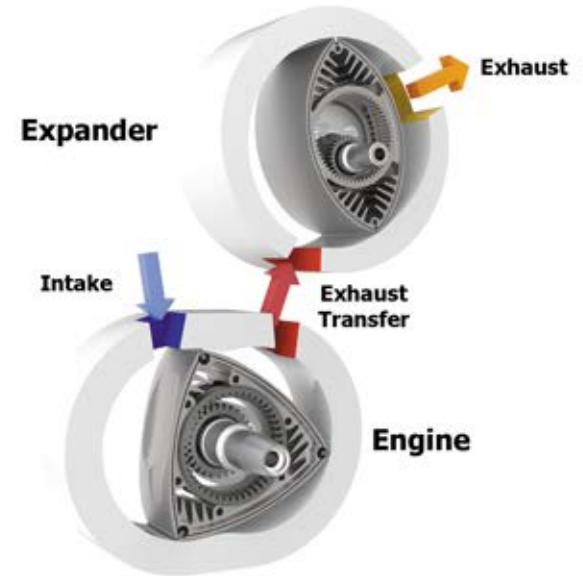


## Technology: Patented, Exhaust Expander System CREEV\*

Wankel Rotary engines have many advantages over reciprocating engines and these advantages can be further enhanced with the use of AIE's patented exhaust expander technology (CREEV\*), reducing overall exhaust emissions and increasing thermal efficiency by up to 20%.

Rotary engines have many advantages for range extender, series hybrid (S-HEV) and power generation applications. The advantages include small form factors, low weight, low vibration and higher power density. Historically their use in these applications has been limited due to the engine's high exhaust energy, heat and emissions (particularly at low rpm and part throttle).

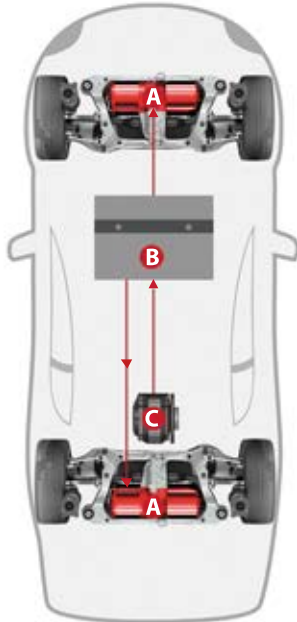
A Rotary engine with a rotary exhaust expander unit (CREEV\*) however overcomes these limitations. Firstly, by reducing overall engine noise and heat due to the expansion of the gas to near atmospheric pressure before leaving the unit. The unit then further acts as an "exhaust reactor" by continuing to consume unburned exhaust products while expansion occurs thus reducing overall emissions of HC, CO and NOx. Finally because the expansion is controlled within secondary rotor chamber the overall thermal efficiency of the engine package is also boosted by up to 20% by recouping otherwise lost exhaust energy back to the engine drive.



\*Compound Rotary Engine for Electric Vehicles

# Technology: Rotary Series Hybrid Range Extender

AIE's high-speed, rotary-engine series hybrid solutions weigh less than 40% of existing units using reciprocating engines and are up to 50% smaller, offering much improved packaging possibilities along with significantly enhanced performance.



**A** Geared Traction Drive    **B** Battery System    **C** Rotary IC Engine

When integrating an IC engine into an electric vehicle for use as a generator in a series hybrid range extender configuration, there are a number of requirements that must be considered, which include packaging volume, overall weight, efficiency, noise and vibration levels.

The typical duty cycle for a range extender engine is particular in that the unit is either completely switched off or operating at high RPM and load. This means the engine effectively acts as dead weight for much of the time. However, during operation, the engine maintains a constant power output, allowing an optimal single-point operating condition. Another consideration is that the transition from "off" to high power may occur when the vehicle is moving slowly in almost total silence under battery power alone. It is essential in this situation that when the engine starts, it is extremely quiet and vibration-free. Requirements like these make the Series Hybrid application ideal for an AIE single-rotor Wankel IC rotary engine, incorporating both SPARCS\* and CREEV\*\* patented technologies.

The series hybrid application fully exploits the enormous strengths of the AIE engine with regards to its compact size, low weight, and extremely low vibration levels whilst mitigating any throttle inefficiency at low power levels.

\*Self-Pressurising-Air Rotor Cooling System

\*\*Compound Rotary Engine for Electric Vehicles