Design Optimization of Planar Springs for an Advanced Free Piston Stirling Power Generator

There are two types of Stirling Engines, Kinematic and free-piston. In a typical kinematic Stirling engine, the power piston and displace piston are dictated by mechanical linkages and dynamic seals. Kinematic engines have inherent life and reliability limitations as a result of crankcase oil vapors leaking past piston and/or rod seals. The free piston Stirling (FSP) engines use the planar spring or flexure to support the power piston and displacer piston. By implementing planar spring and clearance seal, there is no wearing and tearing. The reliability of the Stirling power generator is significantly improved. Free Piston Stirling engines have demonstrated very long maintenance-free operation: three FSP engines designed by this presenter continue with >15-year world records for dynamic machines. The advanced Stirling power generator currently under the development also relies on planar springs to provide the majority of the axial spring force, to provide radial spring force to resist piston rubbing, and to provide mechanical centering forces. This presentation provides general design optimization guidelines that shall be considered when designing a new planar spring. Axial stiffness, radial stiffness, subassembly rocking modes, and flexure arm modes must all be investigated for each new flexure design.