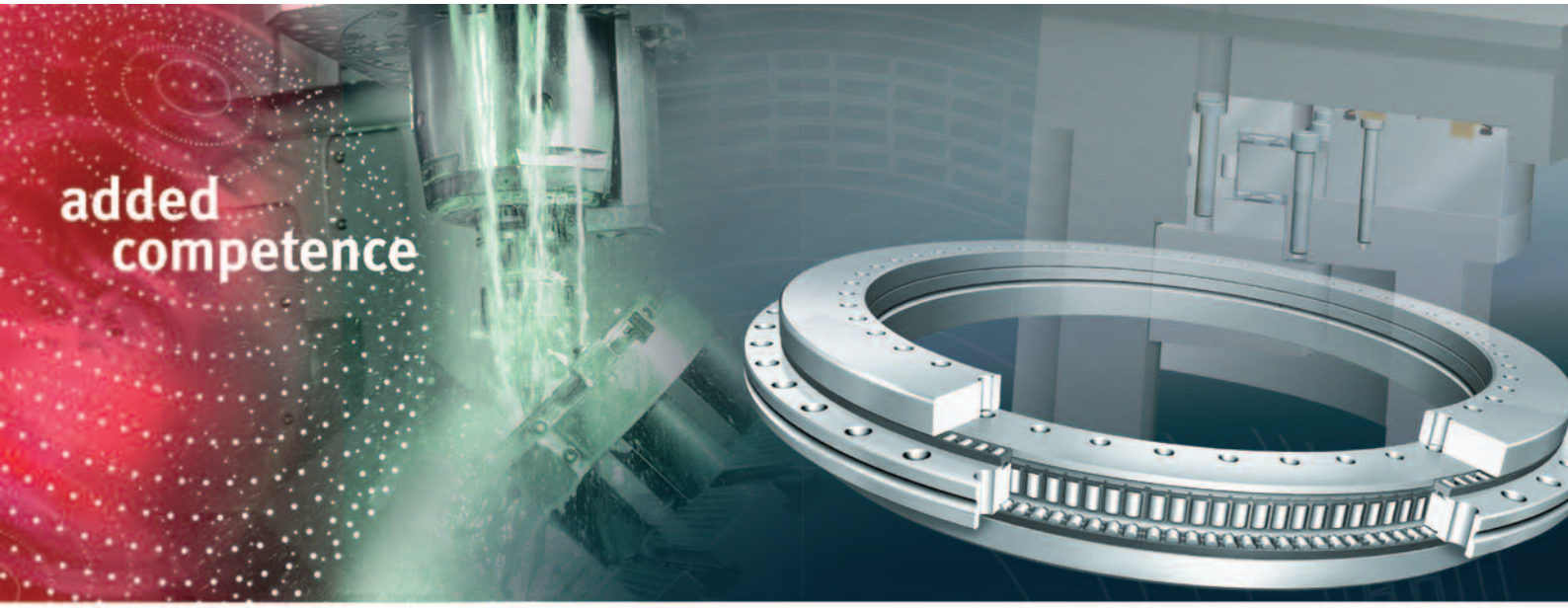

Rotary table bearing system with vibration damping

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Rotary table bearing system with vibration damping

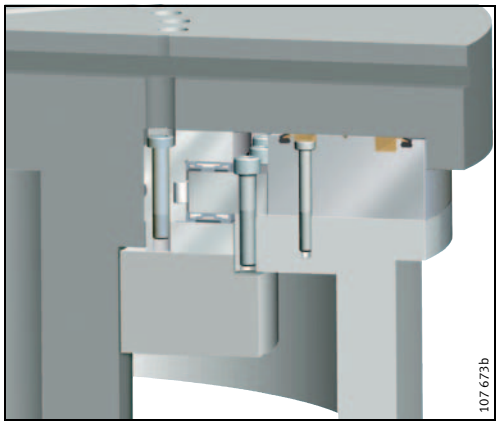

Figure 1: Rotary table with damping element

Vibrations in machine tools restrict the volume of material removed, lead to tool breakage and cause chatter marks on the machined surfaces. This paper presents an approach to achieving a combination of high static rigidity and good vibration damping in rotary tables.

Technical objective

At the current level of technological development, rotary tables are predominantly equipped with ready-to-fit rolling bearing arrangements. This type of bearing arrangement ensures very high static rigidty of the subassembly, which is important in achieving precise and dimensionally accurate machining even when applying large machining forces. Since such bearing arrangements are of an extremely rigid construction, however, their characteristics in terms of vibration damping is very limited. The objective of this development project is to identify possibilities for providing rolling bearing-based rotary tables with vibration damping characteristics in addition to their high rigidity.

Finding a solution

The approach to finding a solution shown in this study involves retaining the rotary table bearing arrangement based on ready-to-fit rolling bearings in order to maintain the static rigidity required for high precision machining. The concept envisages supplementing this bearing arrangement by an additional damping element arranged adjacent to the rolling bearing arrangement, see Figure 1.
The outer ring of the bearing is fitted with an additional washer so that the space between the washer and the rotating faceplate of the rotary table has a defined narrow gap that is also matched to the rolling bearing. This gap is filled with unpressurised oil. As a result of vibrations, the size of the gap varies in accordance with the frequency of the vibration. Due to this behaviour, oil is continously forced out of and sucked back into the narrow gap.
The energy required serves to dissipate the tilting and axial vibrations occurring as a result of the machining process.

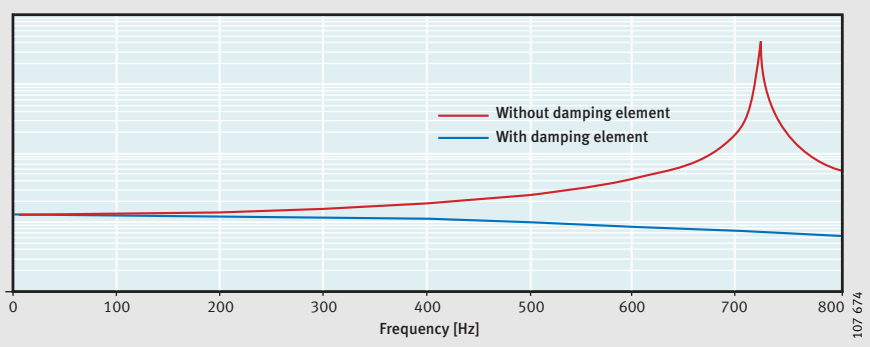

Figure 2: Magnification function

Test results

The impressive damping values that can be achieved despite the highly rigid rolling bearing arrangement are shown both in the calculation results, Figure 2, and by the measurements that were made using a prototype fitted in a rotary table. This is achieved by parallel switching of the spring damper system.

In the measurements, the faceplate of the rotary is excited by a pulse and the vibration is measured over time by means of accelerometers.
The measurement results are shown in Figure 3. This shows the amplitude curve for the same structure with and without damping. The comparison clearly illustrates the damping effect. In the variant with a damping element, the amplitudes induced by the same excitation are significantly smaller and are completely damped out in a very short space of time, which means that they cannot have an effect on the machining result.

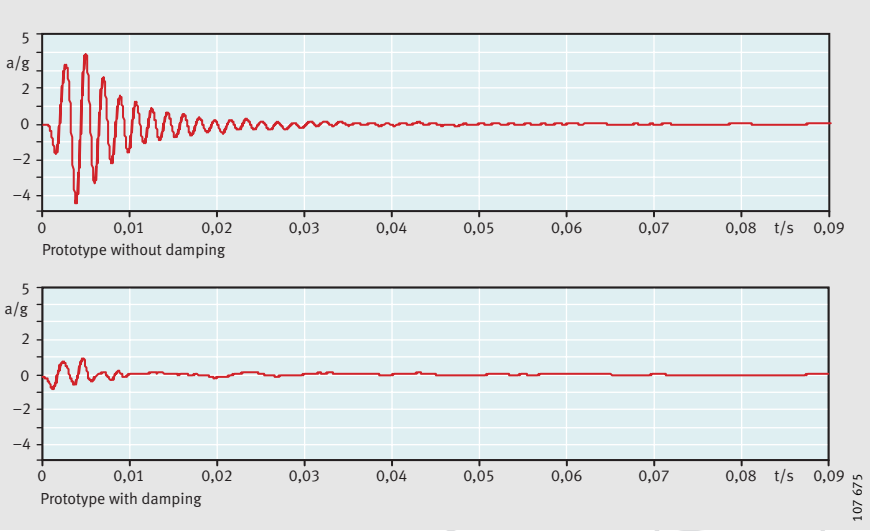

Figure 3: Comparative measurement with and without damping element

Summary

Thanks to the additional damping element matched to the rotary table bearing, excellent damping characteristics are achieved without any impairment of the static rigidity. The dynamic rigidity of rotary tables can thus be improved. As a result, it is possible to achieve good work-piece surface quality as well as precise and dimensionally accurate machining results.

At EMO 2007, we will present this stimulating subject in the form of an actual comparison and are already looking forward to many interesting discussions on this matter.

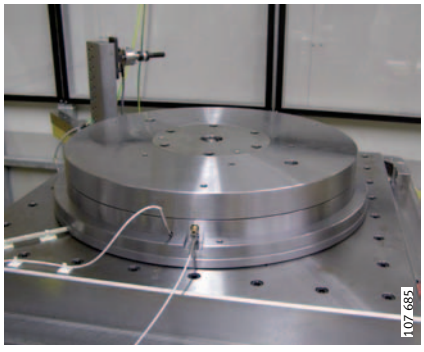

Figure 4: Rotary table in test setup

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