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Wed-Af-Or15-08: Superconducting magnetic bearings for a high-speed electric aircraft motor

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A levitating superconducting bearing assembly is being designed, built and tested to support the rotor of a 10 kW laboratory-scale prototype of a 25,000 rpm superconducting hybrid electric aircraft motor targeting an ultimate power rating of 1 MW. To this end, we have constructed a bearing test rig enabling measurements of the levitation force and stiffness of assemblies of state-of-the-art melt-textured bulk YBa2Cu3O7 superconducting pellets and Nd2Fe14B permanent magnets under cryo-cooled (liquid cryogen free) conditions over a range of realistic potential operating temperatures. We show that commonly available materials provide sufficient levitation force to support the mass of the prototype rotor under conduction cooling across an accessible temperature range, and are scalable to the full-size machine. The experimental results are supported by finite element modelling that is validated against the experiment and used to determine the optimal relative sizes of superconductor and permanent magnet to achieve maximum levitation force under any given set of operational conditions. The stiffness of the resulting bearing assembly is naturally low, and we propose and investigate novel bearing geometries involving shaping of the superconducting bulk and magnet to increase the stiffness to a level applicable to a high-speed machine. The extension of the test rig to a dynamic setup able to investigate bearing stability and damping under high-speed rotation is described. Potential issues relating to the homogeneity of the permanent magnets and our efforts to characterise this are also discussed.

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