



2012

CLIFF GARRETT TURBOMACHINERY ENGINEERING AWARD

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HTF7000 Engine Design, Development and Uses

David K. Winstanley
Honeywell International

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CLIFF GARRETT TURBOMACHINERY ENGINEERING AWARD

Description

This award promotes engineering developments and the presentation of SAE papers on turbomachinery and/or developments that enable or advance the use of turbomachinery. The award honors Cliff Garrett and the inspiration he provided to engineers by his example, support, encouragement, and many contributions as an aerospace pioneer. To perpetuate recognition of Mr. Garrett's achievements and dedication as an aerospace pioneer, SAE administers an annual lecture by a distinguished authority in the engineering of turbomachinery and/or engineering related to creating, enabling, or advancing applications of turbomachinery in power systems, on-highway, off-highway, aircraft, and/or spacecraft uses.

The Award

This award, established in 1984, is administered by the Garrett Award Selection Committee and consists of a framed certificate, a commemorative gift and an honorarium. The award is made possible by a contribution from the Garrett Corporation (now a division of Honeywell).

The lecture honors the memory of Cliff Garrett, an Aircraft pioneer and entrepreneur. Under Cliff's leadership, Garrett was the first to build small auxiliary power gas turbines. One APU series that Cliff's engineers started in the 1950's is still in production today. This is the 85 series, a product that has outlived the company that bore Cliff's name.

Although Garrett ceased to exist as a corporation in late 1987, individual Garrett divisions thrived under the AlliedSignal Aerospace banner until its acquisition by Honeywell. These divisions include the Phoenix-based Garrett Auxiliary Power Division and the Garrett Engine Division, which produce APUs and propulsion engines respectively.

Cliff had an overriding determination to see his company established as a propulsion engine supplier. This was just beginning to happen when he died in 1963. Cliff's successor made that goal a reality. Cliff had an intensity and drive that were unequaled. He built Garrett from ground zero to a billion dollar company. Growth from within was achieved by product engineering innovation, as well as by a strong and dedicated sales team. Cliff represented a personalized, hands-on leadership style that was just right for his time and his company. We will always need leaders of his spirit and vision.

The Garrett Award Selection Committee welcomes nominations for future lectures and suggestions for subject matter related to the basic objective of the program. Nominations and suggestions may be emailed to awards@sae.org. For additional award information, please visit <http://www.sae.org/news/awards/list/garret/>.

AWARD RECIPIENTS

2013 David K.Winstanley

2011 Bernard L. Koff

2010 None

2009 Dr. James W. Fuller

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2007 Vern E. Brooks

2006 V. Ganesan

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2003 Steven D. Arnold

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1999 Robert Lorimer

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1997 J. P. (Jean-Paul) Frignac

1996 None

1995 Heinz F. Moellmann

1994 Frank C. Gillette, Jr.

1993 John Acurio

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CLIFF GARRETT TURBOMACHINERY ENGINEERING AWARD



2012 Recipient

David K. Winstanley
Honeywell Aerospace

David K. Winstanley is currently the Director of Mechanical Chief Engineers for Honeywell Aerospace. Mr. Winstanley is responsible for managing all Chief Engineers who provide design approval and safety review for all Honeywell mechanical products. Mr. Winstanley has previously been responsible as Senior Chief Engineer for developing and installing integrated mechanical systems for the Airbus A350 extended mechanical systems perimeter (EMSP) and JSF/F35 power and thermal management system (PTMS).

Mr. Winstanley was also, as Chief Engineer for Commercial Propulsion Engines, responsible for the design, development, certification and fielding of the HTF7000 turbofan engine.

Mr. Winstanley received BSME & MSME degrees from Purdue University. Mr. Winstanley is a proud member of SAE International.

HTF7000 Engine Design, Development and Uses

David K. Winstanley
Honeywell Aerospace

ABSTRACT

Honeywell has developed a unique turbofan engine for application to the super mid-size business aviation market, the HTF7000. This paper will describe the design of this engine including aeromechanical design of its components. The unique design features of this engine will be described along with the technology growth path to keep the engine current. This paper will also describe several features which have been developed for this engine in response to new regulatory requirements. Some aspects of the engine to aircraft integration will also be described.

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ENGINE FAMILY

The HTF7000 engine is the commercial name for a family of engine specifically designed for the super-mid-sized business jet. The HTF 7000 powers the Bombardier Challenger C300; the HTF7250 powers the Gulfstream G280; and the HTF7500 is proposed to power the Embraer Legacy 450. These engines installed on their respective aircraft are shown in [Figure 1](#).

The HTF7000 family is certified with the FAA designation of AS907 and produces maximum takeoff thrust in the range of 6500 to 7800 lbf. The engine certified ratings are presented in [Table 1](#). The HTF7500 is thermodynamically larger than the other two engines, but the specifics of the flat ranging scheme lead to the specific certification ratings in the table.

Table 1. HTF7000 Engine Family Type Design Comparison (Sea Level Static (SLS) Uninstalled Conditions)

Engine Rating or Limit	HTF7000 (AS907-1-1A) (Certified)	HTF7250 (AS907-2-1G) (Certified)	HTF7500 (AS907-3-1E) (Proposed)
Thrust, MCT (lbf)	7,050	7,337	7,335
Thrust, MTO (lbf)	7,050	7,765	7,638
Low spool speed, MCT (rpm)	9,739	9,800	9,800
Low spool speed, MTO (rpm)	9,830	9,830	9,830
High spool speed, MCT (rpm)	27,530	27,530	27,530
High spool speed, MTO (rpm)	27,686	27,686	27,686
Inter-turbine Temperature, MCT, °F(°C)	1,729 (943)	1,742 (950)	1,742 (950)
Inter-turbine Temperature, MTO, °F(°C)	1,735 (946)	1,751 (955)	1,751 (955)

ENGINE OVERVIEW

The HTF7000 is a 4.2 BPR, two-spool, co-rotating turbofan engine featuring a simple design (see [Figure 2](#)). It

derives its thrust from a single-stage, wide-chord, damperless, high efficiency, inserted-blade fan rotor that is driven directly by an uncooled three-stage low pressure turbine (LPT). The engine compressor core consists of four axial compressor "blisks" (i.e., integrally bladed disks) with two stages of variable and three stages of non-variable axial vanes; and a single-stage centrifugal compressor. The axial and centrifugal compressor rotors are driven by a two-stage, cooled high-pressure (HP) turbine (HPT). The HP and LP spools rotate in the same direction.

The entire rotating system is supported by a bearing and seal system containing only two sump areas, both of which are located in cool environments (i.e., no sump under the combustor). The combustor is a through-flow, annular, effusion-cooled configuration. To reduce noise and improve efficiency, a forced mixer is used to merge the fan bypass and core flows together prior to their exiting the engine through a converging-diverging nozzle embedded in the thrust reverser. The engine includes the full-authority digital electronic control (FADEC) system, which features dual channel electronic control in the form of two independent electronic control units (ECUs); the customer bleed system, providing two sources of bleed air sources to the aircraft; and the accessory gearbox (AGB), which is designed to accommodate airframe needs for such accessories as the generator and hydraulic pump.

The design approach for the HTF7000 engines incorporated two major objectives: (1) to maintain turbine temperatures at a level that precludes the use of exotic materials and thereby keeps maintenance and acquisition