



Heartland Science



Ohio's Legacy of Discovery & Innovation



Aviation & Aerospace

From the Wright Brothers to the Moon

Amazing Propeller Advances

Frank W. Caldwell (1889-1974), born in Tennessee, was an Ohio engineer who made landmark advances in the design of aircraft propellers in the 1920s and 1930s. He pioneered a new propeller design that used detachable blades. Caldwell's essential breakthrough was perfecting the use of a hydraulic rather than a mechanical system to change the angle of the propeller blade. The blade allowed for pitch adjustments -- a feature that made Charles Lindbergh's 1927 solo transatlantic flight possible in 1927.



A propeller is an "air screw" that generates forward thrust, or in the case of a reversible propeller, generates reverse thrust to slow an aircraft rapidly for landing on short runways. The greater the pitch -- angle of the blades -- the more pulling power at a specific spinning speed. Take-offs and landings require coarse pitch; whereas, steady speed for the long haul requires fine pitch, in part to save fuel. The first propellers, carved from wood, were fixed pitch, thus a compromise between maximum thrust and fuel efficiency. Initially variable-pitch propellers required pilots to have great physical strength to move the purely mechanical controls and overcome the so-called centrifugal -- outward (Latin for "center fleeing") -- force of a rapidly spinning propeller.



Later, in 1929, while working at the Hamilton Standard Propeller Corporation, Caldwell developed a hydraulic, two-position propeller that improved takeoff and landing efficiency. In 1933, the Collier Trophy -- awarded in recognition of significant achievements in the advancement of aviation -- was awarded to Hamilton Standard, with particular credit to Frank Caldwell, Chief Engineer, for the development and demonstration of a controllable pitch propeller.

Although work in Great Britain and Germany on the concept of a variable pitch propeller preceded Caldwell's efforts, he perfected a hydraulic rather than mechanical means to change the blade's angle. This new propeller design was incorporated into most planes used in World War II. Using Caldwell's design, Hamilton Standard produced 500,000 propellers for World War II aircraft.

Variable pitch propellers saved many lives during WW II. By minimizing or maximizing the pitch, not only did Caldwell-designed propellers improve aircraft take-offs and landings on short fields, but also most importantly they enabled pilots to "feather" the blades to reduce drag from a disabled engine on a two or four engine aircraft, thus saving valuable fuel and helping to control the craft.



Caldwell also developed a "propeller whirl test" to test his designs for efficiency. The test process called for mounting a propeller to a stand with instruments that measured thrust, endurance, performance, and speed. He later designed whirl-testing facilities for the U.S. government at McCook Field and Wright Field, in Dayton, OH. Caldwell's revolutionary propeller designs brought U.S. flight to a new era of efficiency and safety.

Did you know?

- In 1914, Orville Wright moved to Oakwood, Ohio and encouraged a neighbor's son to enter the propeller business. Robert Hartzell began constructing propellers as part of his father's wood products business. His company, Hartzell Propeller, Inc. responded to the need for propeller manufacture in World War I, and is still a thriving Ohio business today. Hartzell now has four facilities in the Piqua, Ohio area.

Key Facts

- Caldwell earned a mechanical engineering degree from Massachusetts Institute of Technology (MIT) in 1912.
- Many aircraft of the Allied Forces in WWII used Caldwell propellers. Caldwell was responsible for the research, design, and testing of all aircraft propellers used by the U.S. army and navy during WWII.
- In 1990 the American Society of Mechanical Engineers named the Caldwell-designed Hamilton Standard Hydromatic Propeller an International Historic Mechanical Engineering Landmark.

Find out more...

- Hamilton Standard Company History (http://www.hamiltonsundstrandcorp.com/details_printable/1,4291,CLI1_DIV22_ETI3212_LID,00.html)
- Hartzell Propeller Company History (http://www.hartzellprop.com/history/index_history.htm)
- How Stuff Works - The Propeller (<http://travel.howstuffworks.com/airplane18.htm>)
- The Collier Trophy (<http://www.aerofiles.com/collier-trophy.html>)
- Patent Link for one of Caldwell's designs: Variable-pitch or Reversible Propeller Hydraulic Propeller Pat. No. 1,893,612; Filed: May 25, 1929; Issued: January 10, 1933 (<http://patimg1.uspto.gov/.piw?Docid=01893612&idkey=NONE>)