Ring jewels are excellent for oscillating movement, slow arcing motion and sliding applications because they have extremely low breakaway friction and starting torque.

Ruby and Sapphire are synthetic man made crystal materials with amazing credentials, making them an ideal bearing material.

- Almost chemically inert to most acids and alkali great for harsh environments!
- Next to diamond in hardness, 9 Mohs scale, extremely wear resistant. Many time mechanisms using ruby ring jewels are still ticking after more than 100 years.
- Nine times the abrasion resistance of tungsten carbide.
- Nonmagnetic
- They can run dry
- Very high temperature material, 2000 degree C melting point.
- Excellent electrical insulator
- Non-thrombogenic for medical applications

See figure 1 for approximate moment of friction (source Seitz guide for users of synthetic jewels page 20).

PIVOT FRICTION

\[ M = \frac{1}{6} \times S \times \tan \theta \]

\[ S = \frac{F}{A} \]

\[ \tan \theta = \frac{D}{2r} \]

\[ M = \frac{1}{3} \times S \times r \]

\[ M = \frac{1}{2} \times S \times \frac{D}{2} \]

\[ M = \frac{1}{50} \times S \times \frac{D}{2} \]

\[ S = \frac{F}{A} \]

\[ \frac{D}{2r} = \tan \theta \]

\[ M = \frac{1}{3} \times S \times r \]

\[ M = \frac{1}{2} \times S \times \frac{D}{2} \]

\[ M = \frac{1}{50} \times S \times \frac{D}{2} \]
A unique feature, called oliving, can be formed into the journal to enhance the bearing performance as well. (See figure 3.) Primarily this feature offers a degree of radial freedom to reduce binding of the shaft. This is especially important when the two bearings perhaps supported in plates or a bridge cannot be aligned perfectly. Depending on the degree of Radius this type of bearing can provide between 2-5 degrees of radial misalignment. Secondarily, the oliving also reduces friction by minimizing the contact area between the shaft and bearing. The crown of the olive provides a tangential line contact.

INTERLOCKING ASPERITIES AND DETENT
Ruby and sapphire can attain very high surface finish. The finish can be routinely maintained at 2 micro-inch and under.

In good bearing design, the surface finish and the amount of surface irregularities between the moving shaft and bearings as well as the frictional quality of the materials used, all play an important role in bearing performance. Surface irregularities and poor finish increase what is referred to as interlocking asperities.

A good illustration of interlocking asperities would be the knobby surfaced tires of a motor cycle wheel trying to climb a steep incline. As the knobs of the wheel interlock with the surface irregularities of the incline the wheel begins to climb. It will continue climbing until such time as the wheel begins to slip and finally falls back.

Theoretically the best bearing would be one that as it begins to roll, does not interlock, and therefore does not attempt to climb the incline. Such a bearing would be essentially frictionless. But in reality every surface has irregularities and imperfections and therefore interlocking asperities. In the case of ball bearing races the asperities are compounded by the detent (small flats) on the ball surfaces that resist roll. This is why ball bearing races are not recommended for low starting torque or slow oscillating movements. The high surface finish of jeweled bearings minimize the asperities. (see figure 2. Comparing starting torque between olive whole ruby ring jewels and small ball bearing race.)

Jewel ring journal bearings are designed of low friction, wear resistant materials of synthetic ruby and sapphire, with coefficients of friction approx. .14 sliding friction against steel.

There is no chance of detent or flats in the surface since the ID of the bearings are wire lapped. The roundness of the wire, which oscillates thru the bearing much like a honing operation, imparts concise roundness along with the high surface luster.

LUBRICATION
For some applications, engineers wishing to reduce friction further, have added lubrication. (Mainly in closed systems.) DuPont’s Krytox has been shown useful as a good boundary layer. The material is wiped on to the shaft to leave a small film. In some applications such as timing mechanisms, which are closed systems, an oil cup is recessed into the bearing. Typically ruby and sapphire bearings can run dry in open systems to avoid the lubricant attracting debris over time.

TOLERANCES
Concentricity of the ID to the OD of the ring jewel can typically be specified down to .0002” TIR. This can be an important consideration to enhance alignment of the shaft, especially in movements requiring straight hole (bar hole) rings. Bird’s semi-automatic machines can typically maintain .0005” TIR concentricity during mounting into the jewel bushings. (Most manufacturers prefer the jewel rings to be bushed to facilitate easy press fits into their products. This reduces waste and speeds production. Bird precision also offers secondary truing operations to bring the .0005” down to between .0002”and .0003”.

Ring jewel ID tolerance can be specified at .0002” total tolerance, without additional cost impact. (for sizes under .080”ID)

Example .0180/0.0182”

If required tolerance ID’s can be held to a total of .0001”

Example .0180/0.0181”

OLIVING
Advantages of Olive Shaped Ring Jewels (.0126” ID olive ring jewel)

FIG 3

Comparing Starting Torque
for Jewel & Ball Bearings

FIG 2

A comparison of jewel bearings and a typical ball race shows the differences frictional starting torque. The scatter of data from the ball bearing indicates detents on the balls.
The following shapes are the most common. Each shape has a specific design function.

**Bombé Jewel**
This configuration allows the use of a shouldered pivot in place of an endstone, therefore using the radius surface of the ring as an end thrust bearing. Any type of ring jewel may have this configuration.

**Single Cup Rings**
This cup may be used as an oil reservoir by setting the jewel with the cup facing away from the pivot, or the cup may be used to shorten the length of the hole.

**Straight Hole Rings**
The I.D. for this bearing is straight and thus restrict the lateral movement of the shaft. Accurate alignment is required. The area of contact tends to increase the friction.

**Olive Hole Rings**
The olive hole offers minimum contact with a pivot, resulting in minimum friction, allows for misalignment of the shaft.

**Double Cup Rings**
Same as the single cup except that there is a cup on both faces of the jewel.

**Endstones**
Generally used as thrust bearings in conjunction with ring jewels. Also used as wear plates.

Ring jewels can be assembled a number of ways. Many of the options will include an endstone (pallet stone). Endstones are used to take up the end thrust of the shaft. Endstones can be either flat or bombé (crowned surfaced).

The bombé gives the bearing a point contact with a flat shaft, thereby minimizing friction. The reverse is also true. The shaft can have a semi-spherical radius and the endstone can be flat achieving the same point contact. Balls may be used to provide the same effect.

The designer can use the following stock lists, to assemble stock components in various ways to fit his design.

*APPLICATIONS*

Ring Jewels are used widely in precision instrumentation. Dial indicators, altimeters, tone arms, pendulums, compass, turbine flow devices, timing mechanisms, bellows take off arms, linkages, oscillating mirror mounts, ruby matrix heads, relays, moving coil movements, bi-metallic instruments, galvanometer, gyro, gimbals, potentiometers and roller transports to name a few.

Bird Precision maintains a wide assortment of high speed assembly equipment for economical assembly into a variety of jewel mounts.

Bird also maintains a full complement of precision Swiss turning and secondary machines for a completely vertical approach for the production of both standard and custom jewel bearing assemblies.

We will take your drawings, fabricate the mount and assemble the bearing systems.

*Design Considerations*

The following shapes are the most common. Each shape has a specific design function.

- **Bombé Jewel**
- **Single Cup Rings**
- **Straight Hole Rings**
- **Olive Hole Rings**
- **Double Cup Rings**
- **Endstones**

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*Direct Read Compass*

- **Bombé Jewel**
- **Double Shouldered Shaft**
- **Threaded for End Play Adjustment**
- **Alnico 5 Magnet**
- **Bombé Jewel**
- **Straight Shaft**
- **Bombé Jewel with Endstone**

*Typical Assemblies*

1. Fixed assembly with Olive Hole Ring Jewel.
2. Fixed assembly with Single Cup Olive Hole Ring Jewel & Endstone.
3. Threaded, Fixed Assembly with Bombé, Olive Hole Ring Jewel.
4. Threaded, Spring loaded assembly with Bombé, Olive Hole Ring Jewel & Endstone.
5. Tapered Plug, Silicone Cushioning with Bombé Olive Hole Ring Jewel & Endstone.
6. Threaded, Spring Loaded Assembly Single Cup Ring Jewel and Ball.
7. Plug Assembly, Silicone Cushioning with Straight Hole Ring Jewel & Endstone.

*APPLICATIONS*

Ring Jewels are used widely in precision instrumentation. Dial indicators, altimeters, tone arms, pendulums, compass, turbine flow devices, timing mechanisms, bellows take off arms, linkages, oscillating mirror mounts, ruby matrix heads, relays, moving coil movements, bi-metallic instruments, galvanometer, gyro, gimbals, potentiometers and roller transports to name a few.

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- **Olive Hole Rings**
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The designer can use the following stock lists, to assemble stock components in various ways to fit his design.
### LIST OF STOCK OLIVE HOLE RING JEWELS
(PARTIAL ASK ABOUT ADDITIONAL SIZES)

<table>
<thead>
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<th>PART NUMBER</th>
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### LIST OF STOCK SAPPHIRE ENDSTONES
(SEE VEE JEWELS FOR POSSIBLE THREADED CARRIERS)

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<th>DIAMETER</th>
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### LIST OF STOCK JEWEL BUSHING CARRIERS
(SEE VEE JEWELS FOR POSSIBLE THREADED CARRIERS)

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Example Design From Tables

![Example Design Diagram](image-url)
**Bird Precision Endstone Nomenclature**
Sapphire or Ruby

**Bird Stock Pivot Nomenclature**

**LIST OF A FEW STOCK PIVOTS**

<table>
<thead>
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<th>PART NUMBER</th>
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