

Special Applications



Introduction

Our special bearing innovations range from nearly standard bearings with slightly modified dimensions, to intricate assemblies which integrate the bearing function into a complete mechanism. Barden engineers work closely with customers to develop unique bearing designs with specialised features to meet application requirements and solve functional problems.

In many cases the overall cost of a piece of equipment can be reduced by incorporating special or customised bearings, particularly when mating components are integrated into the bearing. Such components include mounting flanges, gear teeth, spring carriers and integral O-ring grooves. The performance and installation benefits gained from using individually designed bearings include:

- ❑ Improved assembly reliability
- ❑ Enhanced rigidity or stability of the system
- ❑ Better location control through proper bearing orientation
- ❑ Reduction in handling operations and contamination
- ❑ Improved alignment of the rotating assembly
- ❑ Weight reduction
- ❑ Improved resistance to temperature extremes
- ❑ Reduction in tolerance stack-up

Capabilities

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Special Applications

Vacuum Pumps

Barden has established an expertise in developing bearings for the entire pump market. Using new materials — and by adding value — bearings can be designed to meet the harsh requirements of today's high performance pump market.

Some of the factors that make high precision bearings the first choice are high temperatures, high speeds, low vibration levels, abnormal contamination levels, poor lubrication, high reliability and long life.

Among the areas of expertise in which Barden bearings are already proven as the solution provider are turbomolecular pump bearings, dry pump bearings and emergency touch down bearings for magnetically supported pumps.

Turbomolecular Pumps

The most important requirements for a bearing used in this application are long life, reliability and high-speed performance. To this end the use of AMS5898 material, ceramic balls, greased for life and special high quality raceway finishes has become the Barden standard. Current "greased-for life" bearing technology can consistently give 30,000+ hour life at speeds in excess of 1 million dN.

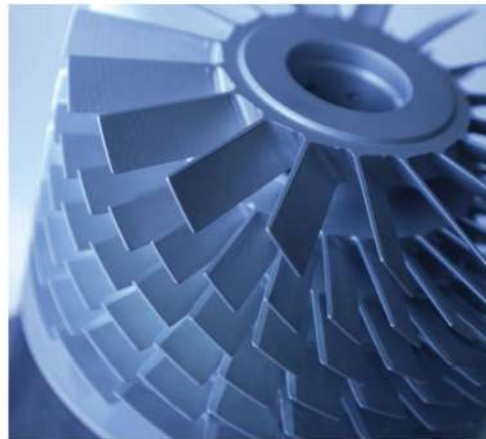
Dry Pump Bearings

While the speed requirements on the bearings for this type of application are often lower than usual, other factors including temperature, contamination and reliability mean that a special bearing design is necessary in order to meet the application requirements. Barden is able to design dry pump bearings for optimal performance with both oil and grease lubrication. Also, by adding value to the bearing so that it reduces assembly cost and pump component count, additional performance and economic benefits can be gained from the use of Barden's special bearings.

Special design features

Some of the value-added design features that enable Barden's special bearings to work reliably in high-performance pumping applications include:

- ❑ **AMS5898 high-nitrogen steel – For optimum performance and reliability**
- ❑ **High performance ceramic balls – Chosen to meet the performance and corrosion requirements**
- ❑ **High-speed small ball technology – For improved pumping speeds**
- ❑ **Shielded angular contact design – To guard against contamination ingress and prolong lubricant life**
- ❑ **Special internal design – To maximise the in-application performance**
- ❑ **Special Barden "TMP Standard" internal finish – For quieter running, longer life and high reliability**



Vacuum pump bearings must endure a range of hostile operating conditions, an environment ideally suited for Barden precision bearings.

Emergency Touchdown/ Auxiliary Bearings

Active magnetic bearing systems provide a practical method of suspending shafts (both axially and radially) in numerous applications, including turbomolecular vacuum pumps, dry pumps, compressors, blowers, air conditioning systems, gas expanders and in energy storage systems as emergency back up power. Barden has a dedicated engineering team specialising in the emergency touchdown bearings that typically accompany the above systems.



Typical full complement hybrid ceramic pair of bearings for emergency touchdown application.

This special application area requires bearings that can withstand the harshest conditions. To successfully control a shaft on which the magnetic bearings have failed often requires a bearing that can accelerate from zero to 2 million dN or higher virtually instantaneously. In addition the bearing system must then control the rotor under the very high radial, axial and shock loading. Barden has developed bearings for this application using a "full of balls" ceramic design with AMS5898 rings to give exceptional performance and corrosion resistance. Barden is able to optimise the bearing design for the maximum number of touchdowns.

Our engineers are able to closely predict the initial shock load characteristics during the crucial first phase of operations and therefore size the touchdown bearing more appropriately. This means an emergency bearing design is not over-engineered or under-engineered for a given application. Touchdown bearings have been developed in numerous configurations, including single and double bearing arrangements.

Designs range from units that fit 4mm diameter shafts up to 120mm OD. For particularly harsh environments such as aggressive gases, the bearings use zirconia balls for extra corrosion resistance.

Barden's Product Engineering Department is able to offer further advice on touchdown bearings for industrial applications by request.



Turbomolecular pump bearing with extended oil catching cage



Special double row assembly with integrated housing for large general vacuum pump



Special heavy section inner ring ceramic bearing for a high performance dry pump



Turbomolecular pump bearing with extended inner ring and special shield arrangement

Aviation & Defence

Auxilliary Equipment

Custom designed and manufactured aerospace bearings are a cornerstone of the Barden product line. Aerospace bearings are specifically designed according to application requirements, with engineering staff often involved early in the development stages of aerospace equipment.

Barden bearings are utilised in pneumatic and electric starters and generators, gearboxes, and a variety of auxiliary aircraft positions. Bearing configurations range from standard deep groove bearings to intricate split inner ring designs. Thanks to state-of-the-art production facilities and a highly experienced workforce, The Barden Corporation is able to manufacture bearings with unusual materials and designs.

Unlike the product designs which vary, product precision remains constant. Super precision ABEC 7 bearings are standard, and as a result Barden aerospace bearings are capable of high speed, reliable operation and quiet running with minimum power losses.

Due to their unique design, split inner configurations can accept reversing thrust and combination loads. The bearings are assembled with one-piece high strength cages that are often silver plated for improved operation under marginal lubrication conditions. Bearing configurations can include puller grooves and flanges, as required. Typically split inner ring bearings are manufactured from high temperature, high strength bearing steels such as AISI M50 and AMS5898. As in other applications, ceramic balls are available and can enable higher speed operation.



Specialty bearings include the flanged split inner ring configuration, shown here, used in precision aerospace applications.

Other typical aerospace configurations include deep groove bearings which are greased and sealed for life at the factory in clean assembly rooms. A variety of grease lubricants are available depending on the application requirements. Barden "T" cages are often recommended for these bearings. In addition to being lightweight and strong, "T" cages allow for high speed bearing operation. The standard high temperature seal material is FKM. This material is generally not reactive with typical chemicals present in aerospace applications.

Barden Flexeals are also available when higher operating speeds are required. AMS5898 and ceramic balls are often recommended to provide corrosion protection for bearings operating in harsh environments.

Auxilliary Equipment



Deep groove bearing with two-piece machined and riveted metallic cage



Angular contact bearing with full ball complement



Wide width, deep groove bearing with light contacting seals



Gothic arch ball bearing with flange and securing holes for aircraft generator application

Aviation & Defence

Instrumentation & Sensing

For over 70 years the Barden Corporation has been offering precision gyro bearing users an extremely wide range of special design bearings and assemblies. Increased performance requirements of gyros in terms of drift rate, life and size have created a demand for bearings produced to carefully controlled tolerances of less than half a micrometre. This accuracy, plus close control of contact surface geometry and finish, cleanliness and ball retainer oil impregnation, results in a number of benefits:

- ❏ **Decreased vibration levels**
- ❏ **Longer useful life with fewer lubrication failures**
- ❏ **Greater stability of preload**
- ❏ **Reduced mass shift due to wear**
- ❏ **Greater performance uniformity from unit to unit**

These improvements are accomplished by means of unusually close control of raw materials, metallurgy, geometry, runout errors, and all critical dimensions.

Barden can offer many bearing types ranging from conventional bearings with modified dimensions to intricate configurations designed to meet unusual performance or application problems. Many special assemblies include shaft or housing members designed integrally with bearing inner or outer rings to reduce mating part errors and tolerance build-up, or to simplify component design and assembly. Such integrated designs have enabled gyro manufacturers to greatly improve the performance of their units, often with an overall reduction in production costs.

Optical Systems

Super precision bearings play a crucial role in ensuring the accuracy and reliability of optical guidance systems used in military sensing applications. Advanced infrared seeker systems used in modern military equipment often utilise bearings to support intricate mirror gimbal arrangements. Commercial optical applications include gyro stabilised camera systems which are used to acquire good quality images and video footage typically from a moving vehicle.

Barden engineers design gimbal bearings for optical systems to have certain key characteristics which are vital for the accuracy and effectiveness of the system. Specifically this includes the radial and axial stiffness of the bearing, friction torque level and lubrication method.



The unique demands placed on gyros makes Barden precision bearings the only option.



Rotor bearings are made to precision tolerances for optimum performance.



Gimbal bearings are offered in a wide range of design configurations to fit a variety of special needs.

Instrumentation & Sensing



Gyroscope rotor bearing



Optical system pivot bearing



Gyroscope end bell rotor bearing



Guidance system gimbal duplex pair



Gyroscope gimbal duplex pair

Aviation & Defence

Actuation Systems

With decades of experience in designing fully optimised and integrated bearings and assemblies for aircraft equipment, Barden can deliver high performance solutions for commercial and defence actuation systems, including primary and secondary flight control for military and civil aircraft, satellite and missile applications.

Typically super precision bearings are utilised in equipment including conventional servo-controls, fly-by-wire and power-by-wire actuation and electro-hydraulic actuation. Standard applications include rudder, elevator and aileron flight control systems.

As aerospace experts, Barden engineers have designed bearing assemblies for a wide range of challenging actuation applications. For example, where bearings are local to the point of actuation, high vibration levels can be expected. The incorporation of dissimilar ball and race materials (e.g. ceramic balls) can lead to reduced adhesive wear during vibrational or non-operational duty cycles.

Barden engineers can create customised internal designs to maximise load carrying capacity and stiffness. Where design envelopes are small, Barden can engineer a range of solutions aimed at easing the assembly process and reduce assembly time. In previous actuator applications this has included the incorporation of screw threads on assembly mating surfaces and inclusion of components from the surrounding shaft and housing within the bearing design. Such features can potentially lead to cost savings over the entire assembly and reduced assembly time.

Bearings for these systems can include a number of further optimising features. Designs can be produced which incorporate:

- ✦ **Sealing technology within the bearing to help save space**
- ✦ **Ability to withstand very high loads**
- ✦ **Operation under boundary lubrication conditions**
- ✦ **Super finished raceways to improve lubrication film generation**
- ✦ **Anti-rotation features to prevent slippage under the effects of the rapid changes in speed and direction of rotation**

Actuation Systems



Nose to body bearing, flanged with threaded OD



Full complement bearing for a fin actuation system



Aircraft actuator motor bearing



Double row, full complement bearing for helicopter control rod application



Thin section bearing for an actuation system

Canning Industry

Canning was a revolutionary invention in the 19th century. It created a way to preserve fresh and cooked food for years, maintaining nutritional value and without requiring chemical additives or processes such as smoking, pickling or salting.

All phases of can forming, shaping and seaming rely on rolling element bearings for continued accuracy and speed of process. Can making and canning are now high-speed, high technology industries. Cans can be manufactured at rates of more than 1,500 per minute, and printed and filled at similar speeds. Barden super precision angular contact ball bearings can be found in machinery that services the high and low volume canning industries.



Barden's specialised bearings set the standard for performance and reliability in the high volume throughput canning industry.

This industry presents a particularly hostile environment for bearings. In addition to aggressive media and harsh cleaning processes, bearing lubricants must also comply with environmental (FDA) guidelines that require the use of thin organic-based oils offering only marginal lubrication characteristics for the majority of the operation.

The use of ceramic balls in this application offers many benefits, including the extreme reduction in surface (adhesive) wear compared to conventional bearings. Wear particles generated by adhesive wear are not

present in ceramic hybrid bearings and as such, lubricant life is extended and lubrication intervals increased. This extension is also aided by the lower temperatures at which ceramic hybrid bearings operate.

By combining the material properties of advanced corrosion-resistant steels with those of ceramic balls, Barden bearings demonstrate superior performance and reliability over traditional steel bearings in this demanding environment.



Seamer tool assembly



Hybrid ceramic, seamer bearing



Double row, hybrid ceramic seamer bearing cartridge

Nuclear Power

In safety-critical applications such as nuclear power plants, component obsolescence is a critical factor in supplier selection. For more than 70 years, Barden has been manufacturing super precision bearings for the nuclear industry worldwide and has a policy of non-obsolescence.

In nuclear power stations, Barden super precision bearings are often found in the fuel handling systems and linear actuation systems that position the control rods into the nuclear fuel bundle to manage the rate of Nuclear Fission. In emergency situations, these control rods are dropped into the fuel bundle in order to reduce the rate of reaction rapidly to zero allowing the reactor to be safely shutdown. This means that component reliability is critical and the bearings must not fail under any circumstances. Barden therefore provides certification, full traceability, controlled lubrication and retention of records for every bearing supplied to the nuclear industry.

Barden is able to produce direct replacement bearings to the same or higher quality standards as the original, and is also able to manufacture these bearings in small batch sizes, anything from 10 to 500 units. Most bearings for nuclear applications range from 20mm up to 180mm in diameter and are of the deep groove ball bearing and angular contact ball bearing types. Some special applications require thin section duplex bearings.

Barden's UK and Germany-based manufacturing plants also provide full clean room facilities, which guarantee contaminant-free assembly of bearings.

Special materials and coatings to suit the application or extreme environments can be used, with bearings available in SAE 52100, AISI 440C, AMS5898 (high corrosion resistance and high temperature operation), AISI M50 and BG42. Balls can be manufactured from ceramic silicon nitride, zirconium dioxide, tungsten carbide or cast cobalt alloy. Cage materials can be specified in steel, bronze, phenolic, polyamide, polyimide, PEEK or PTFE-based. Lubricants used include hydrocarbon, synthetic esters and hydrocarbons, silicone and perfluoroalkylpolyether and special nuclear greases such as Castrol Nucleol.



Deep groove, shielded bearing with a special flange for a nuclear application