Vee Bearing Design Considerations

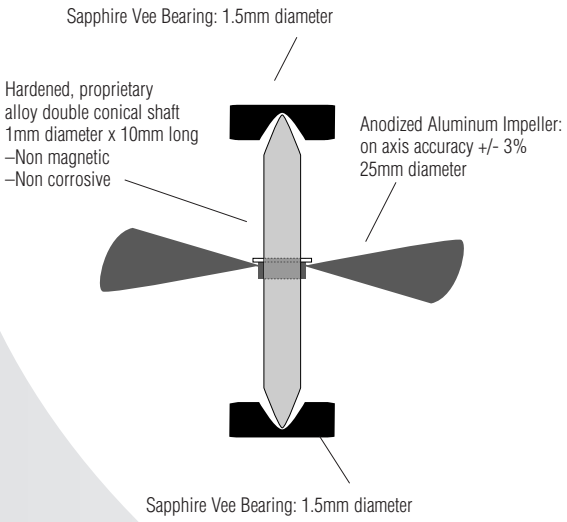
The most important factor to consider when designing a vee jewel bearing system is the relationship between the radius of the pivot and the radius of the jewel. At Bird Precision, we recommend a ratio of approximately three-to-one. That is, with a pivot of .001" radius, the jewel bearing should have a radius of .003" to obtain generally good performance. Higher and lower ratios may be advisable under special conditions of sensitivity, loads, environment or other factors. A ratio which is too high results in excessive sensitivity, poor damping and repeatability and a high susceptibility to damage in handling. A ratio which is too low will result in a system that has excessive friction and which can result in a "sticky" movement. We invite you to use Bird's experience in helping you finalize your design.

Bird Precision vee bearings are available in glass or sapphire. The choice of the materials is determined by the load to be supported, operating conditions and cost. Generally, sapphire is used where the assembly is solid mounted and the moving weight of the instrument exceeds 200 mg. Over 100 sizes are maintained in stock from 1mm to 3mm O.D. Glass jewels, which have lower frictional characteristics, and are lower in cost, are recommended where the supported load is under 200 mg. When glass jewels are protected in their assembly by either a rubber pad or spring, the 200 mg limit does not apply, and each design must be considered on its own merits.

APPLICATION

Low Friction, Ultra Sensitive Bearings and Precision Engineered Aluminum Impeller Make Wind Speed Indicator Possible

Nielsen-Kellerman's goal was a new hand-held anemometer less than five inches long and weighing only 1.5 ounces, yet delivering extreme accuracy. They approached Bird Precision to help in the design of an ultra sensitive, low friction jewel bearing and impeller shaft. Bird Precision rose to the challenge, delivering super polished sapphire conical vee bearings, chosen for their ultra low coefficient of friction, which is better than 0.15 against steel. Sapphire is next to diamond in wear resistance, and was also chosen for its long life. For the shaft, Bird Precision recommended their hardened proprietary alloy, which is known for its non-magnetic, non-corrosive, and wear resistant qualities. The sapphire vee bearings and shafts were critically matched for minimum friction and high performance. Bird Precision designed the bearings and proprietary alloy, double conical shaft using their knowledge of turbine flow instrumentation and calibrated HVAC anemometer instruments, and their experience with U.S. geological survey devices. A precision engineered anodized aluminum impeller with a large diameter-to-weight ratio finished off the improved design.



Other anemometers on the market did not allow the accuracy Nielsen-Kellerman was looking for, mainly because of their material make-up. Roller bearings are often used, resulting in a great deal more friction than Bird Precision's sapphire vee bearings, and plastic is often used for the impeller's shaft. Plastic wears quite easily, and since most anemometers' impellers cannot be replaced, a worn shaft usually means a new unit is necessary. Thanks to Bird Precision's revolutionary new design, the anemometer was improved and sales soared.

e-mail: inquiries@birdprecision.com ▪ www.birdprecision.com
One Spruce Street, P.O. Box 540569 ▪ Waltham, MA 02454-0569 USA ▪ (800) 454-7369 ▪ fax: (800) 370-6308

Vee Bearing Design Considerations

Ring Jewels, Endstones and Assemblies

The Multiple Factors

Ring jewels are most often used in multiple combinations in various precision instruments, such as clock counters, altimeters and dial indicators. What the design engineer hopes to achieve is multiple small gains in frictional starting torque, making a large overall effect in instrument performance.

H.4, Harrison's marine timekeeper. © National Maritime Museum, London

In the late 1700s, the first designer to recognize this possibility was James Harrison, the famous British clock designer. He first introduced the multiple use of ring jewels in his now-famous marine chronometer H.4. He was able to produce a marine chronometer accurate enough to be used to calculate longitude during ocean voyages, thereby giving Britain naval superiority at the time. With this technological achievement, global positioning became mundane, enabling such explorers as Captain Cook to chart the oceans of the world.

Applications

Ring jewels and endstones are used in a variety of instruments, including gauges, indicators, aircraft instruments, watches, clocks, potentiometers, gyroscopes and almost every other type of controlling device. They are normally used in applications where the shaft of a rotating member is cylindrical, requiring the use of an annular bearing. They are also used when it is necessary to have the pivot or shaft extend through the bearing to support some portion of the instrument outboard of the bearing. In addition, they can also be used as electrical insulators. Larger ring jewels may substitute for ball bearings in other applications. The wide variety of shapes and mounting arrangements make the potential uses of ring jewels innumerable.

Concentricity

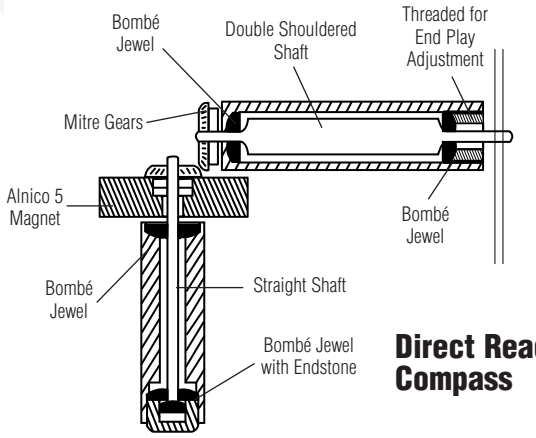
The concentricity of the I.D. of the ring jewel and the O.D. of the housing is an extremely important consideration. Ring jewel concentricity is normally within .0002". In assembling jewel bearings into housings, a normal concentricity of .0005" TIR can be maintained without further operations. A truing operation can improve the concentricity to within .0003" TIR, and if required, further selection can ensure a concentricity of .0001" TIR.

Jewel Tolerances

Jewel tolerances are generally critical on the I.D. and of secondary importance on the O.D. and thickness. An I.D. tolerance of less than .0002" is recommended for jewels up to approximately .080" on the I.D. Jewels whose I.D. is larger require +/- .0003" for economical production.

Why Olive Ring Jewel?

Miniature ball bearings inherently have problems with starting torque due to detent of the balls. This is particularly apparent in low-load oscillating applications. The ruby jewel bearing with an olive shape provides superior frictional starting torque, and is an excellent replacement in most systems requiring low speed, low load and long life.



Direct Read Compass

Typical applications for the ruby ring jewel include altimeters, dip needles, compass gimbal systems, dial indicators and roller transport systems. Ring jewels are also finding wide acceptance for bellows take-off arms, bi-metallic coil arms, timing in clock mechanisms, as well as gyro guidance systems. Most applications requiring long wear, temperature and chemical tolerance, low friction, low starting torque, and the options of either light lubrication or no lubrication are excellent situations for olive ring jewel bearings.

e-mail: inquiries@birdprecision.com ▪ www.birdprecision.com
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