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NOVEL LOCKING DEVICE FOR MAGNETIC BEARING FLYWHEEL ACTUATED BY BIAS SMA WIRE ACTUATOR COMBINED WITH LINKAGE MECHANISM.

Abstract

Novel locking device for magnetic bearing flywheel actuated by bias SMA wire actuator combined with linkage mechanism.

The magnetic bearing flywheel can offer many advantages like nearly zero wear and tiny friction losses, which makes this technology an attractive substitute for traditional ball bearing flywheel. To protect the flywheel from launch vibration damage, a locking device is required to lock the flywheel during the launch process and release it on orbit. Since the whole flywheel is sealed inside a vacuum housing to make sure the rotor can rotate with a high speed, the locking device is required to realize locking and unlocking function through program control. Currently, most locking devices are actuated with DC motors together with gear stages, which increases the size and weight dramatically.

Consequently, a novel program controlled locking/unlocking device actuated by shape memory alloy (SMA) wires and spring is proposed, which is light and compact due to the high power density of SMA. To satisfy the requirements of high locking performance under launch vibration, self-locking block and force amplifying linkage mechanism are employed. The linkage mechanism is designed with a large force transmission angle to amplify the output force of spring. For the enhancement of the reliability, a redundant actuation is designed with two independent SMA wires. Based on the design results of the SMA and spring parameters, a prototype of the locking device is fabricated and tested. According to the performance results, the SMA-actuated locking device can release a preload up to 1000 N. Due to the fatigue of the SMA wires, the life time of the locking device is around 20 cycles. Moreover, environment tests show that the device can endure temperature lower than 75 °C.