RBY76007 Bearing Assembly

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Faculty Mentor: Dr. Sang Hee Won

Background

RBC Bearings, Inc. is a leading company on industrial, aerospace, and defense application bearings. The Hartsville, SC facilities are responsible for assembling the RBY76007. The team for RBC bearing is tasked with designing a machine and process for assembling a RBY76007 bearing.

Customer Needs

The needs for the project were determined from site visits, interviews with employees, and observations. These requirements included performance considerations in addition to requirements for features, durability, serviceability, aesthetics, and conformance. After further refinement and multiple iterations, the project needs were produced as below:
- Assembly under 60 seconds
- Easy Prep/Low Setup Time
- Minimal Human Contribution
- Scalable
- Does not damage bearing components
- Assembled to specifications

Mission Statement

RBC needs the ability to assemble the bearing to designed specifications without damage in less than 60 seconds.

Product Specifications

<table>
<thead>
<tr>
<th>No</th>
<th>Engineering Characteristics</th>
<th>Target</th>
<th>Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cycle Time</td>
<td>60 sec</td>
<td>60 sec</td>
</tr>
<tr>
<td>2</td>
<td>Grease Application</td>
<td>50 % by volume</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>Roller Placement Tolerance</td>
<td>0.15</td>
<td>N/A</td>
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<tr>
<td>4</td>
<td>Force to install last roller</td>
<td>2991 lb</td>
<td>35,343 lb</td>
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<tr>
<td>5</td>
<td>Setup Time</td>
<td>0 sec</td>
<td>5 min</td>
</tr>
<tr>
<td>6</td>
<td>Human Contribution</td>
<td>2 tasks</td>
<td>3 tasks</td>
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<tr>
<td>7</td>
<td>Degrees of Freedom</td>
<td>3 rd</td>
<td>N/A</td>
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<tr>
<td>8</td>
<td>Moving Parts</td>
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<tr>
<td>9</td>
<td>Cost</td>
<td>$3000</td>
<td>$0000</td>
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</tbody>
</table>

Concept Selection

Roller Slide Design
Rotary Cam Design
Helical Design
Piston-Rocker Design

Engineering Analysis

Roller Chute Design

The minimum radius of curvature that would allow rollers to flow was calculated to be 3.63 in:

\[ r_{\text{min}} = \frac{4d^2 + L^2 - 4L^2}{2d - 6} \]

Cam Profile Design

The torque experienced on the shaft is a function of the roller installation force and the slope of the polar cam profile. The goal is to minimize the change in input torque.

\[ \tau_{\text{shaft}} = \tau_0 = \tau_0 \frac{d\theta}{d\phi} = F_{\text{roller}} \frac{dr}{d\phi} \]

Stress Analysis

The head assembly was fully constrained at the top surface from which the head will be mounted. The analysis produced a maximum Von Mises stress of 1339.73 psi and the distribution is shown in the figure below.

Prototype

Testing

Testing was conducted on the prototype to determine the amount of force outputted by the pneumatic hold down cylinders at different pressures. The results show the relationship was linear with an output force equation of

\[ F(P, x) = 0.635P + 1.17x - 1.33 \]

Additionally, the friction between the outer ring and the rotary base was determined using an inclined plane analysis. The coefficient of friction was found to be 0.412.

Summary

Overall, the prototype was a success. The concept proved its ability to install two rows of rollers with minimal input torque. However, the current revision of the prototype has certain reliability issues that can be improved with more capable manufacturing techniques. One improvement made to the design to reduce the occurrence of jamming is the introduction of a d-shaft for the cam to ensure torque transmission without slipping.

Acknowledgements

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