Barnes

New Ball Screws, New Acme Screws & Reconditioning Services

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Barnes Industries Reconditions All Types of Ball Screws

Barnes ball screws are a high load-carrying capacity, long wear life, single or double-nut design with external or internal ball return systems and felt or nylon seals in the nut assembly.

Barnes Industries was founded in 1969. It is the first and only ball screw manufacturing plant devoted to reconditioning ball-bearing leadscrews with any ball return system, Fig. 1, and producing new ball screws, Fig. 23 with a warranty for all services. Operations are carried out in a 62,500 sq. ft. air conditioned manufacturing plant (see back cover) which customers are cordially invited to visit.

Metalworking plants can cut machine tool down time by reconditioning worn or damaged ball bearing leadscrews. Barnes Industries can service any worn screws and provide a warranty which depends upon the type of processing: 1. Reloaded, 2. Reconditioned and 3. Replaced with new screw.

Ball screws fail in machine tools due to one or more of these conditions: 1. normal wear; 2. poor maintenance (lack or excess of lubrication); 3. accidents resulting from electronic malfunctions; 4. poor design-under capacity; 5. too high preload; 6. bent leadscrew; 7. misalignment (improper installation); 8. environmental; and 9. operator error.

Ball leadscrews are machined from top quality material, hardened and ground to super-precision tolerances. They usually do not need replacing when worn. As a result, it is economically feasible to service all types of ball screws by regrinding the screw and installing new nuts, balls and seals.

Barnes Industries can effectively recondition ball screws with any of the designs of nut packages made by leading manufacturers with either external or internal ball return systems, Fig. 1.

New nuts for reconditioned ball screws can be made with the original mounting configurations, but with an increased load-carrying capacity in many cases. This results in an increase in the life of a ball screw. When the original ball nut can be used in the repair of the ball screw, the ball raceways of the nut are never reground. Regrinding can destroy case depth and hardness, severely affecting the life of the ball screw assembly.

Capacity: Ball Screws & Acme Screws

Barnes Industries is completely tooled and has thread grinding, straightening, turning, milling, lead checking and inspection equipment to recondition or manufacture new ball screws up to a maximum of 6-in. diameter by any length.

Delivery

Barnes Industries provides fast delivery on all reconditioned ball screws to reduce customer down time to a minimum. This is made possible by our extensive stock of popular models of new and reconditioned units for exchange and our inventory of new ball nuts and components. In cases where the ball screw is not repairable, a new replacement can be made.

Emergency Repairs

We have on hand a large supply of original salvaged usable parts from major U.S. and foreign ball screw manufacturers. These parts are on hand for emergency repairs only and are never used in our reconditioning process. These repairs carry no warranty.

Price

To determine the cost of reconditioning a ball screw it should be shipped prepaid to Barnes Industries for a no-charge inspection. Proper inspection requires complete disassembly of the unit. After disassembly the ball screw and ball nut raceways are checked for wear and metal fatigue. The screw journals, keyways, V-threads, and snap ring grooves are also inspected. The ball screw, if in good condition, is also inspected for straightness and lead accuracy. When the type of servicing and cost is determined, the customer is notified for a purchase order approval before any other operations are carried out. Our sales department will give firm not-to-exceed costs for our various types of service and the delivery times at the time of inquiry.

Repair of Bearing Journals

Bearing journals that are undersized, scored, damaged or bent are repaired by a process determined by inspection, Figs. 2 and 3. Repaired journals meet AFBMA specifications for Class ABEC-5 or better.

Bearing journals that have been broken off can be repaired by a special process. Ship ball screw and journal pieces to us. We will engineer and install a new journal that meets AFBMA specifications, Figs. 2A and 3A.

Special Services for Customers

Customers who wish to have insurance against machine down time should contact our sales department for a special inventory program.

For ball screw users who are currently having ball screw problems, we will assist in re-engineering and building a unit to fit the particular application.
Reload and Minor Repair

In rare cases a wear condition can be corrected properly by reloading the nut and screw with over-sized balls. The reloading procedure is carried out only if the following conditions are met:

1. The ball screw and nut thread raceways are in good condition.
2. The ball screw and nut raceway radii and root diameters are in tolerance for the ball that is to be used in reloading. This insures that the ball conformity and contact angle are correct.
3. The ball screw thread root diameter must be straight or require minimal lapping.
4. The ball screw thread lead must be within machine tool tolerance. Customer approval is required if lead is out of tolerance.

Only if these four critical conditions are met will the ball bearing leadscrew be reloaded and given a 6-month warranty. Should an emergency condition exist, and Barnes Industries does not have an exchange unit in stock, they will make the unit functional, if possible, with no warranty. At the same time, a drawing can be made and quoted for the manufacture of a new unit on an emergency basis.

Sometimes on integral preloaded nuts (even in good condition), an over-sized ball used to offset wear and to establish preload will not run at the proper contact angle. This results in short wear life and the reload procedure is not carried out, even if items 1 through 4 are good. Under this condition, reconditioning requires a new ball nut. This process is given a 12-month warranty.

Table 1 - Ball Screw Assembly Specifications and Warranties

<table>
<thead>
<tr>
<th>Assembly Description</th>
<th>All Parts New</th>
<th>Ball Screw</th>
<th>Ball Nuts</th>
<th>Balls (Grade 25)</th>
<th>Tubes and Defectors</th>
<th>Wipers or Seals</th>
<th>Lead Accuracy Tolerance</th>
<th>Tested and Preloaded to Mfrs. Specs.</th>
<th>Warranty (Months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reload, Minor Repair and Emergency Repair</td>
<td>No</td>
<td>Original (Polished)</td>
<td>Original (If in good condition)</td>
<td>New</td>
<td>Original or New</td>
<td>Original or New</td>
<td>Original***</td>
<td>Yes</td>
<td>6*</td>
</tr>
<tr>
<td>Recondition</td>
<td>No</td>
<td>Original (Lapped)</td>
<td>New (Barnes Design)**</td>
<td>New</td>
<td>New</td>
<td>New</td>
<td>Original***</td>
<td>Yes</td>
<td>12</td>
</tr>
<tr>
<td>Recondition</td>
<td>No</td>
<td>Original (Reground)</td>
<td>New (Barnes Design)**</td>
<td>New</td>
<td>New</td>
<td>New</td>
<td>±0.0005 in. Per Foot, Cumulative</td>
<td>Yes</td>
<td>15-18+</td>
</tr>
<tr>
<td>New</td>
<td>Yes</td>
<td>New</td>
<td>New (Barnes Design)</td>
<td>New</td>
<td>New</td>
<td>New</td>
<td>±0.0005 in. Per Foot, Cumulative</td>
<td>Yes</td>
<td>24++</td>
</tr>
</tbody>
</table>

*Barnes Option: If Barnes determines a screw non-reloadable and customer wants it reloaded, no warranty applies.
** On housing mounted units, new or original housing is used. ***Customer will be notified of lead accuracy.
+Ball screw raceway hardness must be Rc-58 minimum for full 18 month warranty to apply.
++ Ball screw will be warranted for 24 months or 20 million inches of travel whichever comes first.
The Barnes Ball Screw Reconditioning Process

Fig. 4 - Visual inspection of worn nut.

Fig. 5 - Optical checking of worn leadscrew thread radius to determine radius wear and deformation.

Fig. 6 - Grinding leadscrew ball raceway in a Matrix 70 thread grinder.

Fig. 7 - Straightening of ball leadscrew before lead check.

Fig. 8 - Checking thread lead in master V-block.

Fig. 9 - Pre-cutting internal ball thread raceway in new ball nut before heat treatment.

Fig. 10 - Inspecting timing of ball thread return holes with ball thread raceway before heat treatment.

Fig. 11 - Checking hardness on ball nuts after heat treatment.
Fig. 12 - Grinding ball thread raceway in new ball nut.

Fig. 13 - Optical checking of reground leadscrew thread radius to new engineered specifications.

Fig. 14 - Inspecting radial clearance to determine ball contact angle.

Fig. 15 - Checking drag force and running condition on flange-type nut assembly.

Fig. 16 - Checking journal concentricity to pitch diameter of ball screw, by rotating screw through nut.

Fig. 17 - Testing axial deflection between nut and ball screw to determine point at which preload is relieved.

Fig. 18 - Checking a flanged nut for squareness to the screw axis, and journal concentricity to the screw major diameter.

Fig. 19 - Checking leadscrew centerline, and centerline angularity on a reconditioned leadscrew.
Increasing the Life of Ball Bearing Leadscrews

Ball screws are more easily damaged when installed than conventional leadscrews. To help prevent damage, insure accuracy, and insure longer life; proper installation is required. Barnes Industries ball screws are manufactured, inspected and tested by skilled mechanics to engineered specifications, ready for installation.

Engineering of Ball Screws

Ball screws are super high precision preloaded ball bearings running on a helical raceway. To build a new unit, or recondition a unit to new high quality condition, extensive ball screw engineering analysis is a basic requirement.

Ball screw life can be calculated. Parameters used in calculations include contact angle, ball conformity to the thread radius, number of balls in contact with the raceway, preload, materials, heat treatment case depth and raceway hardness. Manufacturing control of parallelism, squareness, concentricity and lead are also necessary to achieve ball screw accuracy and long wear life.

Since the formation of the company, Barnes Industries engineers have analyzed many failures on major U.S. and foreign ball screws. To prevent failures and give extended life, designs have been continually improved, manufacturing tolerances reduced and design recommendations made to customers.

Engineering analysis of failed ball screws since the formation of Barnes Industries has permitted "Barnes" to establish engineering and manufacturing specifications in which 98% reliability has been attained. "Barnes" new ball screws are warranted for 24 months or 20,000,000-in. life. Reconditioned ball screw warranties fall into two categories (1) 18 months or 15,000,000-in life, (2) 15 months or 12,500,000-in life. See Table 1, Page 3 for complete details.

Load and Life Rating

Ball screw life ratings for ball lead screws are comparable to the L-10 rating for ball bearings as determined by the Anti-Friction Bearing Manufacturers Association. The L-10 or B-10 rating is defined as a reliability requirement * where a failure rate of 10% is allowable. This means that about 90% of any large group of screws will meet or exceed this life rating. 50% will last five times as long, and about 10% will fail before reaching that rating.

<table>
<thead>
<tr>
<th>Out of 100 Identical Units</th>
<th>Ball Nut Carries Load In Both Directions, Nut Travel (Inches)</th>
<th>Hours Life of Ball Nut Traveling at Inches Per Minute</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100 IPM</td>
<td>200 IPM</td>
</tr>
<tr>
<td>10</td>
<td>Less Than 20,000,000</td>
<td>NA</td>
</tr>
<tr>
<td>20,000,000</td>
<td>3,334</td>
<td>1,667</td>
</tr>
<tr>
<td>40,000,000</td>
<td>3,334</td>
<td>2,223</td>
</tr>
<tr>
<td>60,000,000</td>
<td>5,001</td>
<td>3,334</td>
</tr>
<tr>
<td>80,000,000</td>
<td>6,668</td>
<td>4,445</td>
</tr>
<tr>
<td>100,000,000+</td>
<td>16,670</td>
<td>8,335</td>
</tr>
</tbody>
</table>

NOTE: In the case of a vertical screw or jacking load, the figures in the chart would be reduced to one half, since the load is always in one direction on the screw.

CHARTS COMPARING LIFE INCREASE BY USING ALL LOAD BALLS IN CONTACT WITH RACEWAYS WHEN ALL OTHER PARAMETERS MEET ENGINEERING STANDARDS.

Out of 100 identical units, 20 units with load and spacer balls are distributed in chart 'A' and 80 units with all load balls are distributed in chart 'B'.

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<td></td>
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</tr>
<tr>
<td>40,000,000</td>
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Load and life rating of ball screws are based on axial load. This applies to both the manufacturer and the reconditioner. Fig Nos. 20, 21 & 22 show how axial load and radial load affect the life of a ball bearing leadscrew.

Fig. 20 - Rabbit-eared and chipped outside diameter on worn lead-screw resulting from improper ball contact angle and overload condition.

Fig. 21 - Improperly radial-loaded ball screw assembly showing ball contact path in bottom of raceway. This condition reduces life to 1/8 of original.

Fig. 22 - Axially-loaded ball screw assembly showing correct ball contact path on raceway.

*BALL SCREW LIFE CHART FOR BALL NUTS WITH L-10 RATING DESIGNED FOR 20,000,000 INCHES TRAVEL FOR A REVERSING LOAD.
Running Condition
A ball bearing leadscrew is nearly frictionless in operation. The load between the screw and nut is carried by ball bearings which provide the only contact between the nut and screw. The ball screw assembly will operate with either the nut rotating around the screw or the screw rotating through the nut. A simple check for running may be made in your plant:
1. Make sure the screw is clean and lightly oiled.
2. Rotate the nut around fixed screw by hand. The nut should rotate smoothly with no sticking or hang up. Sticking should not be confused with the balls being squeezed as they enter the raceway going under load between the nut and screw from the return system. Sticking or hang-up (keystoning) causes the balls to skid, wearing flat spots on the balls, and the nut will ultimately lock up. In severe cases, skidding balls will damage screw raceways beyond repair.

Torque and Preload
The torque to drive the load is as important as all other factors related to the design of a ball screw. These factors are inter-related at the original design layout.
High preload provides higher positioning accuracy and high system stiffness, but increases drag torque. Higher than required preload increases drag torque more rapidly than stiffness and results in loss of screw life. A high preload can cause inaccurate positioning. A high preload will also contribute to electrical malfunctions. Low preload gives low system stiffness and low drag torque, resulting in poor system accuracy.

Alignment and Load Application
Close alignment of the ball screw journal mounting with the ball nut is required for long life and positioning accuracy. Radial, bending or overturning loads imposed on the ball screw assembly will reduce the life of the unit and its thrust bearings. Radial misalignment results in increased torque as the ball nut approaches the bearing mountings. Bending or overturning loads cause rough running and noise. Radial, bending or over-turning loads will have a negative effect on positioning accuracy.

Overloading of ball screw resulting from tight gib, roller cages or improper lubrication will reduce ball screw life and cause improper positioning.

Ball Screw Maintenance (Lubrication and Cleanliness)
A ball screw must be properly lubricated and kept clean at all times. Otherwise its life will be reduced. When ball screws are not lubricated, the wear life drops by as much as 85-percent. Lubrication reduces friction, prevents corrosion and allows the ball screw to operate more efficiently. Oil and grease are both used for lubrication. Grease is not normally used in low temperature or high speed applications. Graphite grease or grease with suspended solid particles are never used because they tend to clog the ball return system.

The oil supply should insure a light film of clean oil with filtration levels of three(3) microns or less at all times. Lubrication contaminated with dirt and chips increases friction. Balls traveling over metal chips in the ball thread raceway cause "spalling", and the ball screw fails.

Use lubricants recommended by the machine tool manufacturer. As in the case of any high precision assembly, contamination by chips, dirt or other foreign matter will cause and ultimately induce ball screw failure. Limited protection is provided by seals or wipers. Bellows or telescopic covers are recommended if the environment has a high concentration of contaminants.

Periodic inspection for cleanliness and lubrication will extend the life of the ball screw.

Storage of Ball Screw Unit
Keep the unit stored in plastic sleeve in the original shipping container. If stored for a long time turn container over at three-month-intervals so protective oil will be distributed over the screw.

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New Barnes Ball Screw and Acme Screw

New Barnes ball screws are a high load-carrying capacity, long wear life, single or double-nut design with external or internal ball return systems and felt or nylon seals in the nut assembly. The ball leadscrew is SAE 6150 steel, induction-hardened to a minimum hardness of 58Rc to required case depth. The nuts are aircraft quality SAE 8620 steel, also hardened to minimum hardness of 58Rc.

The hardened and ground balls, Grade 25 or better, are either 52100 or 440C stainless steel. The return tubes are SAE 4130 steel heat-treated to 63-66 Ra hardness. Deflectors are 17-4 PH stainless steel with a maximum hardness of 40Rc.
Barnes Industries Manufacturing Facility
World Headquarters for Ball Screw Reconditioning

Fig. 25 - Ball thread internal and external thread grinding department.

Fig. 26 - Milling department.

Fig. 27 - Assembly and test department.

Fig. 28 - Turning and straightening department.

Since 1969
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