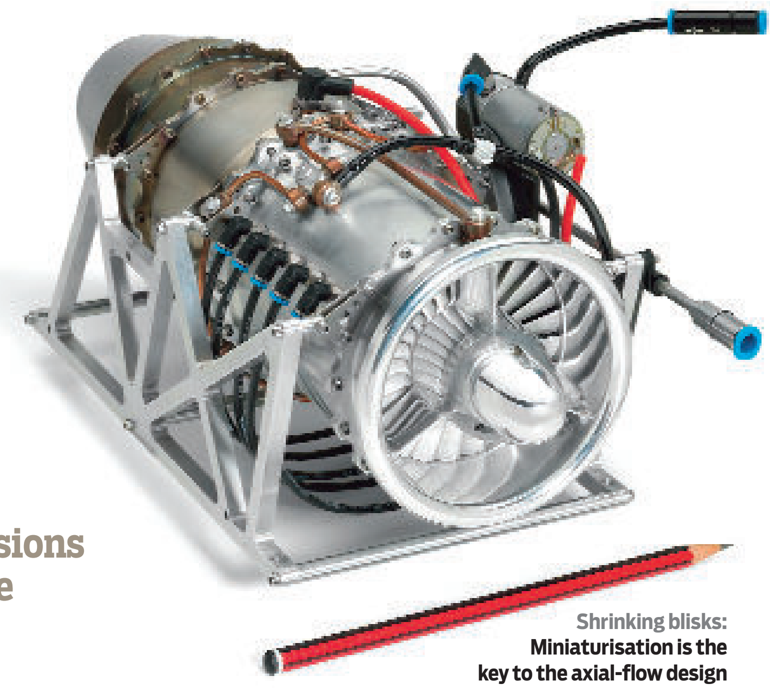
Step on the gas



Shrinking blisks: **Miniaturisation is the key to the axial-flow design**

The battle to reduce carbon emissions is now leading to the revival of the gas turbine powered car

By Lee Hibbert

Many "new" ideas are rooted in the past. And that's certainly the case with plans to develop and build a gas turbine powered car.

Back in the 1950s, Rover produced a two-seater model powered by the same kind of engine that had been developed for aircraft a few years earlier by Sir Frank Whittle. The experimental Jet 1 caught the public's imagination, reaching a top speed of 152mph. But it proved difficult to build a jet engine small enough to fit in a car, and fuel efficiency was poor. Jet 1 also suffered from slowness to respond to the throttle.

Other car companies picked up the mantle, with Chrysler, Toyota and Volvo developing conceptual models. And, while Chrysler actually got its gas turbine car into limited production, it was the reciprocating engine that was deemed better suited to directly powering a vehicle.

Now we look to have gone full circle, with renewed interest in the technology. British firm Bladon Jets is at the forefront of this activity, developing an axial-flow micro gas turbine engine to provide a highly efficient, lightweight, multi-fuel alternative to the reciprocating engines used in most cars today. The engine is deemed particularly suited for use in hybrid electric vehicles.

Bladon Jets will lead a £2.2 million project funded by the Technology Strategy Board to develop an ultra-lightweight range extender for next-generation electric vehicles. The objective is to produce the world's first commercially viable gas turbine generator designed specifically for automotive applications.

The range extender will incorporate a patented, axial-flow gas turbine engine coupled to a high-speed generator using proprietary switched reluctance technology from Harrogate-based SR Drives. Vehicle integration will be overseen by Jaguar Land Rover, calling on its original experience of developing Jet 1.

Fundamental to the project is Bladon Jets' patented process that enables the production of axial-flow compressors and turbines in smaller sizes than has previously been possible – down to 40mm in diameter. The technique allows integrally bladed disks (blisks) to be manufactured in virtually any profile, with varying section, edge radii and taper from root to tip, and from any metal/alloy, including aluminium alloys, nickel alloys, stainless steel and aerospace grades of titanium. Improved performance and efficiency are achieved by closer tolerances and reduced hub-to-tip ratios. Improved reliability is due to stress-free machining from solid material and low inertial mass.

Paul Barrett, co-founder and chairman of Bladon Jets, says: "Successful miniaturisation of the axial-flow compressor has been the key to what we are doing. We've now got the blisk down in size to 40mm diameter, although 75mm is the optimal size for our prototype engine.

> "We believe this is a really exciting technology for multiple sectors

"Ultimately, the axial-flow design enables higher efficiencies from the compressor, and allows more stages to deliver higher pressure ratios. This provides an advantage over traditional centrifugal compressors."

One of the major problems with early gas turbine powered cars was turbine lag, creating a one- to two-second delay from stepping on the throttle to the car accelerating. Early models also suffered poor fuel efficiency at low speed and idle. Barrett says that the advent of all-electric drive in a serial hybrid electric vehicle overcomes both these problems.

"Electric motors provide considerably more torque, and hence acceleration, at low revs than even a piston engine," he says. "And a gas turbine driven generator can be operated continuously at its optimum speed – with any excess power being used to charge the vehicle's batteries. As a result, the gas turbine is allowed to run at its most efficient operating point."

Barrett says that an axial-flow turbo-shaft engine directly coupled to a high-speed generator is the perfect on-board power source for a hybrid electric vehicle. It requires no water-cooling system, oil or catalytic converter, thus providing vehicle weight savings of up to 10% compared to a piston engine, with a consequent reduction in fuel consumption and carbon emissions. "There is much less stuff to carry about, meaning reduced fuel usage and carbon emissions," he says.

Further environmental benefits could be gained from the fast warm-up of the gas turbine engine, typically a few seconds, as opposed to several minutes for a conventional engine, along with cleaner combustion and lower manufacturing energy requirements, he says. And, since gas turbine engines run on just about any fuel, including LPG and biofuels, they are not dependent on dwindling oil reserves.

Barrett says that Bladon Jets' axial-flow gas turbine will be fitted in a vehicle within 18 months. The company is also developing the technology for small aeroplanes. It also believes that its axial-flow micro gas turbine technology would bring the advantage of higher efficiencies to power generators, especially in combined-heat-and-power systems. And it sees potential in the turbo molecular pump sector.

"There's an awful lot going on," says Barrett. "We believe this is a really exciting technology for multiple sectors."