DISC SPRINGS – STACKING

STACKING

Stacking individual Disc Springs provides the designer with:

- A wide range of possible force/deflection combinations;
- The ability to design application specific load curves – both progressive and regressive; and
- The opportunity to design a range of damping characteristics into the design.

METHODS OF STACKING

**IN PARALLEL**
- **Deflection:** Same as single disc
- **Force:** Single disc multiplied by the number of discs

**IN SERIES**
- **Deflection:** Single disc multiplied by the number of discs
- **Force:** Same as single disc

**IN COMBINATION**
- **Deflection:** Single disc multiplied by the number of discs in series
- **Force:** Single disc multiplied by the number of parallel discs in a set

Consideration needs to be given to the friction between the parallel disc surfaces. A reasonable allowance is 2 - 3% of the force for each sliding surface – a greater force for loading and a lesser force for unloading. Discs in parallel should be well lubricated and it is suggested that the number of discs in a parallel set be limited to a maximum of 4 to reduce the deviation from calculated to measured characteristics. Discs in parallel have increased self-dampening (hysteresis) characteristics.

STACK CONSTRUCTION

**EVEN NUMBER OF DISCS**
- **RIGHT**
- **WRONG**

**ODD NUMBER OF DISCS**
- **RIGHT**
- **WRONG

It is normally desirable to have both ends rest on the larger outer edge of the disc. With an uneven number of pairs in a stack, this is not possible. In this case, the end resting on the outer edge should be arranged to be on the end on which the force is applied – the moving end of the stack.
Stacks need to be guided to keep the discs in position. The preferred method is internal, such as a rod through the inside diameter. In case of external guidance, a sleeve is suggested. In either case, the guiding component should be case-hardened to a depth of not less than 0.6mm and a hardness of 58 HRC. A surface finish of ≤ 4 microns is also recommended.

Since the diameter of the discs change when compressed, the following clearance values are recommended:

<table>
<thead>
<tr>
<th>$D_a$ or $D_i$ (mm)</th>
<th>CLEARANCE (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 16</td>
<td>0.2</td>
</tr>
<tr>
<td>Over 16 to 20</td>
<td>0.3</td>
</tr>
<tr>
<td>Over 20 to 26</td>
<td>0.4</td>
</tr>
<tr>
<td>Over 26 to 31.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Over 31.5 to 50</td>
<td>0.6</td>
</tr>
<tr>
<td>Over 50 to 80</td>
<td>0.8</td>
</tr>
<tr>
<td>Over 80 to 140</td>
<td>1.0</td>
</tr>
<tr>
<td>Over 140 to 250</td>
<td>1.6</td>
</tr>
</tbody>
</table>

The stability of a disc with a thickness of 1mm or less can present a problem at the bearing surfaces. In such cases, the use of intermediate flat discs is recommended with outside diameter contact.

Progressive loading can be obtained by assembling stacks in which discs will deflect consecutively when loaded. Generally, this is done by 1) stacking single, double and triple parallel sets in series, or 2) stacking discs of various thickness in series. It is, however, necessary to provide a means to limit the compression of the weaker disc to avoid overstressing while the stronger discs are still in process of compression.
SPIROL Application Engineers will review your application needs and work with your design team to recommend the best solution. One way to start the process is to visit our Optimal Application Engineering portal at www.SPIROL.com.

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