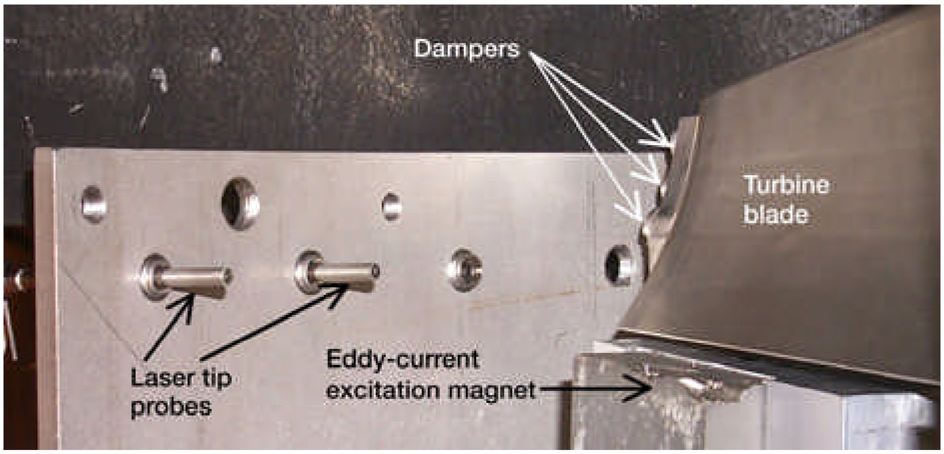
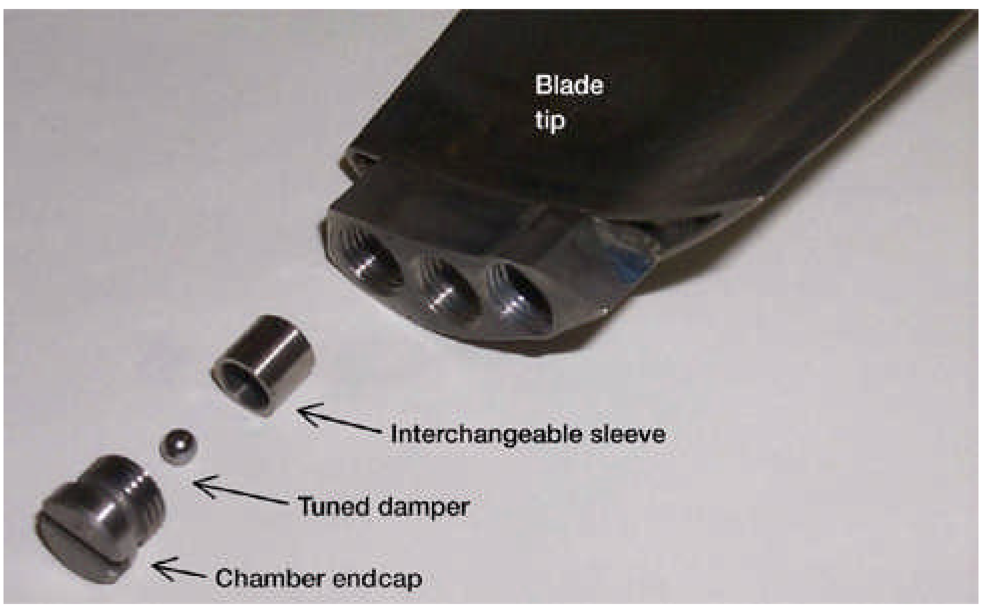
Spin Testing for Durability Began on a Self-Tuning Impact Damper for Turbomachinery Blades



Glenn's Dynamic Spin Facility-Pratt & Whitney turbine blade with self-tuning impact dampers installed at the blade tip.



Turbine blade with exploded view of the self-tuning impact damper.

NASA has a program to develop passive damping technology for turbomachinery blade airfoils to reduce blade vibration. Spin tests in flat plates and turbine blades have shown that a self-tuning impact damper being developed is effective. Spin testing completed this year in NASA Glenn Research Center's Dynamic Spin Rig showed as much as a 50-percent reduction in the resonant response of a damper in a Pratt & Whitney turbine blade. We plan to investigate its durability and effectiveness in upcoming spin tests.

NASA and Pratt & Whitney will collaborate under a Space Act Agreement to perform spin testing of the impact damper to verify damping effectiveness and durability. Pratt & Whitney will provide the turbine blade and damper hardware for the tests. NASA will provide the facility and perform the tests. Effectiveness and durability will be investigated during and after sustained sweeps of rotor speed through resonance. Tests of a platform wedge damper are also planned to compare its effectiveness with that of the impact damper. Results from baseline tests without dampers will be used to measure damping effectiveness.

The self-tuning impact damper combines two damping methods-the tuned mass damper and the impact damper. It consists of a ball located within a cavity in the blade. This ball rolls back and forth on a spherical trough under centrifugal load (tuned mass damper) and can strike the walls of the cavity (impact damper). The ball’s rolling natural frequency is proportional to the rotor speed and can be designed to follow an engine-order line (integer multiple of rotor speed). Aerodynamic forcing frequencies typically follow these engine-order lines, and a damper tuned to the engine order will most effectively reduce blade vibrations when the resonant frequency equals the engine-order forcing frequency.

This damper has been tested in flat plates and turbine blades in the Dynamic Spin Facility. During testing, a pair of plates or blades rotates in vacuum. Excitation is provided by one of three methods--eddy-current engine-order excitation (ECE), electromechanical shakers, and magnetic bearing excitation. The eddy-current system consists of magnets located circumferentially around the rotor. As a blade passes a magnet, a force is imparted on the blade. The number of magnets used can be varied to change the desired engine order of the excitation. The magnets are remotely raised or lowered to change the magnitude of the force on the blades. The other two methods apply force to the rotating shaft itself at frequencies independent of the rotor speed. During testing, blade vibration is monitored with strain gauges and laser displacement probes.

Bibliography

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