"ULTAGE" Series Precision Bearings for Machine Tools

To meet the market needs for faster, more efficient, and more precise machine tool main spindles, NTN has created new bearing designs and recently reorganized our product line into "ULTAGE Series" bearings.

The paper explains various bearing types and their applications in plain terms. The paper also describes the configurations of “ULTAGE Series” bearings.

1. Introduction

To meet the market needs for faster, more efficient, and more precise machine tool main spindles, NTN has been involved with the development and improvement of various bearings. Recently NTN adopted an approach of "What are the bearing specifications that are truly desired of precision bearings" and reviewed the bearing designs of traditional product series. As a result, the traditional product line has been reorganized into "ULTAGE Series" bearings.

In the last Technical Review, Issue No. 71, NTN introduced the "ULTAGE Series" bearings. Since then, NTN added four new types, changed the names of some of those products, and reorganized the product line for the customers to readily understand the characteristics of different types. In this issue, we have re-defined the configuration of the "ULTAGE Series" bearings.

ULTAGE is a term created by NTN combining "ULTIMATE" and "STAGE" to represent NTN's pursuit for the highest level of precision in machine tool bearings.

2. Development history of precision bearings for machine tools

The applications for the machine tool precision bearings are divided largely into those for main spindles and those for feeding systems. For the main spindle application, there are angular contact ball bearings (for radial loads and axial loads) and cylindrical roller bearings. For the feeding system application, there are ball screw support bearings. Table 1 shows the chronological development of precision bearings for machine tools. (Y-axis is the scale of high-speed/high functionality.) Also added is a brief history of the development of the above-mentioned three types of bearings.

*Industrial Engineering Department    Industrial Sales Headquarters
2.1 Angular contact ball bearing

2.1.1 Angular contact ball bearing for radial load
The standard angular contact ball bearing (7xxx type) is the base for the angular contact ball bearing for radial load. In the middle of the 1980’s, the rolling elements were made smaller in diameter to produce the HSA type, and in the late 1980’s, the HSA type was improved to reduce heat generation and the HSB type was announced. In the early to mid 1990’s as demands increased for faster and more rigid machine tool main spindles, NTN added to this product line, the HSBxxxCAEX1 type and the HSC type, which uses even smaller rolling element diameter than the HSB type.

In 2000 JIMTOF, NTN announced the HSE type with improved wear and seizure resistance and a low-noise type (predecessor to the HSL type).

Again in 2002 JIMTOF, NTN announced, in addition to the HSE type bearings, sealed angular contact ball bearings (BNSxxxLLB type, 7xxxLLB type) for longer life and eco-conscious angular contact ball bearings (HSL type) for low-noise, low air-oil consumption purposes, both of which are called the "ULTAGE Series" bearings.

NTN has added yet another type bearing based on the standard angular contact ball bearing. The standard 7xxx type was improved in its speed and functionality to build the new 70xxU/79xxU types, which were added to the "ULTAGE" Series.

2.1.2 Angular contact ball bearing for axial load
For a long time, duplex thrust angular contact ball bearings (562xxx, 742xxx types) have been the main stream of angular contact ball bearings for axial load. In the late 1980’s, when applications began to demand faster operation, NTN announced the HTA and the HTB types of bearings that combined two single-row angular contact ball bearings. Since then, the HTA type has replaced almost all the traditional bearings for this use in Japan. However, recent requirements for even faster operation prompted NTN to review the specifications of the HTA type bearing. A new HTAxxxU type bearing was created to meet this need and added to the "ULTAGE" Series.

2.2 Cylindrical roller bearing
Cylindrical roller bearings come in double-row cylindrical roller bearings (NN30, NN49, NNU49 types) and single-row cylindrical roller bearings (N10xxxHS type).

2.2.1 Double-row cylindrical roller bearing
The NN30 type has been the most popular double-row cylindrical roller bearing. NTN has been engaged in the development of the cage material and profile. Some bearings employ resin cages (T2), but the standard bearings use high-strength brass cages. Adoption of resin cages is effective to extend the grease life, and for this reason NTN developed a new resin cage (T6). The new resin cage has been adopted in the new high-speed NN30xxHST6 type and super high-speed NN30xxHSRT6 type, and they are added to "ULTAGE" Series product line.
### Table 2 ULTAGE series

<table>
<thead>
<tr>
<th>Category</th>
<th>Model</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Standard</strong></td>
<td>70U-type &amp; 79U-type</td>
<td>By optimizing the internal design and utilizing a new resin cage, NTN has increased axial capacity and decreased heat generation. Available bore sizes: 10~130 mm. Also available with ceramic balls (&quot;5S&quot; prefix).</td>
</tr>
<tr>
<td><strong>High-Speed</strong></td>
<td>5S-2LA-HSE-type</td>
<td>The use of special materials and surface improvements have greatly increased wear resistance and seizure resistance. The optimization of internal specifications has resulted in a high-speed, high-rigidity and highly reliable bearing. Also available with steel balls (no &quot;5S&quot; prefix).</td>
</tr>
<tr>
<td><strong>Ultra High-Speed</strong></td>
<td>5S-2LA-HSF-type</td>
<td>In addition to the features of the HSE-type bearing, this bearing also uses small ceramic balls to achieve greater speed due to less heat generation.</td>
</tr>
<tr>
<td><strong>Eco-Conscious Model</strong></td>
<td>5S-2LA-HSL-type</td>
<td>These bearings use special materials and surface improvements for greatly increased wear resistance and seizure resistance. Based on the high-speed HSE-type and ultra high-speed HSF-type bearings, this design has an eco-conscious nozzle that should be used exclusively with air-oil lubrication. These bearings provide the same high-speed operation as HSE and HSF bearings, but operate more quietly and reduce air and oil consumption. Therefore, they contribute to a cleaner working environment and save energy. HSL-type is also available with steel balls (no &quot;5S&quot; prefix).</td>
</tr>
<tr>
<td><strong>Standard</strong></td>
<td>Non-Contact Seal Model</td>
<td>For this design, non-contact seals are utilized on both sides, special grease is used and the internal design has been optimized to create a pre-greased bearing that is resistant to heat generation. Also available with ceramic balls (&quot;5S&quot; prefix).</td>
</tr>
<tr>
<td><strong>High-Speed</strong></td>
<td>Non-Contact Seal Model</td>
<td>This bearing utilizes special materials and surface improvements for greatly improved wear resistance and seizure resistance. Various improvements have also been made to the internal design and the non-contact seals at both ends, and the utilization of special grease. The result is a pre-greased bearing that provides longer bearing life. Also available with steel balls (no &quot;5S&quot; prefix).</td>
</tr>
<tr>
<td><strong>For Axial Loads</strong></td>
<td>HTA U-type</td>
<td>Internal specifications have been optimized to create an angular contact bearing for axial loads that offers the same level of rigidity as the conventional HTA-type, but with increased axial capacity and a higher operating speed. Also available with steel balls (no &quot;5S&quot; prefix).</td>
</tr>
<tr>
<td><strong>Open Model</strong></td>
<td>2A-BST-type</td>
<td>This open-model bearing provides longer service life and improved fretting wear resistance due to bearing ring surface improvements.</td>
</tr>
<tr>
<td><strong>Light Contact Model</strong></td>
<td>2A-BST LXL-type</td>
<td>Bearing raceway surface improvements and special grease greatly increase service life and fretting wear resistance. This pre-greased bearing also has a low-torque, light-contact seal that provides greater dust resistance, longer grease life and improves bearing handling and installation characteristics.</td>
</tr>
<tr>
<td><strong>Ultra High-Speed</strong></td>
<td>N10HSRT6(K)-type</td>
<td>Optimization of the internal design and utilization of a special resin cage that allows for high-speed operation have resulted in a high-speed bearing that is resistant to heat generation. This bearing provides better speed performance than the standard N10HS single-row cylindrical roller bearing.</td>
</tr>
<tr>
<td><strong>Eco-Conscious Model</strong></td>
<td>Ultra High-Speed</td>
<td>This bearing is based on the N10HSRT6-type and has an eco-conscious nozzle that should be used only with air-oil lubrication. This bearing provides the same high-speed performance as the N10HSRT6-type, but operates more quietly and reduces air and oil consumption. Therefore, it contributes to a cleaner working environment and saves energy. HSL-type is also available with steel balls (no &quot;5S&quot; prefix).</td>
</tr>
<tr>
<td><strong>High-Speed</strong></td>
<td>NN30 HST6(K)-type</td>
<td>Optimization of internal specifications and the use of a new resin cage result in bearings that achieve high-speed operation with low levels of heat generation. Both grease lubrication and air-oil lubrication are acceptable.</td>
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<td><strong>Ultra High-Speed</strong></td>
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2.2.2 Single-row cylindrical roller bearing
The standard single-row cylindrical roller bearing used to be the N10 type bearing. When high speed performance was demanded in the late 1980's to early 1990's, NTN developed a high-speed N10xxHS type which used smaller rolling element diameter than that of the N10 type. The single-row cylindrical roller bearing was once again challenged by the needs for even faster speed, NTN announced in the 2002 JIMTOF new type bearings for the main spindle rear application. They are the super high-speed N10xxHSRT6 type that adopted resin cages and the eco-conscious N10xxHSLT6 type that reduced noise and air-oil consumption.

2.3 Ball screw support bearing
Demands for high-speed with oil lubrication increased for ball screw support bearings in the late 1980's. NTN developed the BSTxx-1B type bearing then, and later in the early 1990's, announced the BSTxx-1E type which used a larger rolling element diameter to extend life. Then, during the 2000 JIMTOF, NTN announced the open type 2A-BSTxx-1B and the light contact seal type 2A-BSTxx-1BLXL for higher speed, longer life, and better resistance against fretting.

3. Configuration of ULTAGE Series product line
As shown in the preceding page, the new ULTAGE series bearing product line has added four new types (indicated in bold characters below) and includes name changes of the HSE type products. In the end, the new series now has 14 types of products, which are shown in Table 2 on the preceding page.

The configuration of the "ULTAGE" series has been reorganized for easy understanding, comprising three types of angular contact ball bearings for radial loads, standard (7xxxU type), high-speed (HSE type), and super high-speed (HSF type), two types of sealed angular contact ball bearings, standard (7xxxLLB type) and high-speed (BNSxxxLLB type), and two types of eco-conscious angular contact ball bearings, high-speed (HSL type) and super high-speed (HSFL type).

Angular contact ball bearings for axial loads are available in only 1 type, standard (HTAxxxU type).

There are four types of cylindrical roller bearings. The double-row resin cage model comes in high-speed (NN30xxHST6 type) and super high-speed (nn30xxHSRT6 type) types, and the single-row resin cage model comes in super high-speed (N10xxHSRT6 type) and the eco-conscious (N10xxHSLT6 type) types.

The ball screw support bearings are largely divided into two types, open (BSTxx-1B type) and sealed (BSTxx-1BLXL type).

4. About publication and revision of the Precision Rolling Bearings catalog
To become a comprehensive catalog for the precision rolling bearings, this catalog was renewed in the fall of 2003 (catalog No. 2260/J) with addition of the "ULTAGE" series product line and review of some of the technical contents.

The new catalog not only changed the bearing product configuration by adding the "ULTAGE" series, but also it made the following two major changes.

1) The bearing specifications were reviewed, changes made to the allowable rotating speeds, and the speed coefficients were adopted.
2) The allowable axial loads for the angular contact ball bearings were changed.

The catalog has been revised incorporating the new four types of the "ULTAGE" series bearings. Please see the catalog for the details.

5. Conclusion
For the past 4~5 years, NTN has made an overall improvement and introduced new models to the precision bearings line-up for machine tools. The final product is the "ULTAGE" series product line. We believe that the "ULTAGE" series is the most advanced precision bearing series that provides improved reliability and high functionality to the machine tool main spindles.

We know that users will demand more. NTN is committed to perform our duties as a supplier of precision bearings and serve our customers as their good partner. We will continue to seek improvement and undertake development projects to become "NTN, the maker of precision bearings."

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