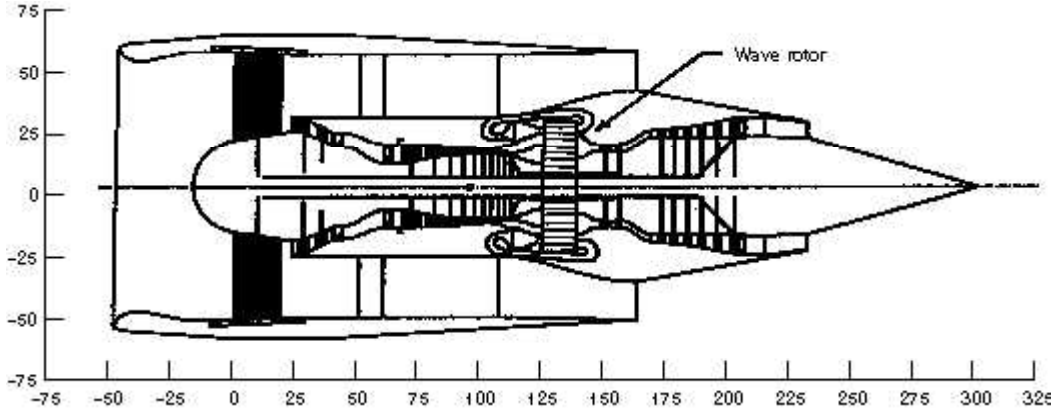
Performance of Gas Turbine Engines Using Wave Rotors Modeled



Schematic of high-bypass turbofan with wave rotor component

A wave rotor is a device that can boost the pressure and temperature of an airflow. When used as part of the core of a gas turbine engine, a wave rotor can significantly improve the thrust or shaft horsepower by boosting the flow pressure without raising the turbine inlet temperature.

The NASA Lewis Research Center's Aeropropulsion Analysis Office, which is identifying technologies and research opportunities that will enhance the technical and economic competitiveness of the U.S. aeronautics industry, is evaluating the wave rotor to quantify the potential benefits of this device. Preliminary studies such as these are critical to identifying technologies that have high payoffs.

Ongoing cycle, weight, and mission studies will determine the benefits of incorporating a wave rotor into a gas turbine engine core. The engine types being modeled include a high-bypass turbofan and several turboshaft engines. The performance of the wave rotor component is being modeled by Lewis' Turbomachinery Technology Branch.

Major accomplishments in these studies include the one-dimensional, steady-state modeling of a turbofan and turboshaft engine that incorporate a wave rotor component in place of a conventional combustor. In these studies the wave rotor acts as a burner with a pressure rise. The pressure rise across the wave rotor is 13 to 20 percent depending on the temperature ratio across the wave rotor and the amount of cooling flow required from the wave rotor. Off-design operating characteristics for the wave rotor were used in calculating engine off-design performance. It was shown that the off-design steady-state behavior of the wave rotor is compatible with these engine types. There are challenges to be overcome, however. The wave rotor adds weight and complexity to an engine, and parts of the wave rotor must withstand extreme temperatures and pressures. Ongoing technology development programs will help further define and solve these limitations.

Results from these studies show that the wave rotor can increase the specific thrust of a

high-bypass turbofan by 3 percent. Although this seems minor, when included on a subsonic transport (similar to the Boeing 777), this 3-percent gain in specific thrust reduced aircraft takeoff gross weight by 7 percent. The benefit of the wave rotor in turboshaft engines is even more dramatic: it increased specific power at design and partial power conditions by 15 to 20 percent. Other potential applications for the wave rotor, such as auxiliary power units and ground power units, are also being investigated.