



PATENT



TECHNOLOGY SUMMARY

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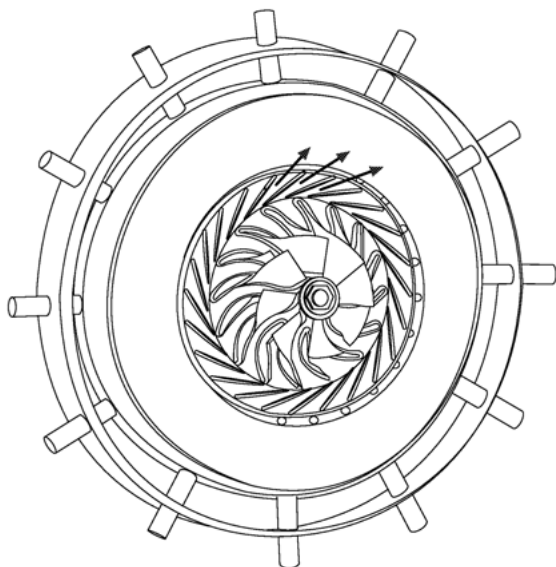
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New Patented Engine Design Proving Great Things Come in Smaller Packages

“Re-inventing the wheel” is a well-used phrase with negative connotations. But what about “reconfiguring the engine” to improve it? That’s the idea behind a recently patented invention coming out of the Air Force Institute of Technology (AFIT).

The invention is a new configuration of a gas-turbine jet engine, referred to as the “disk engine.” The components in a typical engine are arranged from front to back from the intake, the compressor, the combustor, the turbine, and the nozzle. However, this new version places the combustor outboard of a radial compressor and a radial turbine that are positioned back-to-back. This means the combustor, the compressor, and turbine pair occupy the same axial length.

“The idea came out of my master’s work. The project was to integrate an ultra-compact combustor (UCC) into a traditional gas-turbine engine,” said Lt. Col. Brian Bohan, Ph.D., who was studying aeronautical engineering at AFIT at the time. “In a



A side cut-away sectional view of the compressor side of the disk engine.

TECHNOLOGY

PATENT NUMBER:

US 11,415,046 B1

TECHNOLOGY NAME:

Disk Engine with Circumferential Swirl Radial Combustor

INVENTORS:

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Marc Polanka
Brian Bohan

TECHNICAL PROJECT OFFICE:

Air Force Institute of Technology

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UCC, the combustor is shaped as a circumferential cavity where the fuel and air are swirled inside and exhausts radially inward. Think of this as a burning swirl inside a donut and exhausting into the hole.”

The concept Bohan created was an engine that is much shorter, though wider in diameter, than a traditional gas-turbine engine. He believes this engine could be used in turbo-shaft applications to drive a propeller, rotor, or a generator.

“With its shorter axial length, the engine and generator combined could be about the length of just the engine by itself of a typical gas-turbine configuration,” Bohan explained.

The foundational research for this invention goes back as far as 2006 with Bohan and many AFIT student researchers, advised by Dr. Marc Polanka – a co-inventor of the disk engine -- toiling away. But it began to pick up speed in 2015.

“I brought the idea to incorporate a radial turbine below the combustor to Dr. Polanka when I returned to AFIT for my PhD. I had intended to create and research this engine for my dissertation but was advised that it was too large of a project for a single person to tackle,” Bohan recalled.

He and his team faced many challenges with integrating a UCC into a traditional gas-turbine engine, including getting all the hot gases out of the circumferential cavity to span the entire turbine height and make a uniform temperature profile going into the turbine. Over the years the concept evolved into a new design that achieved what the team had set out to do.

“However, because the hot gases in a UCC are swirling and they exhaust radially inward, this is the perfect setup for a radial inflow turbine as used in the patented invention,” Bohan said. “Once this concept was created, it was a matter of incorporating the compressor and achieving a flow path inside the combustor that would achieve complete combustion before exiting into the turbine.”

When he became a faculty member at AFIT, Bohan decided to employ a divide-and-conquer approach to the disk engine project, breaking the process down into phases with students assigned to each. Active research intensified in 2019 and Bohan submitted documentation for a patent in 2020 with a patent being awarded in August of 2022.

Since this engine design takes up less axial space, it would benefit the Air Force by leaving more room on an aircraft for other integral systems such as fuel or weapons. It could also have practical use for ground-based power generation and would be more portable for deployed units.

Patent in hand, Bohan says it is the realization of a dream he’s had for a long time, and he has advice for likeminded visionaries.

“Since I was in high school, I wanted to invent something completely original and receive a patent I could hang on my wall. I hope that this is the first of many,” he said. “The process may seem daunting and the timeline for approval is long. But if you have an idea you are passionate about, it is worth pursuing.”

Bohan is currently the deputy Chief of the Innovative Solutions and Disruptive Technologies team at Air Force Futures at the Pentagon. He continues to search for developing technologies that will make significant impacts to assist the warfighter.

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