Abstract: A magnetically levitated high-speed spindle assembly (20) is provided for forming non-circular holes (22) in workpieces (24) or non-circular surfaces on pins. The non-circular holes (22) can be formed with dimensionally varying axial trajectories at high speeds and with great accuracy. This is accomplished by supporting a rotating spindle (26) between first (58) and second (60) magnetic bearing clusters and independently controlling these bearing clusters (58, 60) to move a shaping tool (32) at the end of the spindle (26) in a predetermined orbital path (B). A multiple input - multiple output control strategy is used to control spindle (26) movements in the X and Y axes. The tilt angle between the cutting edge (34) of the shaping tool (32) and the orbital path (B) is maintained perpendicular under this multiple input - multiple output control of the magnetic bearing clusters (58, 60) to further improve shaping precision and spindle (26) stability during high-speed operations.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
   IPC: B24B 05/00

   USPC: 409/231,186,193,135;408/147;82/1.11,1.2,1.3,1.4,1.5;310/90.5
   According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

   Minimum documentation searched (classification system followed by classification symbols)
   U.S.: 409/231,186,193,135;408/147;82/1.11,1.2,1.3,1.4,1.5;310/90.5

   Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

C. DOCUMENTS CONSIDERED DURING THE INTERNATIONAL SEARCH (name of data base and, where practicable, search terms used)

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>JP 61152304 A (Tsumaki) 11 July 1986 (11.07.1986) abstract and figures 1-7</td>
<td>1-74</td>
</tr>
<tr>
<td>X</td>
<td>US 4,189,946 A (Heijenskgjold et al.) 01 January 1980 (01.01.1980), entire document</td>
<td>1-12, 14-40, 43-54, 56-66, 68-74</td>
</tr>
<tr>
<td>Y</td>
<td>US 4,250,775 A (Jereue et al.) 17 February 1981 (17.02.1981), column 1, lines 20-27 and figures 1, 2, 9 and 10</td>
<td>13, 41, 42, 55, 67</td>
</tr>
<tr>
<td>A</td>
<td>US 4,612,833 A (Slee) 23 September 1986 (23.09.1986)</td>
<td>1-74</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search: 19 December 2006 (19.12.2006)

Date of mailing of the international search report: 05 FEB 2007

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