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VIBRATION ASSISTED SPINDLE FOR A SIGNIFICANT PRODUCTIVITY INCREASE

This spindle unit for multi-axial vibration assistance of cutting tools allows the control of all vibration-relevant parameters, such as frequency, amplitude, and vibration shape. It improves the drilling, milling, or grinding of brittle hard materials and composite materials, like CFRP, ceramic, silicon carbides, or hardened steel. Due to optimized chip-breaking and chip removal, the current prototype shows a significant increase in production time, tool life, and machining quality.

BACKGROUND

Composite materials, hard-to-machine alloys, and brittle materials are increasingly used in the aviation, medical, and electronic industry. The requirements on surface quality and precision are usually very high. Vibration-assisted machining (VAM) can substantially improve the cutting process of these materials. The vibration generated on the tool repeatedly causes tool-work piece separation for a short period during machining, which significantly ameliorates the chip-breaking process. Known VAM tools use ultrasonic vibration restricted to the resonance frequency of the tool. In this context, the development of a machining system that enables the control of all vibration-relevant parameters, such as frequency, amplitude, and vibration form, is of utmost interest.

TECHNOLOGY

The new spindle unit works with low vibration frequency (up to 200 Hz) and can vibrate the tool in up to three directions. While a hydraulic impulse actuator generates an axial vibration, radial vibrations are generated at the front-bearing block by a piezo actuator system. This allows multi-axis hybrid machining. An integrated balance mass allows active pulse decoupling. Thus, the vibrations are directed to the tool and not introduced into the machine structure. The spindle unit enables the control of all vibration-relevant parameters, such as frequency, amplitude, and vibration shape, and can be adjusted to individual user needs.

Fig 1: *vibration assisted spindle*

Feasibility studies for a customer in the area of deep hole drilling showed that the feed rate could be increased by a factor of 10 to 20 compared to conventional single-lip drilling.

KEY BENEFITS

- Significant increase in material removal rate
- Significant increase in tool life
- Improvements in chip flushing
- Increase in positioning accuracy
- Reduction of production cost and time

REFERENCE: M046/14

APPLICATIONS:
Aviation, medical, and electronic industry;
Processing of brittle hard materials or composite materials

DEVELOPMENT STATUS:
prototype

KEYWORDS:
Hybrid machining,
vibration-assisted machining,
oscillating spindle,
piezo actuator technology

IPR:
EP,US,CN patent granted

OPTIONS:
R&D - Cooperation,
License Agreement

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