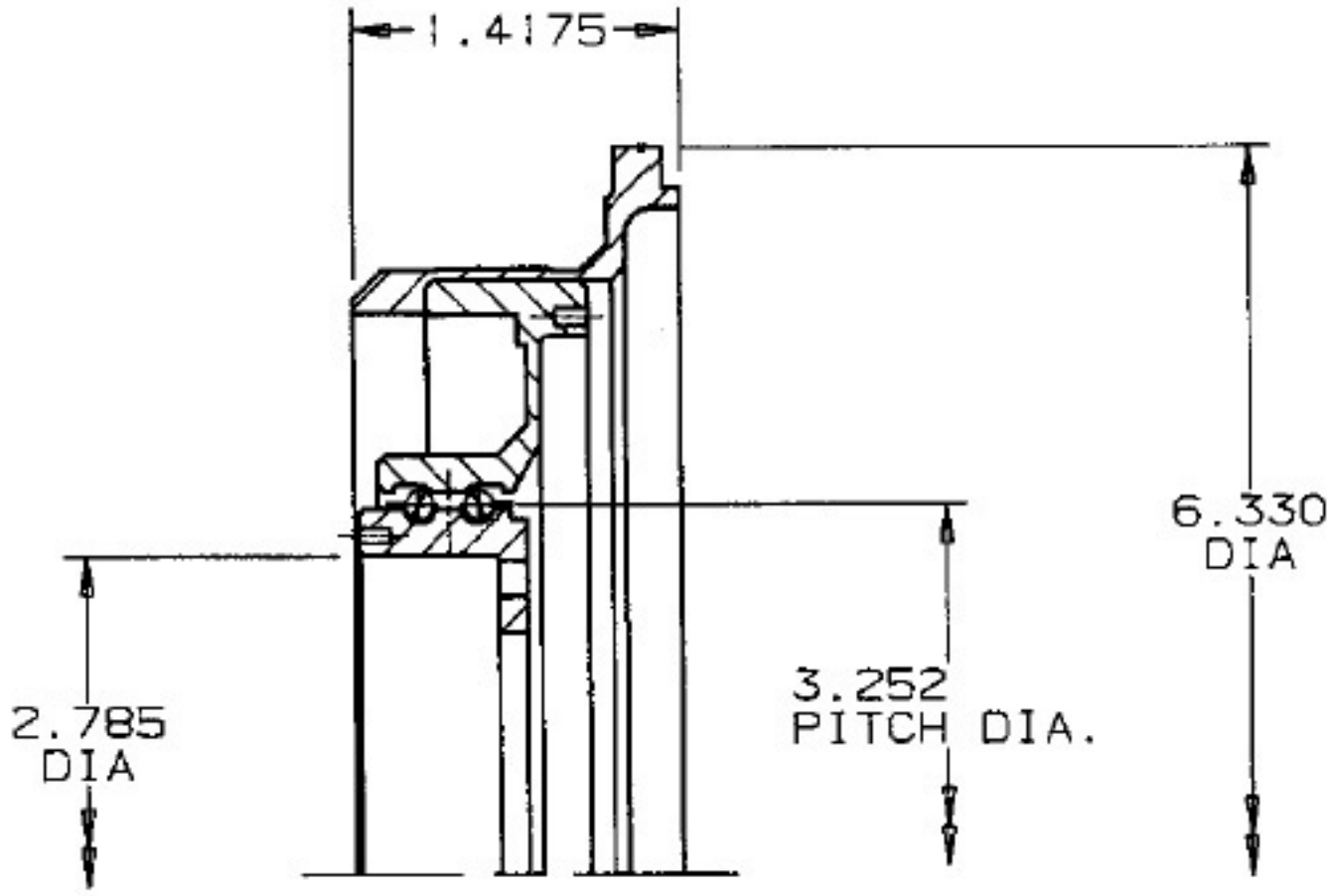
Missile Guidance System, Gyro Integrated Bearing

Client Problem

A missile guidance bearing requiring high running accuracy, high stiffness, low torque and low dynamic un-balance can not be efficiently produced with existing conventional bearing pair.

ITB Bearing Solution

After working closely with our customer, the gimbal with bearing integrated to both inertia ring and shaft was manufactured. This integrated version not only eliminated the time consuming bearing mounting operation at the gimbal assembly line, but also the bearing performance is predictable.



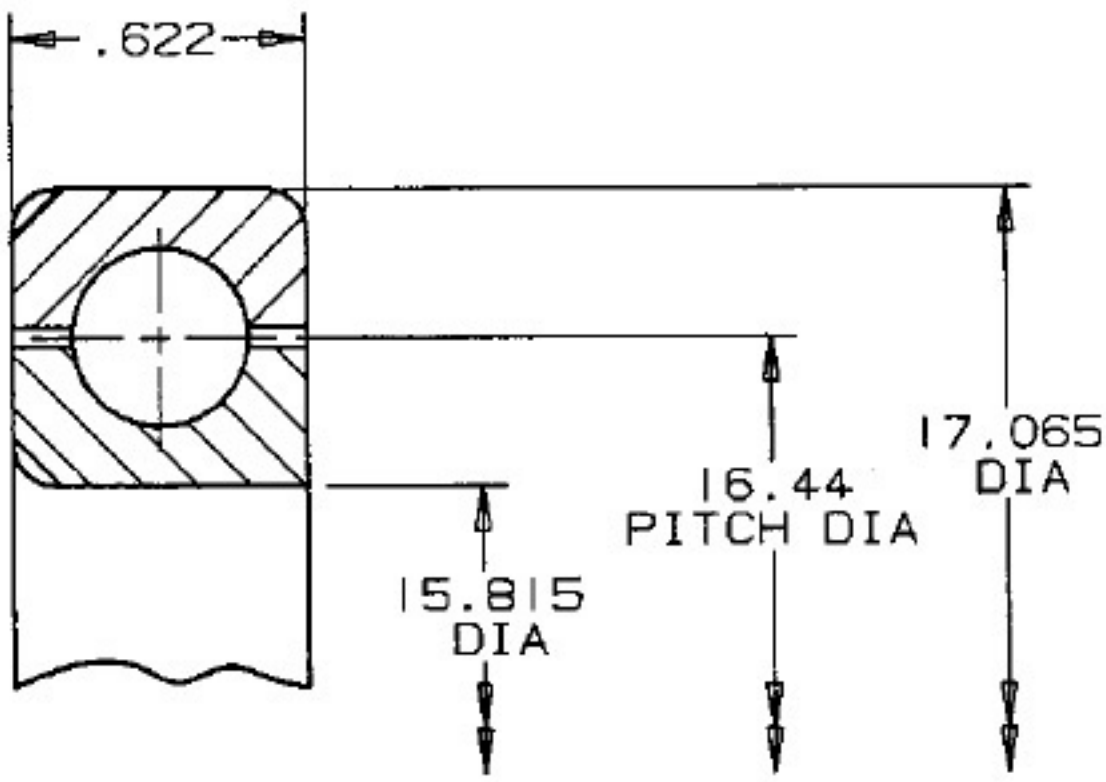
Jet Engine Control Surfaces

Client Problem

A large single row ball bearing was required to operate at temperatures to 700°F in air. The application imposed oscillating motion with high radial and thrust loads.

ITB Bearing Solution

The deep groove ball bearing designed incorporated high shoulders acting as shields and to accommodate large thrust loads. Rings were fabricated of through-hardened, high-temperature, corrosion resistant bearing steel. The raceways were thin-dense-chrome plated for added corrosion protection and wear resistance. Ceramic balls were chosen for this application.



Nuclear Reactor Bearing

Client Problem

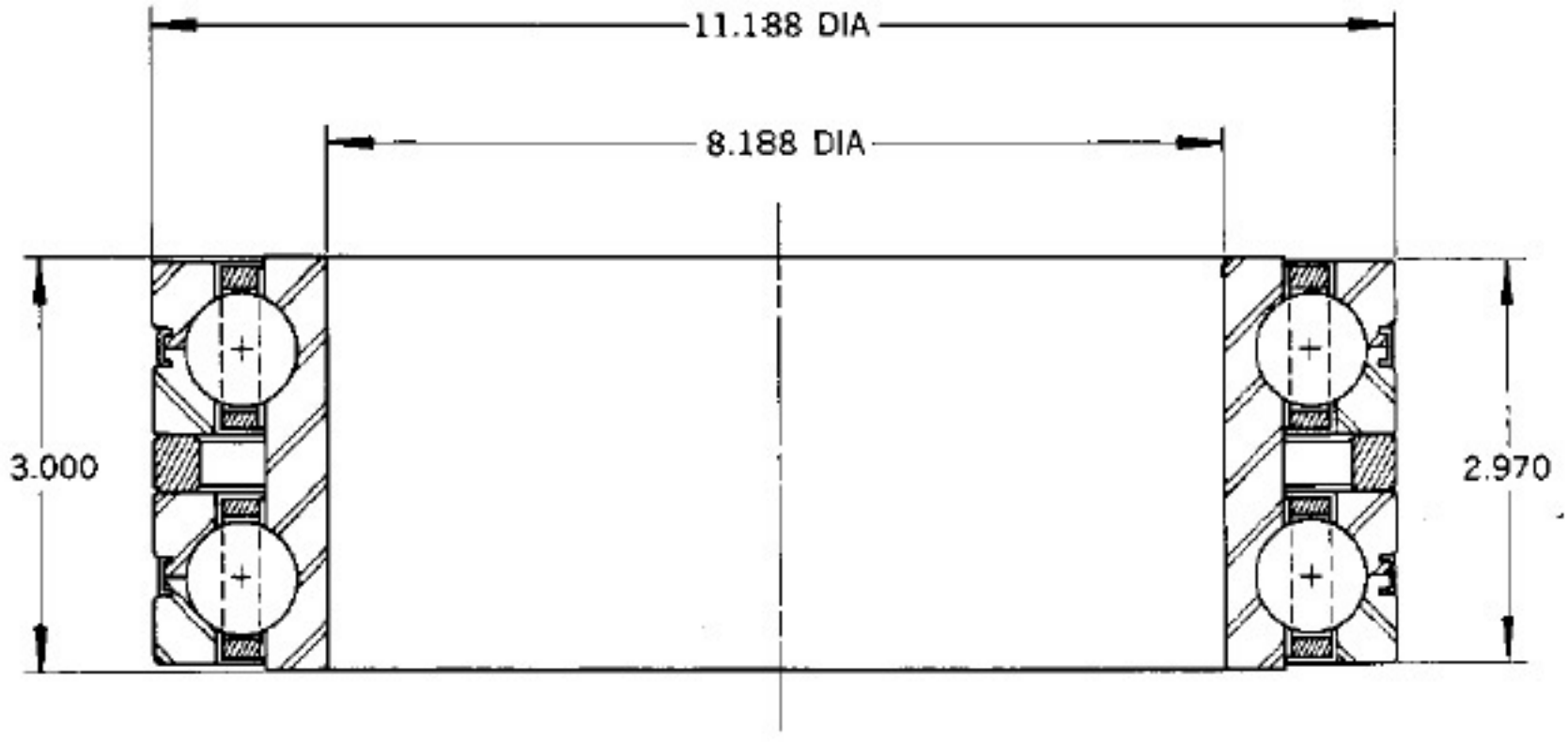
Bearing to accommodate the thrust load in a control rod drive mechanism. Bearing is lubricated with chemically pure water, de-ionized and de-oxygenated.

ITB Bearing Solution

The double row ball bearing was made of cobalt alloy materials, the separator of 17-4 PH.

To obtain the maximum capacity in this double gothic arch thrust bearing, the outer races are split, permitting the maximum quantity of balls in each row.

Thrust sharing of two rows is accomplished by accurate match grinding of the spacer ring to fit the gap between the outer races, and by matching the contact angle in both rows equal within two degrees.



Precision Gimbal Bearing

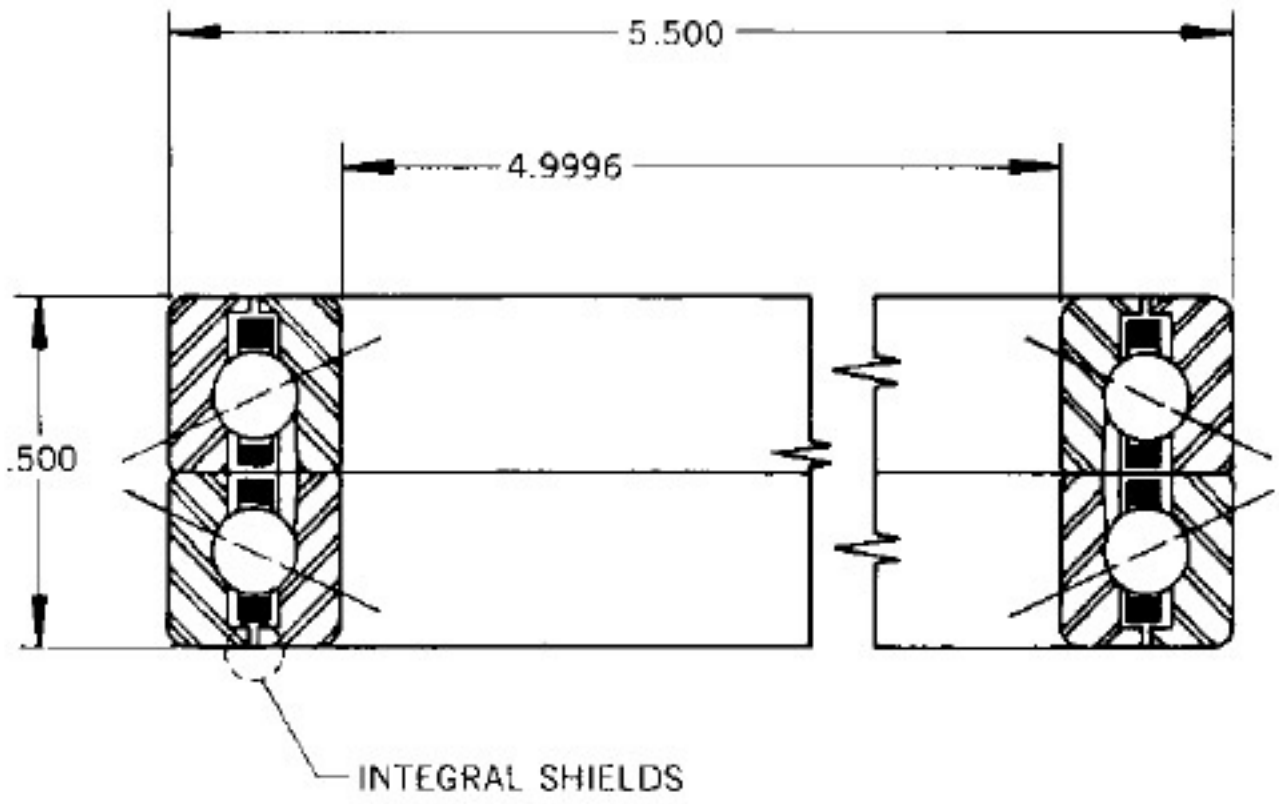
Client Problem

Bearings for an instrument gimbal assembly in a missile were subjected to combined radial, axial and moment loads. Bearings required low torque and had to be corrosion resistant.

ITB Bearing Solution

A duplex pair of angular contact bearings were designed with a light preload. The bearings are manufactured with integral shields as part of the race rings.

To keep starting torque to a minimum, alternate balls had TFE spacer rings around them. This feature resulted in a marked reduction in starting torque. It also allowed for a maximum load capacity, because the TFE rings do not require as much space as a standard type separator.



Cryogenic Bearings

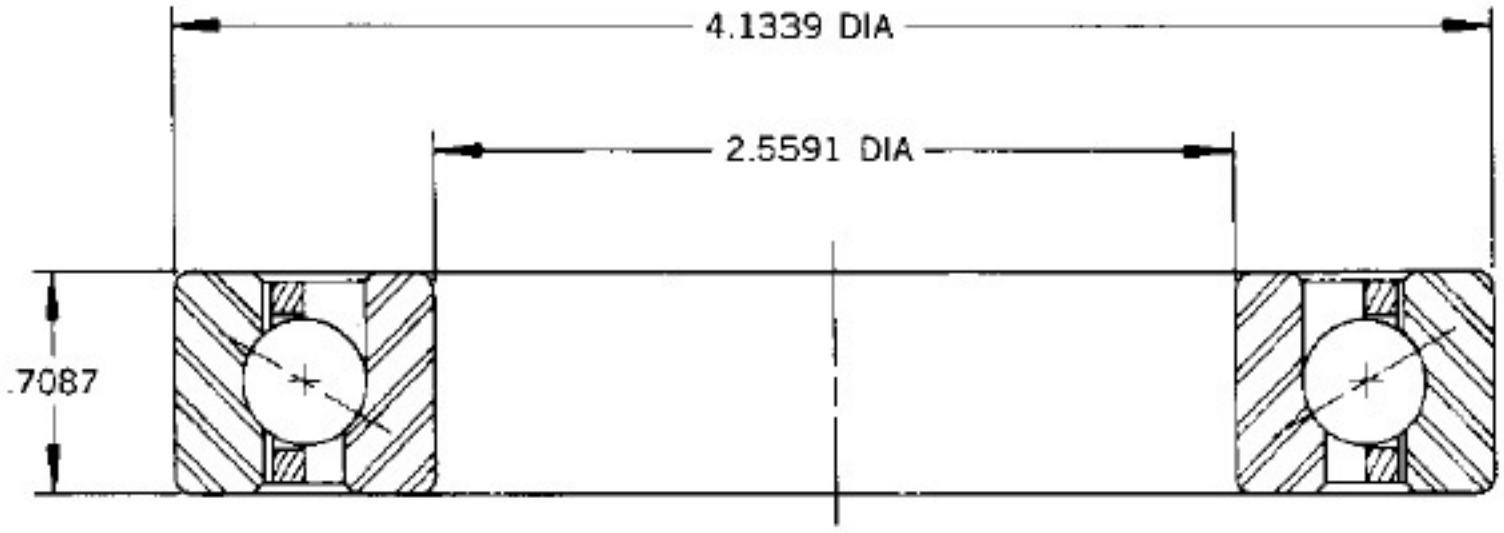
Client Problem

High speed ball and roller bearings for use in cryogenic equipment. Bearings should also operate in cryogenic liquid or gaseous environment.

ITB Bearing Solution

Ball and roller bearings of ABEC-5 tolerance grade were made of AISI-440-C material, with special sub-zero treatment in liquid nitrogen. This sub-zero treatment gave the bearings the dimensional stability necessary for operating in cryogenic equipment. The bearing separators were made of fiberglass reinforced teflon.

This basic bearing design criterion has been used in almost all liquid hydrogen and oxygen turbo pumps used in present day rocket engines.



Water-Lubricated Bearings

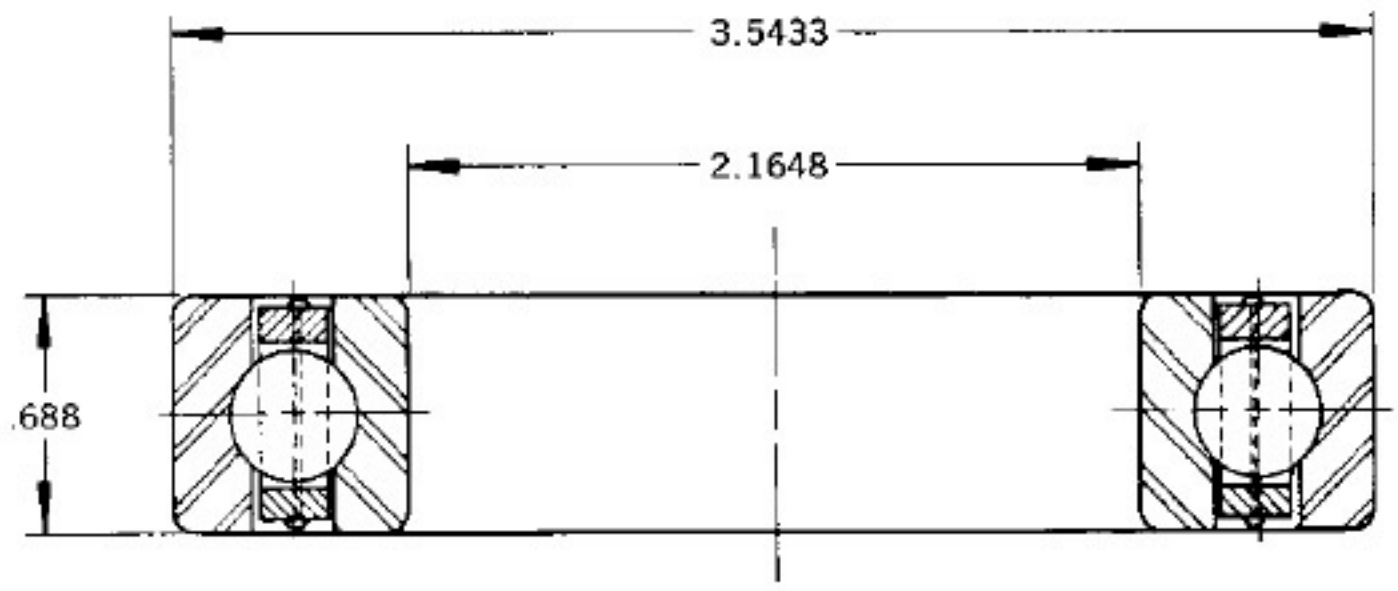
Client Problem

Long-life, wear-resistant bearings for running in water.

ITB Bearing Solution

Bearing rings were made of L-605 cobalt alloy. For increased wear resistance an ITB developed cold working technique was used to increase the hardness of the alloy to Rc 53 minimum after heat treatment. Normal cold worked and heat treated hardness of this alloy is Rc 47.

The separators in the bearings were made from 17-4 PH corrosion resistant material, heat treated to increase wear resistance.



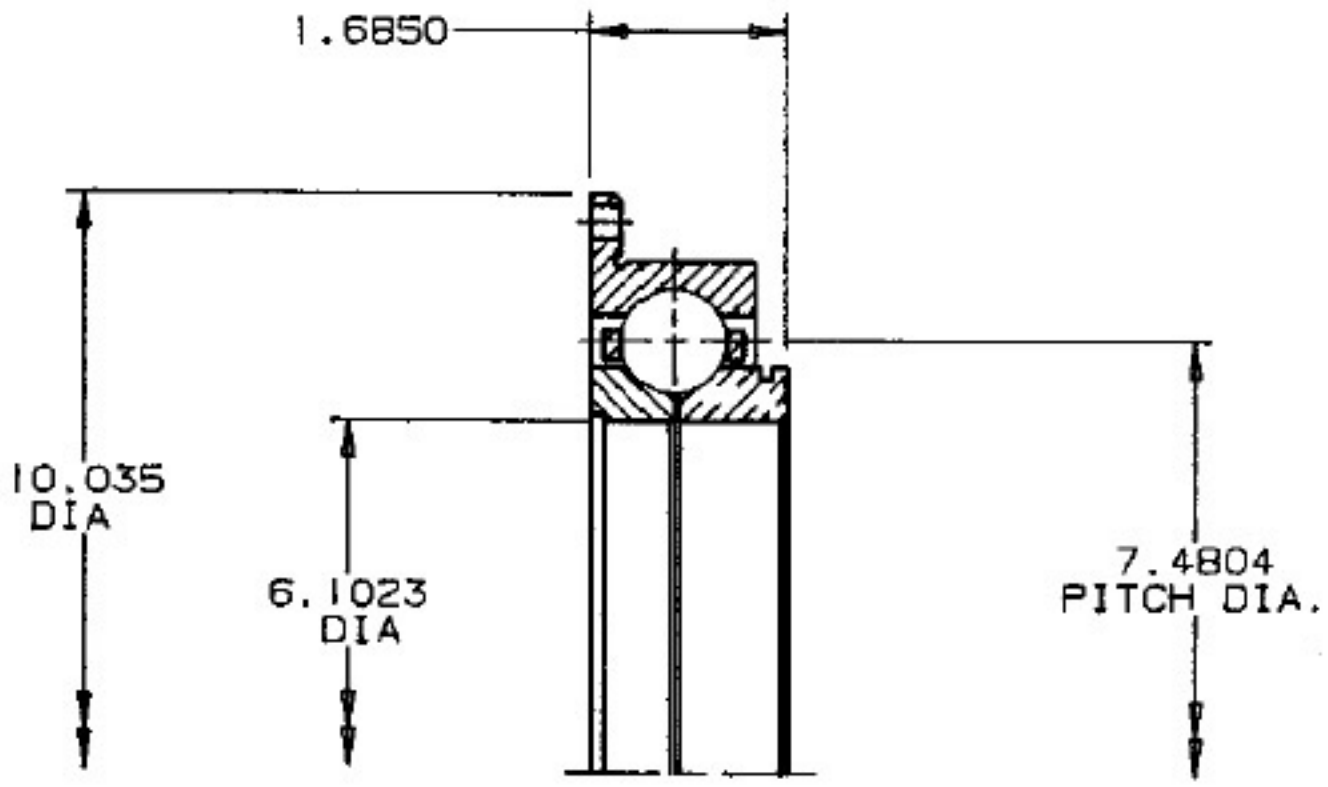
Turbo-Machinery Bearing

Client Problem

A large jet engine bearing carried heavy axial and radial loads, hence, elongated ball pockets were desired for best performance. Reliability and cost were important considerations.

ITB Bearing Solution

The ITB developed and patented ball retention method is particularly suited, but not limited to separators with elongated ball pockets; the design consists of circumferencial "fins" which are uniformly bent in a single operation. They are capable of fully retaining the balls in their pockets upon disassembly from the raceways.



High-Speed Turbo-Machinery Bearing

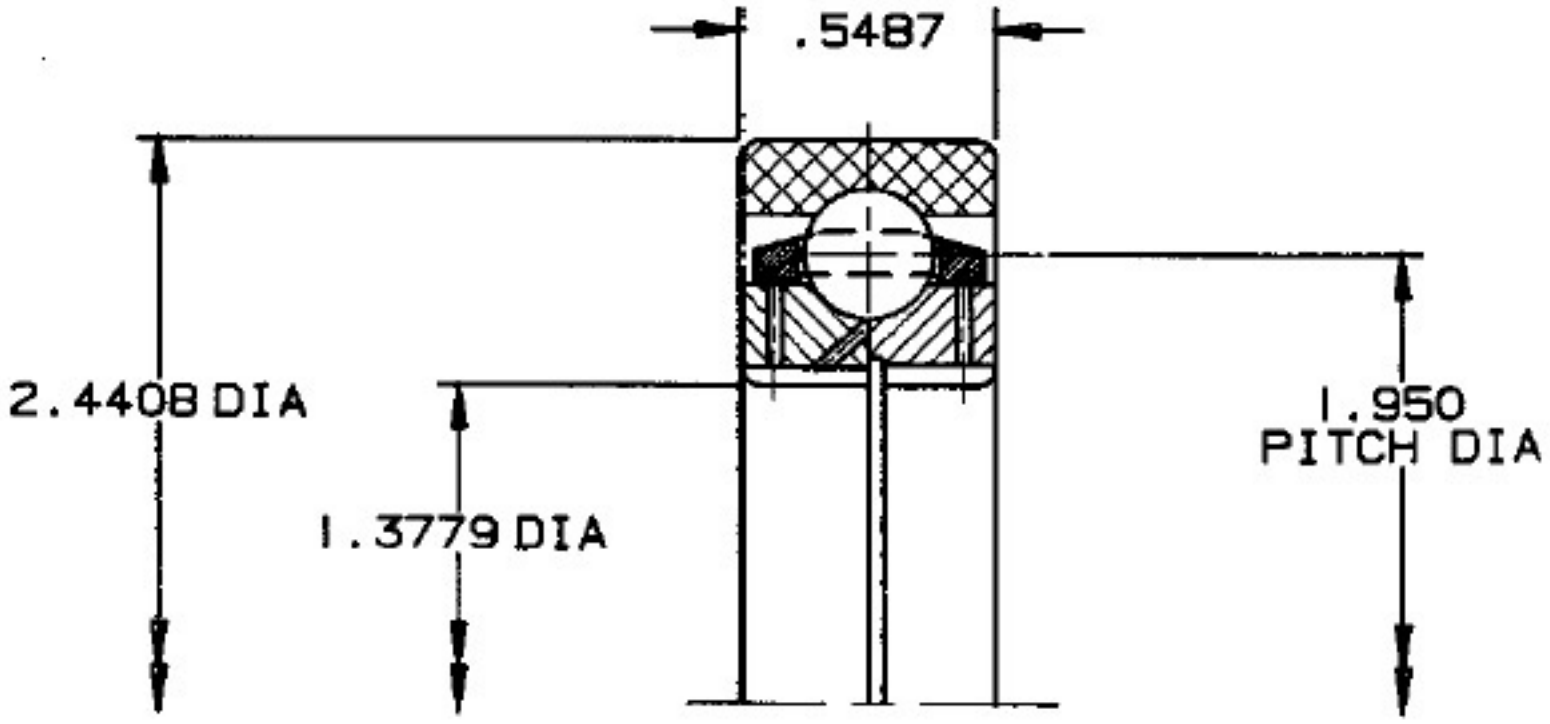
Client Problem

Application required a high-speed split-inner ring ball bearing with optimized performance. Lubricant was supplied axially and was also required at a downstream face seal.

ITB Bearing Solution

Due to churning effects the power demand of a high-speed bearing increases when the flow of lubricant into the bearing is increased. It is therefore desirable to introduce only a limited amount of oil into the bearing cavities while the balance of the available lubricant is used to cool the exterior bearing surface.

The patented ITB design provided under race cooling and metered an exact volume of lubricant to selected bearing portions, i.e. to the raceways and separator lands without restricting orifices. A specified portion of the oil flowed axially to the downstream face seal.



Self-Lubricating Main Shaft Bearing

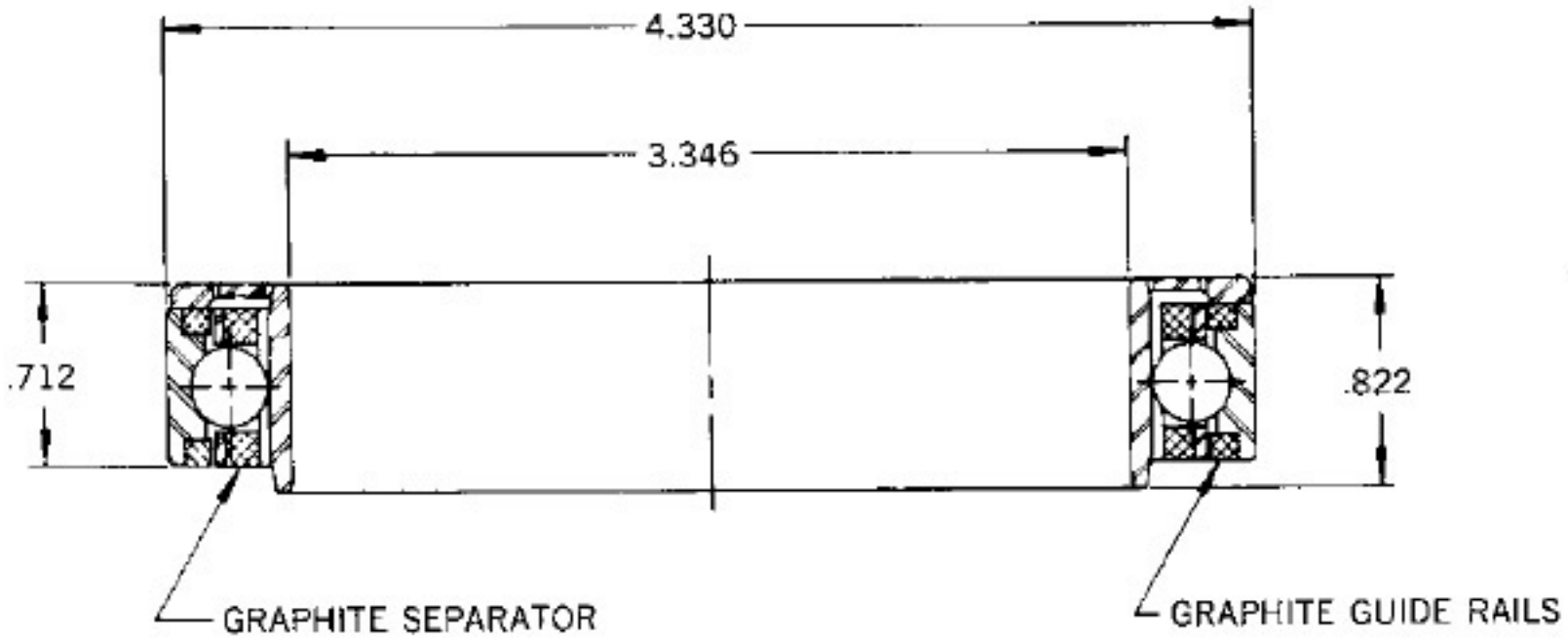
Client Problem

Mainshaft bearing for a vertical lift engine. For weight reduction, the bearing should be self-lubricating to eliminate a portion of the engine lubricating system. Speed of the 85mm bore bearing was 16,000 RPM. The bearing, located in turbine end of the jet engine, accommodates axial shaft expansion.

ITB Bearing Solution

Bearing was manufactured from CEVM AISI-M50 material for the races and balls. The separator of shrouded graphite was outer land guided on two graphite rings, pressed into the outer race ring.

To prevent damage to the graphite while inserting the shaft into the bearing, a side plate was added which prevented any accidental contact of the shaft with the graphite separator. To allow for the excess graphite to purge from the bearing, holes were put in the protective side plate.



Self-Aligning Bearing Operating in Liquid Polyethylene

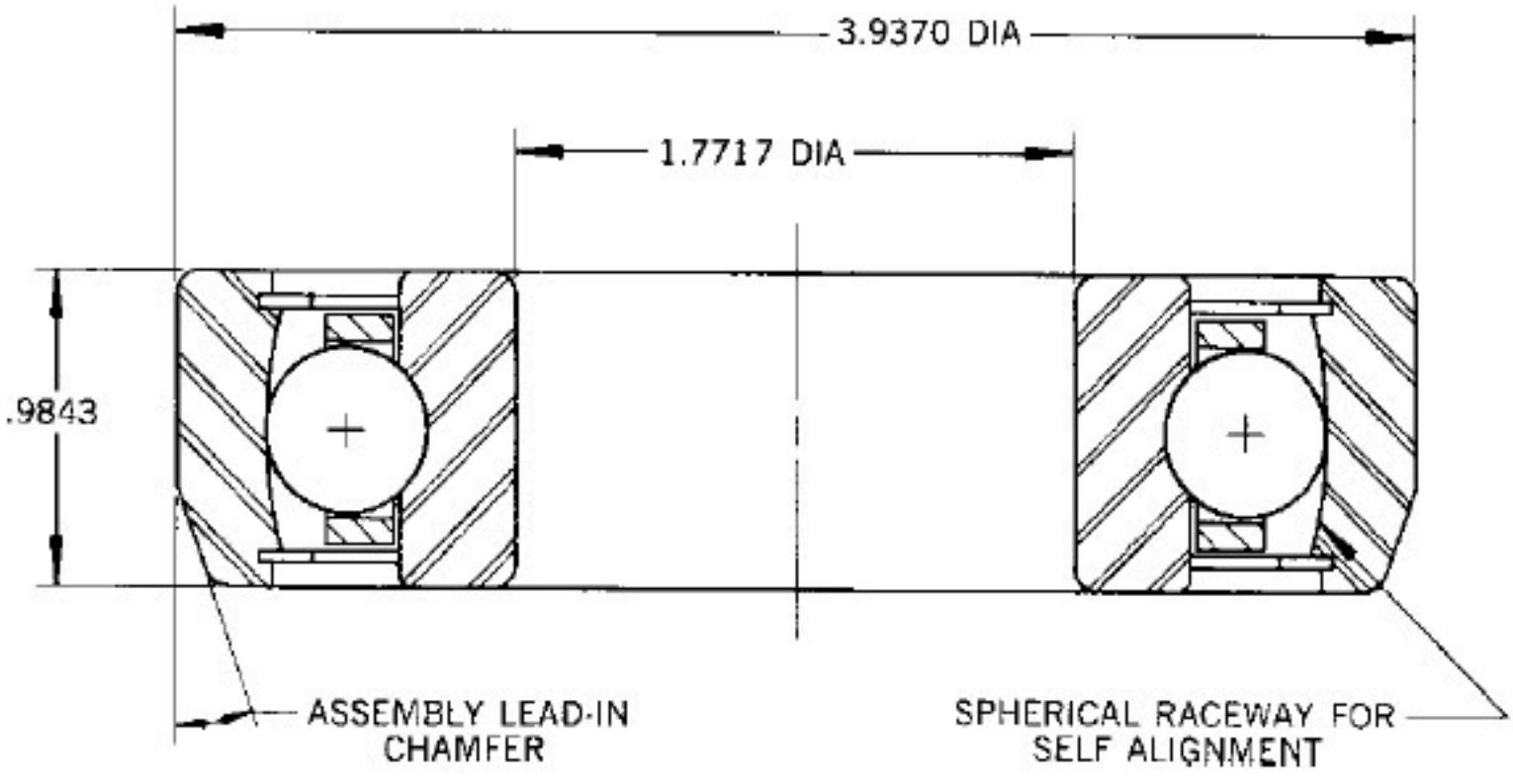
Client Problem

A rolling contact bearing was required on a vertical shaft which rotated in a catalytic-polyethylene autoclave. The bearing had to withstand 650°F operating temperatures and run in liquid polyethelene. Blind assembly of the bearing and the 10,000 lb. shaft was necessary, due to the autoclave design.

ITB Bearing Solution

The bearing was manufactured from AISI-440-C material, specially heat treated to resist the high operating temperatures. The separator material was L-605 cobalt alloy which offered the necessary wear resistance.

To solve the client's problem of inserting the eighteen-foot-long assembly into a blind housing, a large lead-in chamfer was formed on the outside of the bearing. The self-aligning feature of the outer raceway accommodated large shaft misalignments, eliminating operational problems.



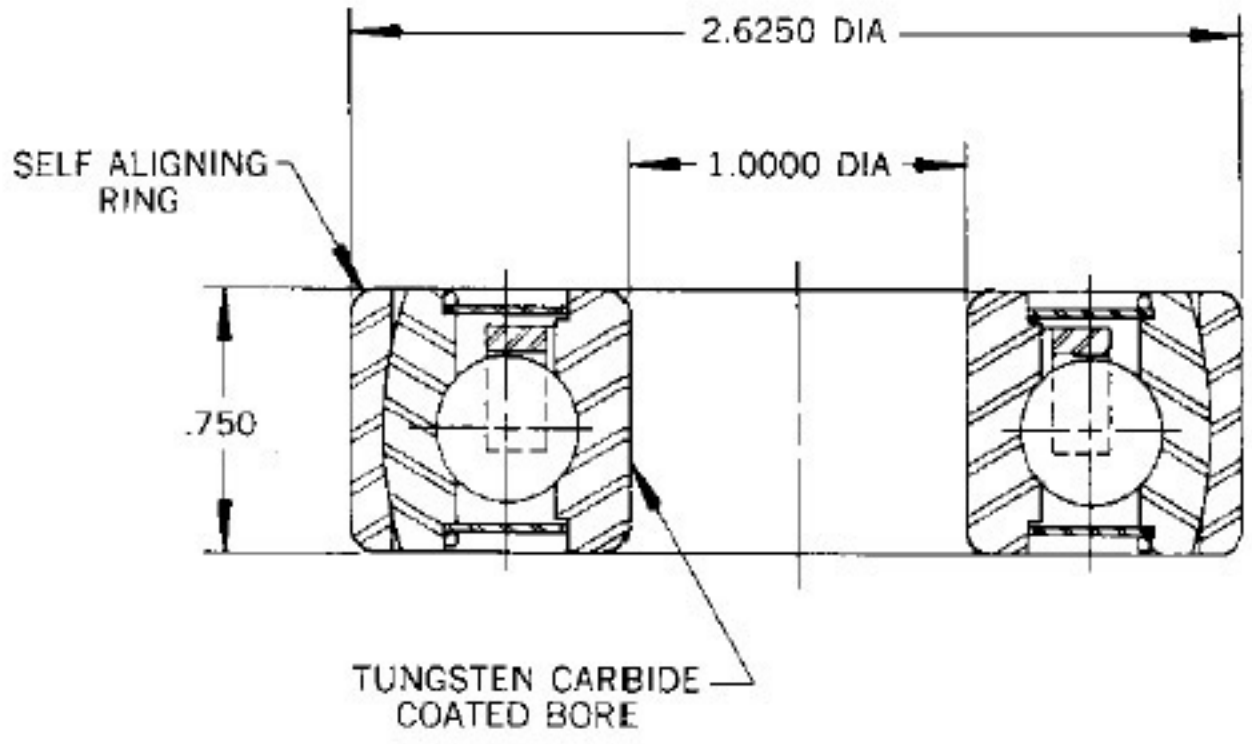
Heat Chamber Conveyor Bearings

Client Problem

Graphite journal bearings in a heat chamber were experiencing fracture.

ITB Bearing Solution

A radial ball bearing was made of AISI-M2 tool steel with a self-aligning housing surrounding the OD of the bearing to compensate for shaft misalignment and frame distortion at high temperatures. The bearing utilized tungsten carbide balls for wear resistance. The bearing raceways and self-aligning surfaces were coated with a dry film, capable of lubricating at temperatures to 1000°F. The bearing bore was coated with flame sprayed tungsten carbide .003 to .005" thick.



PTO Shaft Bearing for Jet Engine

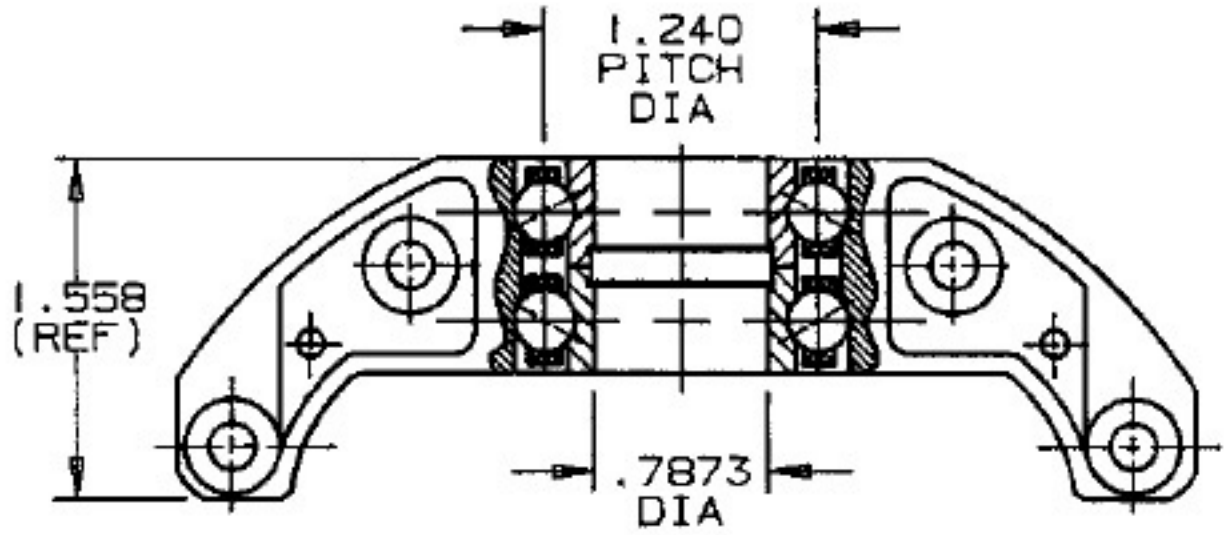
Client Problem

A duplex ball bearing pair for a high speed pinion shaft was failure prone. The bearing pair of conventional configuration had marginal capacity. Space limitations precluded the selection of larger bearings.

ITB Bearing Solution

The successful design integrated the bearing outer rings with its flanged containment housing. The material of this housing was changed to VIM-VAR M-50 bearing steel, and the outer raceways were machined directly into this housing. As a result, the bearing cross section, and hence it's capacity, was increased.

The separate bearing outer ring and all ancillary components such as spacers and bolts could be eliminated.



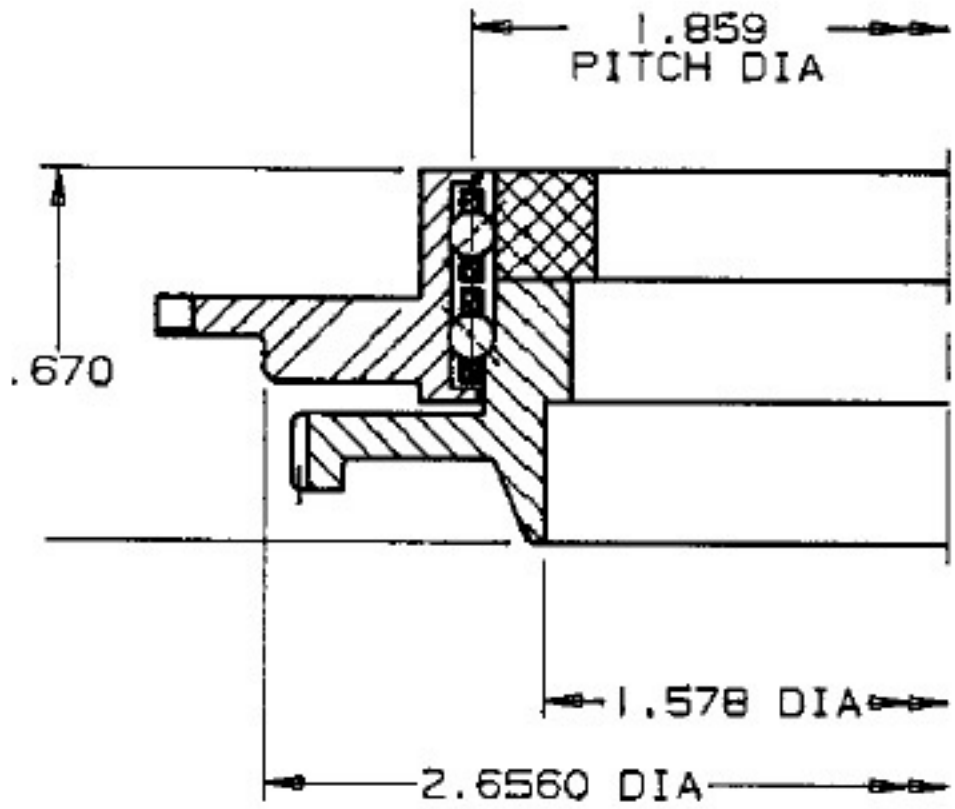
Missile Control System

Client Problem

A bearing of complex shape required extremely high accuracy for angular runout, high moment stiffness and low running torque. A limited space envelope was available. Requirements for moment stiffness and torque could not reliably be met with an existing single-row four-point contact bearing.

ITB Bearing Solution

A duplex angular contact ball bearing design offered better control of the internal preload and resulted in higher precision, greater stiffness and lower torque. To maximize bearing capacity, the outer raceways and shields were integrated with the outer ring. This bearing also includes a helical gear as part of the inner ring.



1200°F Oscillating Bearing

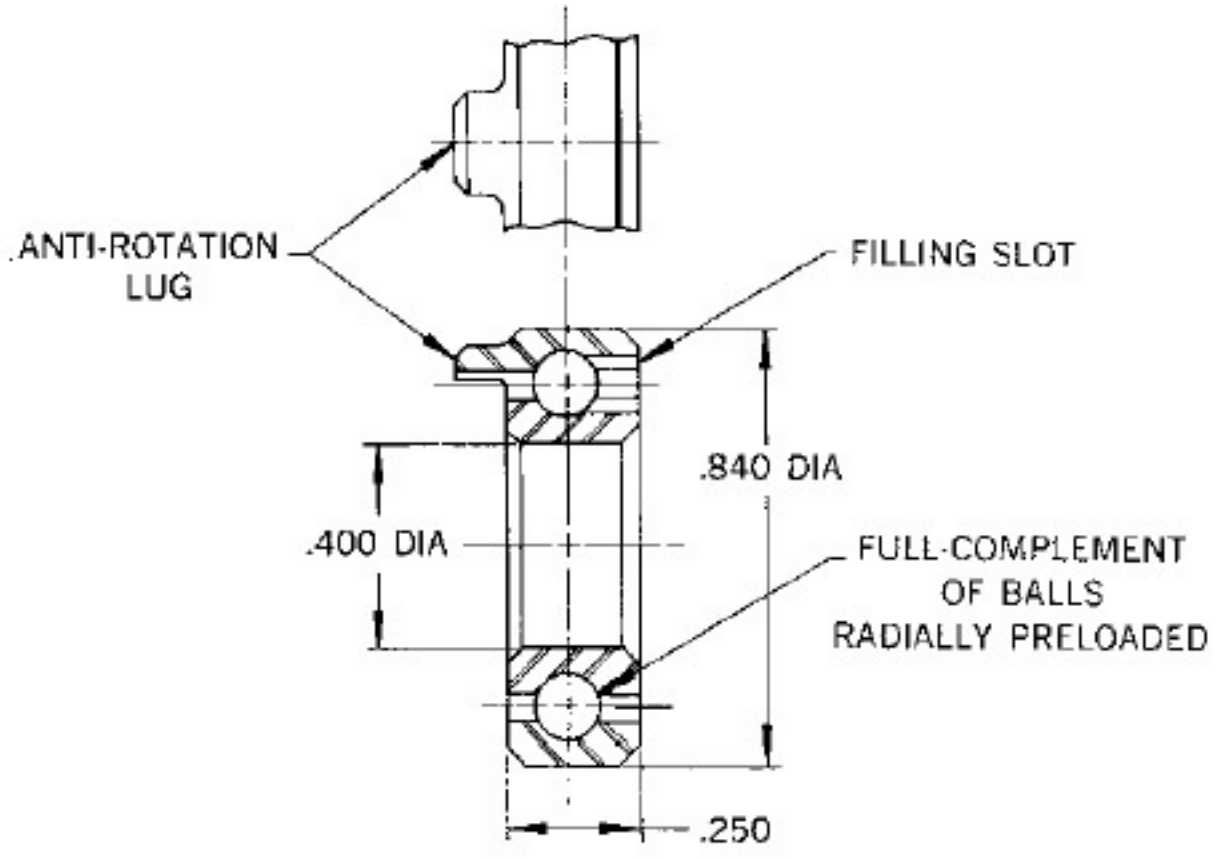
Client Problem

A high temperature rolling contact, oscillating bearing for operation at 1200°F, subjected to high vibration loads.

ITB Bearing Solution

The bearing was manufactured of cobalt alloy 6B material which was cold worked by an ITB proprietary process to obtain a hardness of Rockwell C-53 minimum in the raceway areas. The balls were made of L-605 cobalt alloy. The full complement bearing was designed with loading slots for insertion of the balls, and negative radial clearance of .0003".

Due to the high temperature characteristics of the cobalt alloy, no external lubricant was required. The increased hardness of the raceways to Rockwell C-53 minimum produced a bearing which was capable of operating up to 1200°F with extreme wear resistance.



Gearbox Bearings With Self-Lubricating Separators

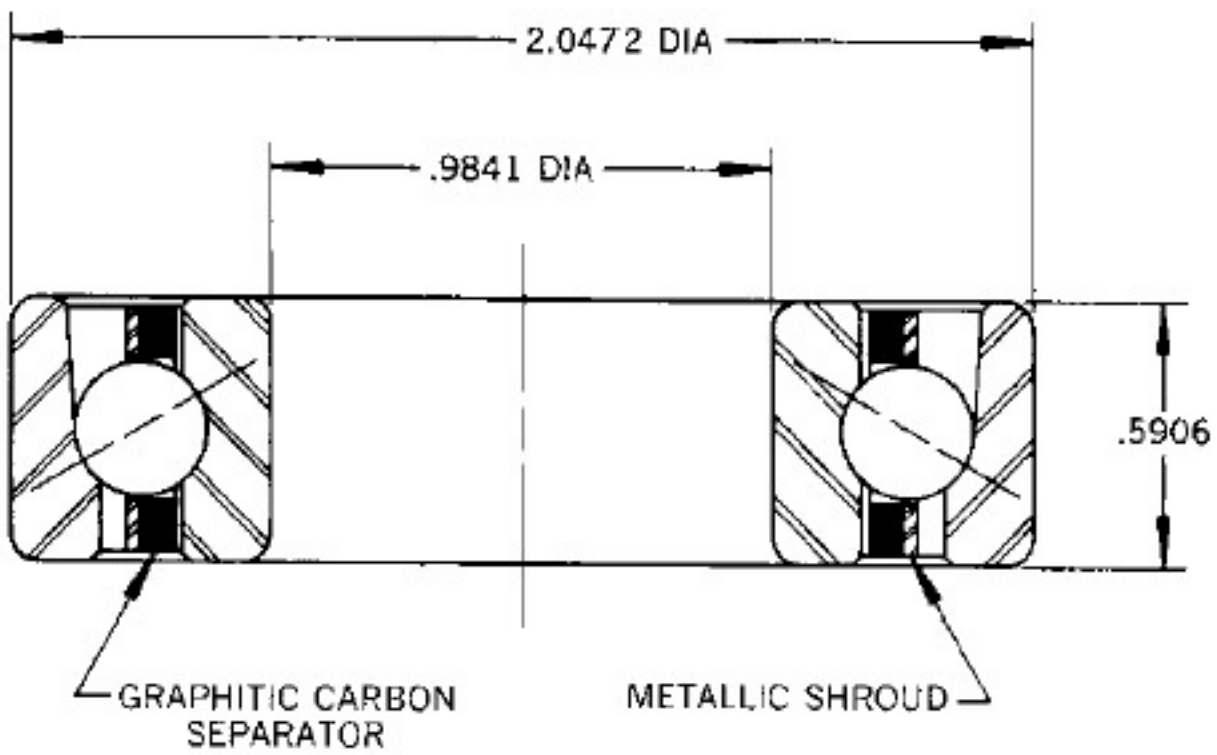
Client Problem

Bearings were needed for operation in high-temperature gear-boxes at 600°F to 650°F. Conventional lubrication such as oil was not available; therefore the bearings would have to be self-lubricating.

ITB Bearing Solution

Angular contact ball bearings were designed, utilizing an inner land guided separator of graphitic carbon material. The separator was reinforced on its outside diameter with a metallic shroud to withstand the centrifugal forces from high operating speeds and resist fracturing, which could result from the tremendous acceleration rate of the bearing rotation.

The balls and raceways were coated with an impinged, tungsten-disulfide dry-film lubricant of approximately .000020" thickness. With this dry film, the bearings were capable of operating at the required speed without any break-in period normally required for bearings incorporating dry, self-lubricating separators.



High Temperature, Actuator Thrust Bearings

Client Problem

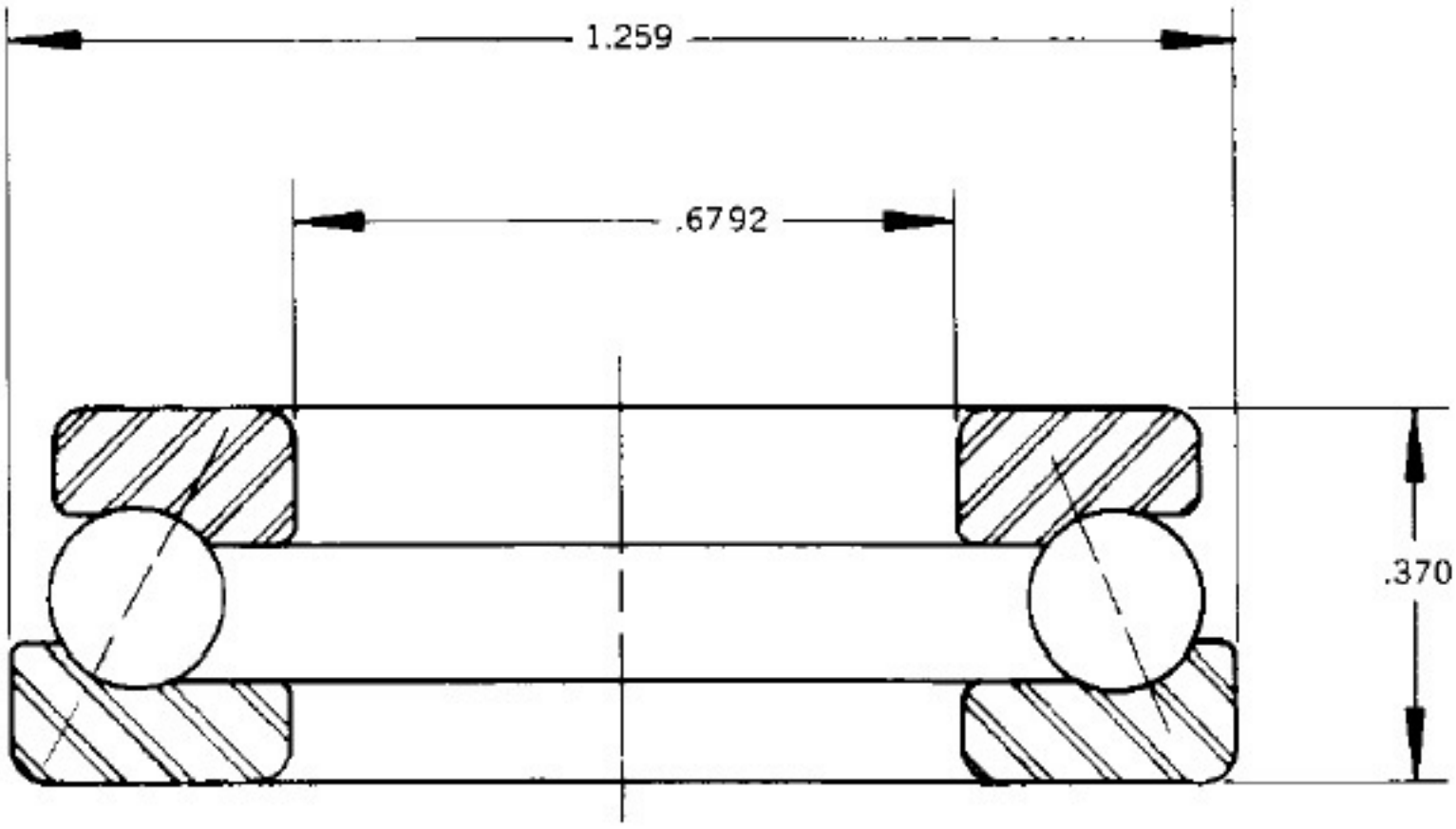
A high temperature thrust bearing was needed to support the reactive thrust of a ball screw actuator. Bearings had to be capable of operating at approximately 850°F.

ITB Bearing Solution

Bearings were manufactured from CEVM M-2 tool steel with a full complement of sixteen .187 diameter tungsten carbide balls. The bearing was designed with a contact angle of 60° to handle the high thrust load and some radial loading.

The races were coated with a proprietary dry-film lubricant prior to installation of the bearing in the application.

The significant design feature which allows the bearings to operate at 850°F and at speeds up to 750 RPM without excessive wear is the combination of the tungsten carbide balls running against the M-2 tool steel raceways. Similar designs using M-2 tool steel balls had worn rapidly at relatively short periods of application at the operating temperatures.



Non-Magnetic Bearing

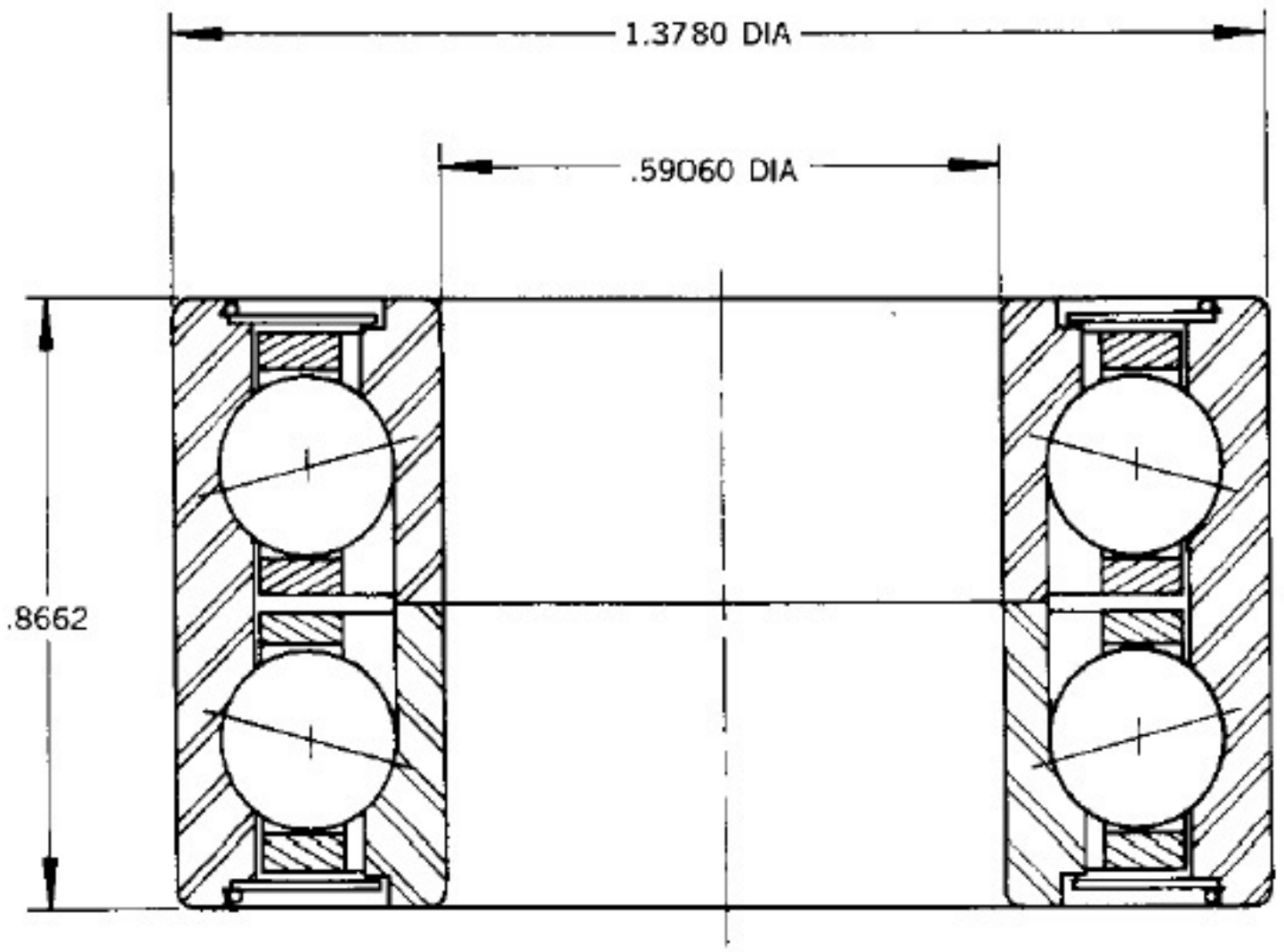
Client Problem

A newly designed rotating magnetometer for ore analysis required a non-magnetic bearing.

ITB Bearing Solution

ITI manufactured the bearing from Berylco 25 material. This material was used for the inner and outer races, balls and shields. The separator was manufactured of a phenolic material.

The bearing was designed as a common outer duplex DB pair, lightly preloaded. Shields were incorporated to reduce the possibility of contamination. The bearing was lubricated by plating the raceways with MIL-G-23827 grease.



Food Processing Equipment Bearings

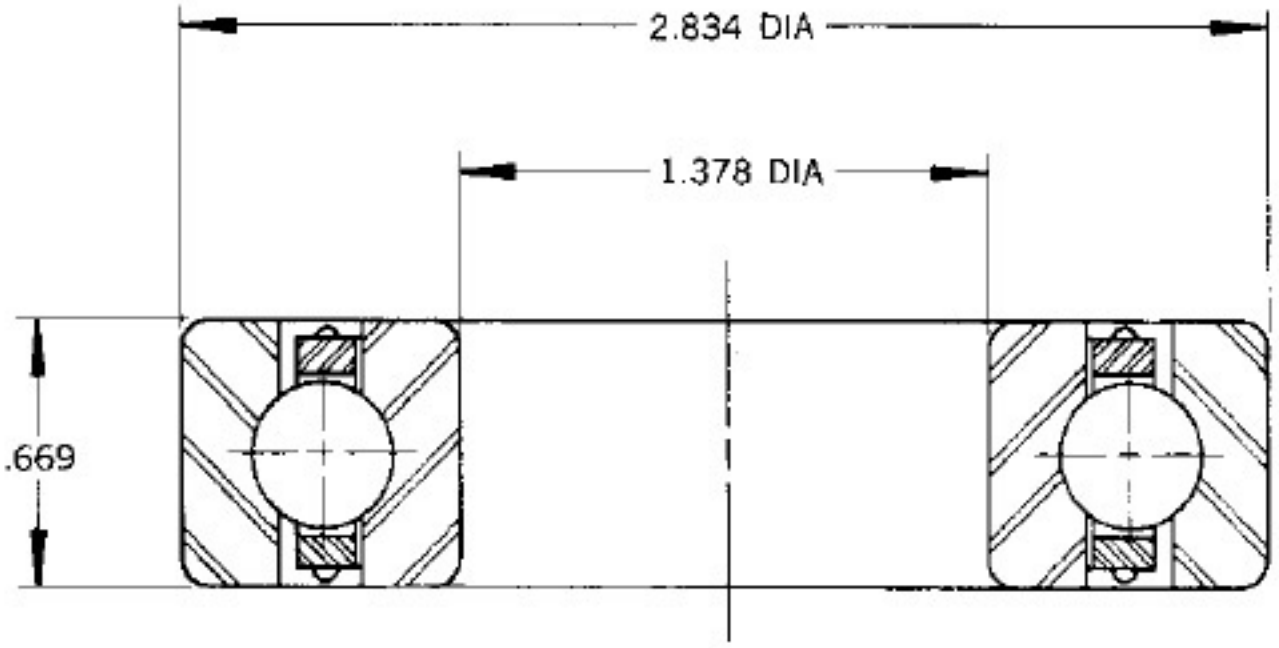
Client Problem

Relatively short life was obtained on bearings made of 316 stainless steel in food processing equipment. 316 stainless steel was required to prevent contamination of the food products.

ITB Bearing Solution

A search of various materials which were resistant to the food products handled by this particular piece of equipment showed that certain cobalt alloys could be used without fear of contamination or corrosion.

For improved wear resistance and increased hardness, the raceways were cold worked and age hardened. The alloy used for the raceways and the balls was L-605. Separator material was 17-4 PH.



1400°F Self-Aligning Ball Bearing

Client Problem

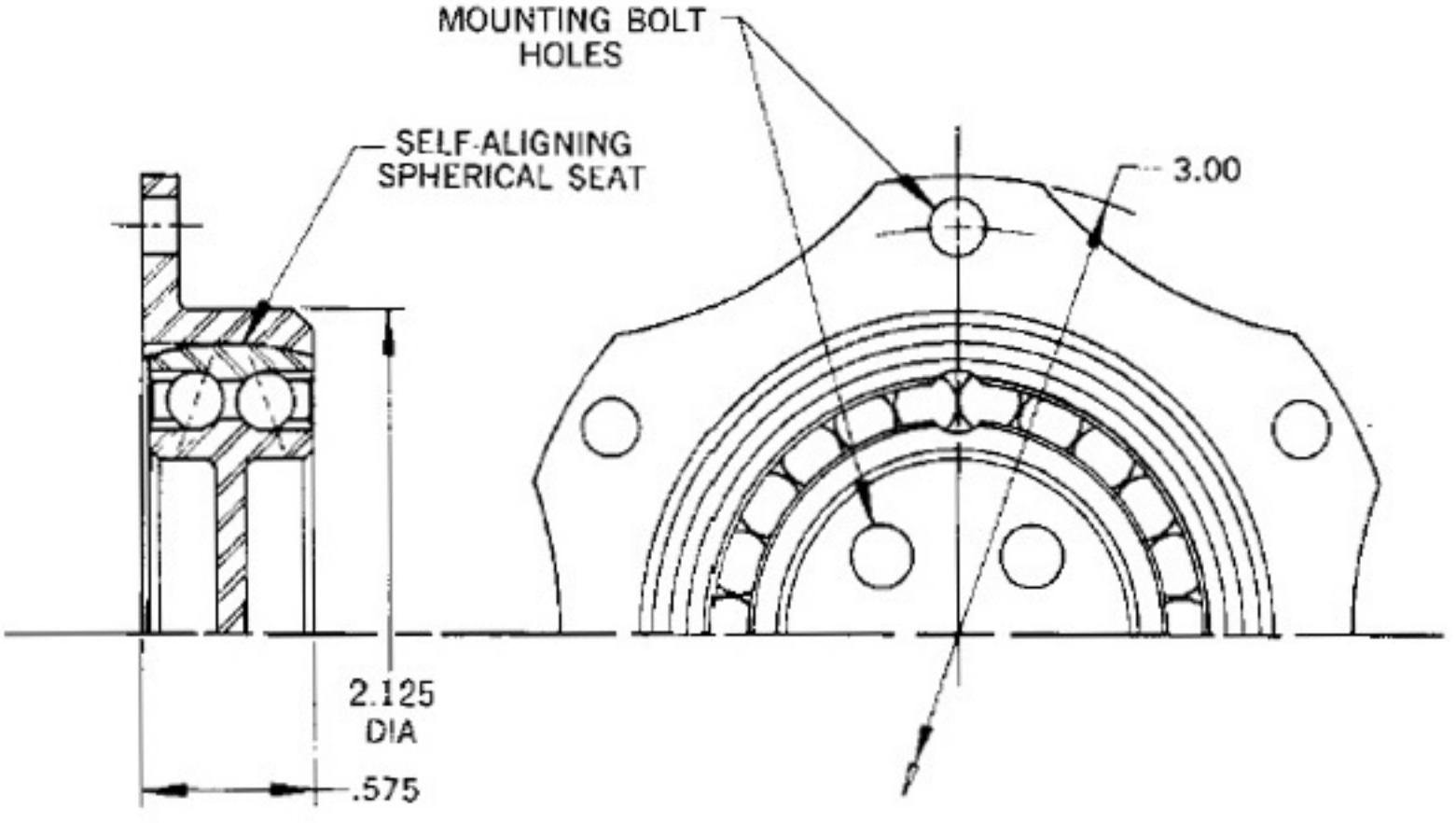
A hinge bearing on the exhaust ducts of a jet engine used to propel and lift a ground effect vehicle.

ITB Bearing Solution

The double row ball bearing cartridge unit utilizes L-605 material for the raceway and balls. The bearing was mounted in a self-contained spherical housing to compensate for misalignment of the shaft during operation, which occurs due to temperature differentials between the frame and the exhaust nozzles.

The races were made by a special ITI developed proprietary race hardening technique. With this technique the L-605 cobalt alloy material is work hardened and then heat treated to a Rockwell C-53 minimum.

The bearing operated successfully when exposed to 1400°F exhaust gas.



Integral Bearing Assembly

Client Problem

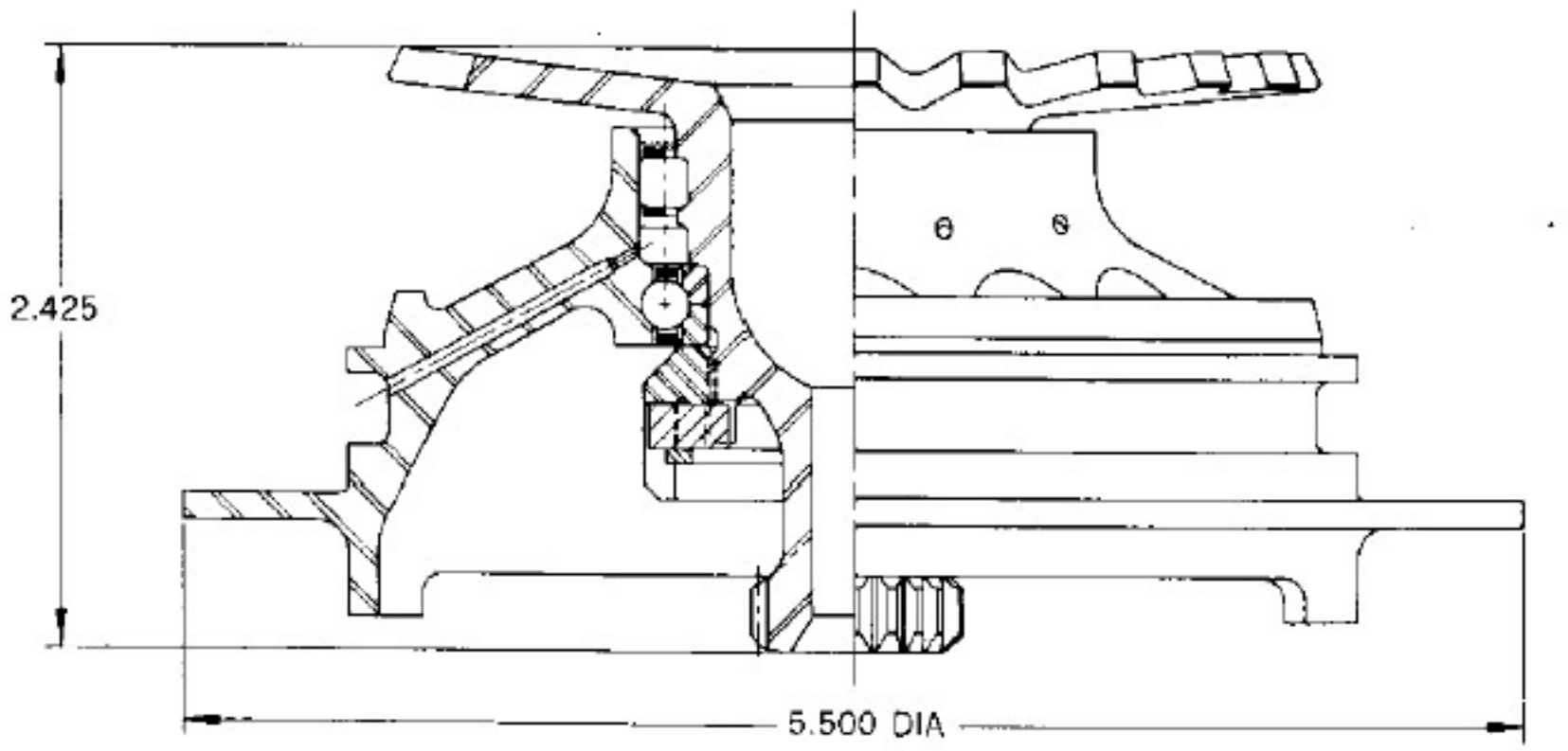
Save space and weight in an application involving a power take-off drive from a high speed gear-box.

ITB Bearing Solution

The bearing housing was designed to incorporate the outer raceways of the roller bearing and the split inner race ball bearing. To increase the rolling contact fatigue life, the housing was manufactured from CEVM M-50. The gear was made integral with the shaft and the inner raceway of the roller bearing. The gear shaft was manufactured from CEVM AISI-9310 case hardened to Rc 61-64 on the gear tooth surfaces and in the roller bearing raceway.

In order to facilitate lubrication of the bearings, holes were drilled through the housing into the space between the two bearings. The lubricant was fed through these holes from an annular groove in the housing.

The two halves of the split inner race were retained to the gear shaft by a lock nut. The combined integral assembly of bearings, gear shaft and housing provided the desired space and weight reduction and gained improved operational accuracy. In addition, it afforded easier installation into the gear-box.



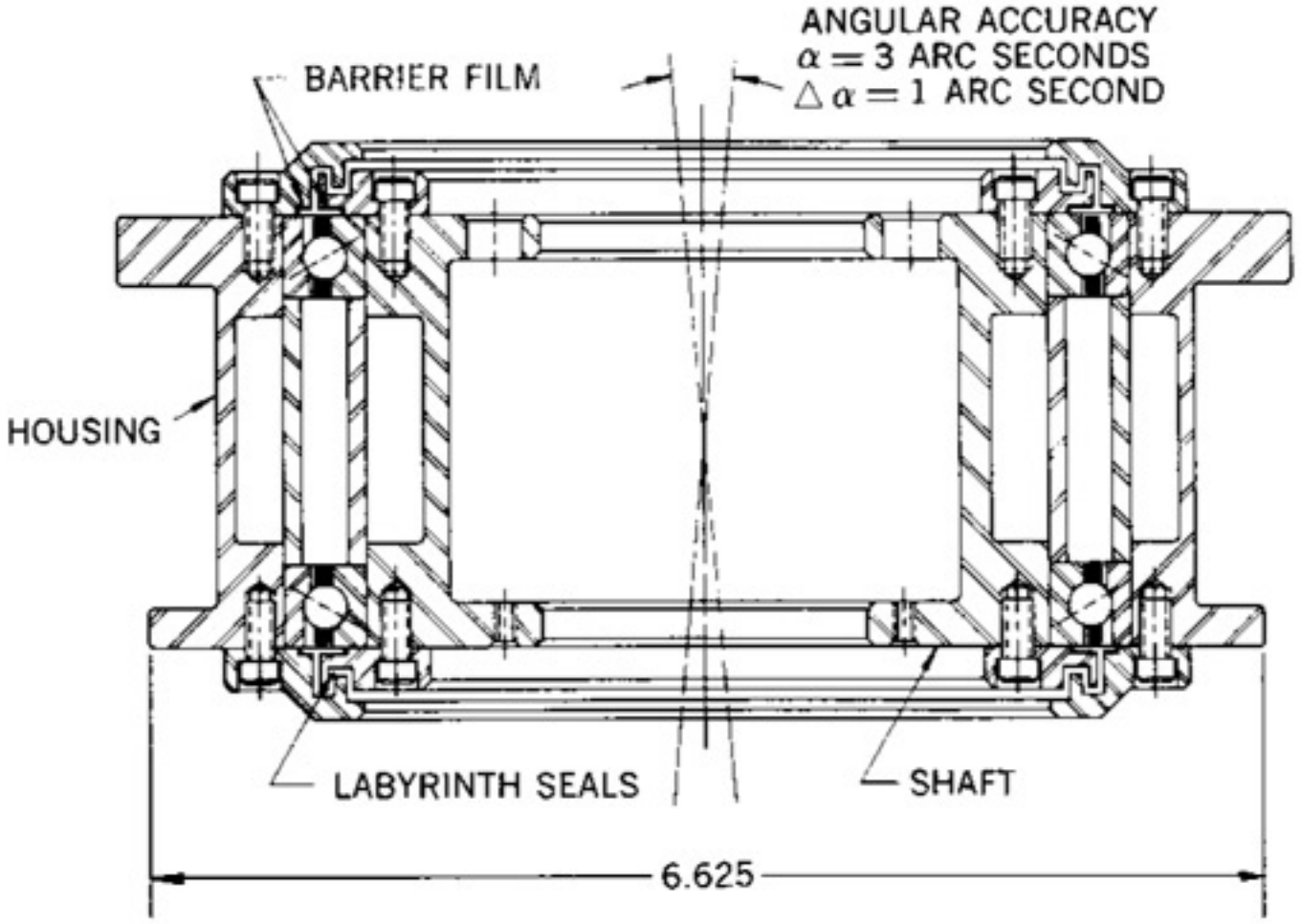
Extreme Angular Accuracy Bearings

Client Problem

To provide a set of bearings which maintain an extreme precise angular accuracy of the center line of the shaft to the housing. The angular accuracy requirement was a non-repeatable error ($\Delta\alpha$) of one arc second, and a repeatable error (α) of three arc seconds.

ITB Bearing Solution

Bearings were made as part of the cartridge assembly and all angular measurements for accuracy were made relative to the housing and shaft. Bearings were preloaded and spaced axially to help overcome geometric inaccuracies of the bearing. The bearing raceways and balls were made from Consumable Electrode Vacuum Melted AISI 440-C matieral. As the bearings had to operate in a vacuum, the separator material necessitated a special open weave phenolic material impregnated with a special silicone oil. To prevent migration of the oil from the cartridge assembly, the labyrinth seal was coated with a barrier film.



RBC Aerospace Bearing Products

Innovation. Commitment. Quality.

RBC has been producing bearings in the USA since 1919. In addition to unique custom configurations, RBC offers a full line of aerospace bearings, including:

Spherical Bearings

- MS Approved to MIL-B-81820
- Boeing and Airbus Approved
- Self-lubricating • Metal-to-Metal
- Slot loaders • High temperature
- Low coefficient of friction
- Special configurations and materials

Thin Section Ball Bearings

- Standard cross sections to one inch
- Stainless steel and other materials are available • Sizes to 40 inches
- Seals are available on all sizes and

Journal Bearings

- MS Approved to MIL-B-81934
- Boeing and Airbus Approved
- Plain and flanged • Self-lubricating
- High temperature • High loads
- Available in inch and metric sizes

Airframe Control Ball Bearings

- MS Approved to AS7949 (formerly MIL-B-7949) • Single and double row
- Radial, self-aligning, and pulley series
- 52100 Cad plated and 440C stainless

Ball Bearing Rod Ends

- MS Approved to AS6039 (formerly MIL-B-6039) • Boeing Approved
- Various shank configurations
- Low coefficient of friction

Ball Screws

- Precision ground, rolled, ball splines

Rod End Bearings

- MS Approved to MIL-B-81935 & 81936
- Boeing and Airbus Approved
- Self-lubricating • Metal-to-Metal
- Slot loaders • High temperature
- Low coefficient of friction
- Special configurations and materials

Cargo Roller Bearings

- Boeing Approved
- Features precision ground, semiground, and unground ball bearings
- Offered in caged and full complement configurations

Track Rollers

- MS Approved to MIL-B-3990
- ATF single row and ATL double row
- Sealed with lube holes and grooves
- Heavy duty cross sections

Heavy Duty Needle Roller Bearings

- Pitchlign® caged heavy duty needle roller bearings
- Inner rings, TJ TandemRoller® bearings for long life

Tapered Roller and Thrust Bearings

- Tyson® brand case-hardened in many sizes
- Used primarily in aircraft landing gear wheel systems

Specials

- RBC manufactures many specialty bearings, custom-configured for aerospace applications

RBC AEROSPACE BEARINGS

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