Tech Brief December 1998

Army Research Laboratory

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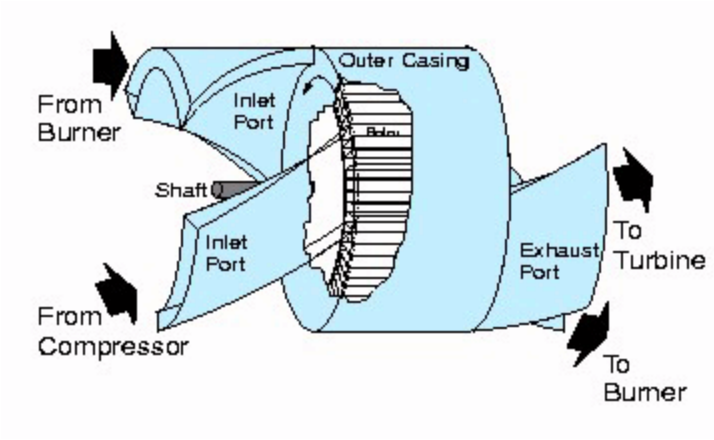

Four-port wave rotor technology

The Army Research Laboratory is experimenting with four-port wave rotor technology to improve gas turbine engine performance. The current experiment, underway at ARL's Vehicle Technology Center at NASA's Lewis Research Center, Cleveland, is being done to better understand the flow physics in the wave rotor passages and to better quantify losses associated with a turning rotor assembly inside a pressurized housing. After these experiments, plans are to build and operate an engine-wave rotor system to demonstrate fuel saving gains.

Even a small increase in power with a corresponding decrease in fuel consumption could add up to millions of dollars saved when applied to a fleet of helicopters. To do this, ARL, along with NASA and industry partners, is pursuing the wave rotor, a device originally invented during World War II.

Basically, the device is a shrouded rotor with axially aligned blades housed in a stationary casing which is added to the engine between the compressor and the burner. Timed gas dynamic waves in the rotor further compress the air on its way to the burner and thus increase the overall pressure ratio of the engine, making it more efficient and powerful.

The wave rotor is well suited for Army gas turbine engine applications because it provides an alternative to the classical compressor which becomes prohibitively small at these high pressures. The wave rotor's impact is similar to what a supercharger does for an automobile engine.

Research so far has been encouraging. A series of in-house experiments have been used to fine tune ARL/NASA tools for designing and analyzing wave rotors. Studies of the benefits of the wave rotor in an Allison 250 engine carried out in collaboration with the Allison Engine Company have shown power increases as high as 20 percent with a corresponding 15 percent decrease in fuel consumption. The Allison 250 engine size is typical of the turboshaft engines that power military and civilian helicopters today.

The wave rotor offers other advantages. A major one is that it is self cooling. This permits engine operation at higher temperatures and pressures which is more efficient. It also means that engines can operate at the highe temperatures now, rather than wait until more exotic, high temperature engine materials are developed. Another advantage is its geometric simplicity which keeps manufacturing costs low. The rotor spins at a low rate of revolutions per minute which means stresses remain low

The Brown-Boveri company developed the wave rotor into the commercially available Comprex R supercharge for ground vehicle diesel internal combustion engines. Both General Electric and Rolls-Royce investigated the use of wave rotors for aircraft engines during the 1960s and showed that it was workable. However, at the time it was decided to stay with more proven, conventional turbomachinery. Now with the Army's emphasis on more efficient systems, it looks like the wave rotor offers more of an impact. Its time may have come.

Dr. Chang installed as director of ARO

Dr. Jim C. I. Chang was installed as director of the U.S. Army Research Office (ARO) by Gen. Johnnie E. Wilson, commander, U.S. Army Material Command, on Sept. 28. Chang is the third civilian director since ARO's inception. Located in Research Triangle Park, N.C., ARO is the Army's executive agency for development, execution, and transfer of extramural basic science research to meet Armywide requirements. ARO invests in programs that seed scientific and far-reaching technological discoveries. ARO-supported scientists have won nine Nobel prizes.

Dr. Chang will also serve as Deputy Director for Basic Science at the Army Research Laboratory (ARL), headquartered in Adelphi, Md. ARO joined ARL effective Oct. 1. ARL is the Army's primary in-house laboratory for fundamental and applied research.

During his 20-year civil service career, Dr. Chang served in high level scientific positions in the Air Force Office of Scientific Research, Naval Air Systems Command, the National Aeronautics and Space Administration, and the Naval Research Laboratory. While at Westinghouse Corp., Dr. Chang was lead analyst for the development of the nation's first liquid metal fast breeder reactor and worked on the development of the advanced reentry vehicles and ballistic missiles at McDonnell Douglas Astronautical Corp. He earned a doctor of philosophy degree in theoretical and applied mechanics at Cornell University in 1971. He holds a master of science degree in civil engineering from Michigan Technological University and a bachelor of science degree in hydraulic engineering from Taiwan Cheng-Kung University.

ARL shared 1998 R&D 100 awards

ARL shared 1998 R&D 100 awards with two small companies for technology innovations developed cooperatively through the Army's Small Business and Innovative Research program.

Research & Development Magazine established the R&D 100 in 1963. The awards honor the top technical innovations of the year.

Winners were Materials Modification Inc., Fairfax, Va., for an invention called NANOGEN, and Hitec Products Inc., Ayer, Mass., for the development of Convoluted Thermocouples for Ceramics Temperature Measurements.

NANOGEN was developed by Krupashankara Sethuram and Raja Kalyanaraman of MMI, in conjunction with Robert J. Dowding of ARL's Weapons and Materials Research Directorate.

Metal and ceramic parts are currently made with micron-size (0.7 to 100 mm) powders. NANOGEN synthesizes many nanoparticulates that significantly increase material strength and hardness. The process creates metallic, intermetallic, and ceramic nanoparticulates with an average particle size of less than 100 nm. A microwave plasma causes input materials to react, dissociate, or vaporize to create the particles.

NANOGEN can increase performance capabilities for materials used in kinetic energy penetrators, gas turbine blades, and capacitors.

Convoluted Thermocouples for Ceramics Temperature Measurements are the first wire thermocouples that stay attached to ceramic components. The new technology involves installing wires using high temperature cements and flame-spray coatings. The convoluted design enables the wires to expand without detaching from the ceramic material.

The thermocouples were designed by Dr. Jih-Fen Lei of ARL's Vehicle Technology Center, NASA Lewis Research Center, Cleveland, and Stephen Wnuk Jr., Hitec. Compared to thin film thermocouples, Convoluted Thermocouples are 10 times less expensive and reduce manufacturing and installation times by a factor of 20.

This product is extremely important and useful for the design and development of advanced aerospace vehicles such as the advanced gas turbine engines which are being developed for the Army's Joint Technology

Advanced Gas Generator program.

Dr. Robert W. Whalin next director of ARL

Dr. Robert W. Whalin, director of the U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS, will be the next director of the Army Research Laboratory (ARL).

Dr. Whalin will replace Dr. John W. Lyons who is retiring from government service on December 30. Dr. Lyons has served as the first permanent director of ARL since September of 1993. A Change of Command ceremony is scheduled for December 17 at Adelphi. Gen. Johnnie E. Wilson, commander of the U.S. Army Material Command, will preside.

Prior to joining ARL , Dr. Lyons served as director of the National Institute of Standards and Technology. While at ARL, Lyons oversaw the introduction of several important management initiatives including the formation of the Federated Laboratory, a concept of joining or "federating" with private sector and academic partners to share expertise to accomplish the technical tasks required by the Army's effort to digitize the battlefield.

He also oversaw the implementation of a laboratory quality improvement program and a personnel demonstration program aimed at simplifying and speeding recruitment, hiring, placement, and separation; establishing pay for performance, simplified classification (pay bands including a new senior level band),and an improved staff development program; giving greater responsibility to managers and managing to the in-house budget.

Whalin was named the first permanent civilian director of WES in January of 1992. He had served as WES technical director since 1985. Under his leadership, the WES research and development program increased from about 100M to 350M. ARL's mission is to execute fundamental and applied research to provide the Army the key technologies and analytical support necessary to assure supremacy in future land warfare.

The laboratory has two main sites in Maryland: the Adelphi Laboratory Center, Adelphi; and Aberdeen Proving Ground.

Other sites are located at White Sands Missile Range, NM; the NASA Lewis Research Center, Cleveland, Ohio; and the NASA Langley Research Center, Hampton, Va.

ARL conducts a broad array of science and technology programs including digitization and communications science, armor and armaments, soldier system, air and ground vehicle technology and survivability/lethality analysis.

Dr. Whalin entered the Senior Executive Service in May 1982 upon selection as technical director of the Army Corps of Engineers Coastal Engineering Research Center, (CERC) at Fort Belvoir, Va., and held that position (CERC relocated from Fort Belvoir to WES in 1983) until 1985. He began his professional career with six years of private industry experience in southern California followed by 15 years experience at WES in the position of chief, Wave Mechanics Branch and chief, Wave Dynamics Division.

He received his bachelors degree in physics from the University of Kentucky, his masters degree in physics from the University of Illinois, and his doctorate in physical oceanography from Texas A&M University.

He is a member of Phi Eta Sigma and Phi Kappa Phi honorary fraternities and Sigma Xi research society.
