They approached the jet engine problem in different ways, but they both solved it.

The Converging Paths of Whittle and von Ohain

Pictured in 1987 is Frank Whittle and the Whittle W1X, the engine he designed. The engine is on display in the jet gallery at the National Air and Space Museum in Washington, D.C.

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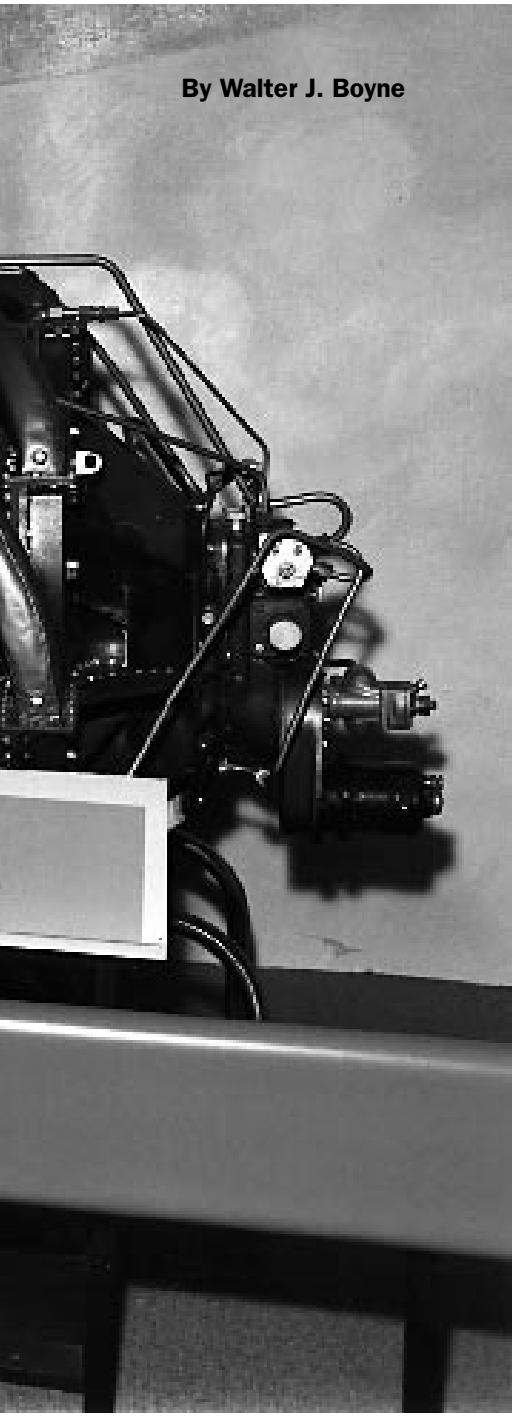


By Walter J. Boyne

No one who witnessed the first flight by a jet aircraft had any idea of the revolution that the jet engine would bring. The secret flight in Germany of the Heinkel He-178 on Aug. 27, 1939, led to revolutions in aviation, warfare, transportation, politics, and the world economy.

A functioning jet engine was realized at about the same time by two independent inventors, British Frank Whittle and German Hans Pabst von Ohain. They could not have differed more in personality.

Whittle, an extremely proficient Royal Air Force pilot, was quick tempered and acerbic, and he did not suffer fools gladly.

Von Ohain, an academic, was much younger, only recently graduated from his university, and possessed of a warm, engaging personality enhanced by a natural diffidence.

They approached the problem of creating a jet engine differently as well. Whittle totally immersed himself in the hands-on work, subcontracting out only those elements that were too complex for him to build. He was constantly applying theory to, and deriving theory from, the engine as it progressed.

In contrast, von Ohain was not a mechanic and taught himself to be an engineer only after he had received his doctorate. He hired a skilled mechanic to create the original model engine and then worked within the framework of a large aircraft company to bring the engine to fruition.

Whittle was totally unaware of von Ohain's work. Von Ohain was conscious of other efforts to patent a jet engine, but did not draw upon any of the available knowledge. His preferred operating style was to work out his own ideas first, then see what others had done.

The two men had three things in common: initial governmental failure to recognize the immense potential of their experiments; totally inadequate rewards for their great invention; and extravagant exploitation of their efforts by others.

Out of the Midlands

Frank Whittle was born in Coventry, England, in 1907 to a working class family. His father was an inventive mechanic who, despite his lack of a technical education, provided Frank with the incentive to excel technically. Young Whittle fulfilled a dream by joining the Royal Air Force as an apprentice at the age of 16. His goal was to become a pilot.

Hugh Trenchard, Marshal of the Royal Air Force, made many important contributions to the RAF, but none more so than his concept of apprentice training. Trenchard insisted that his enlisted and noncommissioned personnel have a sound education. Then he wanted his average RAF airman to have three years' training as an apprentice before entering service as a mechanic or other skilled worker.

Trenchard believed that only educated and well-trained men could become professional airmen. To sweeten the pot, he further stipulated the top five apprentices in each class could become cadets and receive flight training.

Whittle was rejected on his first attempt to join the Boy Apprentice Training program for poor physical fitness, but followed a diet and exercise regime that allowed him to pass his next attempt. He reported for training in September 1923. It was the best investment in personnel the RAF would ever make.

Whittle performed well enough to be selected for pilot training and was a natural pilot. He graduated second in his class despite some crashes, nonregulation low flying, and a few disciplinary problems.

Whittle earned his high class ranking by excelling in his studies—in spite of his reluctance to engage in team sports. He was troubled by a sharp temper that would affect his dealings with others for much of his life.

At the RAF College at Cranwell, he wrote a groundbreaking paper, "Future Developments in Aircraft Design." It postulated that speeds of 500 mph or more could only be achieved in the stratosphere and that a new form of propulsion—rocket or gas turbine—would be required.

On graduation, Pilot Officer Whittle was posted to No. 111 Squadron at Hornchurch, flying the Armstrong-Whitworth Siskin IIIA. In September 1929, he was posted to the famed Central Flying School at Wittering to learn how to become an instructor pilot.

His distress at leaving the atmosphere of an operational squadron was offset by additional free time. More important, he met others who believed in his idea of a gas turbine. One of these was Flight Officer W.E.P. Johnson, who had been a patent agent in civil life. Whittle settled on a new type of gas turbine,

A Concise History of Jet Propulsion

Jet propulsion is an application of Isaac Newton's 1697 Third Law of Motion: For every action there is an equal and opposite reaction. Thrust out the back moves the aircraft forward.

A turbine was patented by John Barber in England in 1791.

In 1884, Charles A. Parson designed a turbine intended to convert the power of steam directly into electricity.

In 1903, Norwegian Aegidius Elling built the first turbine that sustained itself in running.

Romanian inventor Henri Coanda attempted to fly a primitive jet aircraft in 1910, using a four-cylinder internal combustion engine to drive a compressor at 4,000 revolutions per minute. It was equipped with what today might be called an afterburner, producing an estimated 500 pounds of thrust. Countless loyal Coanda fans insist that the airplane flew. Others say it merely crashed.

In 1918, General Electric established a gas turbine division. There, Sanford A. Moss moved closer to the true jet engine with his GE turbosupercharger that used hot exhaust gases to turn a turbine that drove a centrifugal compressor used for supercharging. The device was critical to the success of the B-17, B-24, P-38, and many other airplanes.

In later life, Moss would laughingly remark that he did not know how close he came to inventing the jet engine.

By 1920, Alan A. Griffith developed a theory of turbine design, based on gas flow past airfoils rather than through passages. Later he was a proponent of the turboprop engine—and an opponent of Whittle.

There were other experimenters contemporary with Frank Whittle and Hans von Ohain. American Nathan Price developed a 3,500-pound-thrust engine, and Clarence "Kelly" Johnson designed an advanced fighter to use it, but the Army Air Corps considered it so advanced that it was unlikely to be completed before World War II was over. The Army Air Corps therefore rejected it.

one using neither a piston engine nor a propeller.

Johnson smoothed the way for Whittle to present his ideas to the British Air Ministry. There, Whittle ran into the bureaucratic opposition that would delay the development of his engine by five critical years. The agonizing process would also do much to wreck his health.

Under the guidance of Alan A. Griffith, the Air Ministry's position was that the materials needed to endure the heat and stress implicit in a gas turbine were not available. The ministry also felt that the gas turbine would require too much fuel to be practical.

Unfortunately for both Whittle and the United Kingdom, Griffith had a basic conflict of interest, favored piston engines, and had a proprietary interest in the subject.

Whittle persisted, and a patent was granted in 1930.

In 1936, Whittle and two former RAF pilots, J.C.B. Tinling and Rolf Dudley-Williams formed a new company, Power Jets Limited, to act on behalf of Whittle and to raise money for developing his invention. Whittle, scrupulous about any possible conflict of interest, informed the government, which allowed him to proceed on the basis that it not interfere with his normal duties.

On Paper, Anything Is Possible

On paper, Whittle seemed to have solved the problem of jet propulsion. In practice, he was challenging the limits of everything known about compressors, turbines, metals at high temperatures, and the physics of compressed air flow.

Whittle learned how to build a jet engine by building one.

Power Jets always lacked money, but Whittle's persistence and frugality kept it alive through many lean years.

The critical initial experiments in combustion did not begin until October 1936. Some preliminary testing of Whittle's engine took place in March 1937, the same month that Griffith furnished an official Air Ministry report that essentially declared the jet engine noncompetitive with conventional power plants. The "WU" (for Whittle Unit) was fired for the first time on April 12, 1937.

The initial firing of the jet engine was a near disaster. The engine ran away, reaching a then-incredible 8,000 revolutions per minute before Whittle was able to shut it down.

There followed a series of nerve-racking trials, each one fraught with the possibility of a catastrophic explosion. Whittle's life was often in danger as he stayed with the engine, trying to control it—and sometimes succeeding.

The combination of financial and developmental problems undermined Whittle's health. He was now on the RAF special duty list, able to devote his full time to the redesign and manufacture of his engine.

Testing on the new engine began in April 1938. Results were mixed. For a while, sustained runs of more than an hour were being made, but the engine eventually broke down and was redesigned and rebuilt.

It was not until the summer of 1939 that the Whittle engine began running at sustained speeds of up to 16,000 RPM.

The declaration of war on Germany on Sept. 3, 1939, at last induced the British Air Ministry to pursue the advantages

Photo/Eddie Creek collection

This 1942 photo, taken at the Heinkel works in Rostock, Germany, shows Heinkel employees (from top left to right) Hans Antz, von Ohain, Fritz Shafer (in cockpit), Gotthold Peter, and two unidentified crew members (on wing).

Von Ohain was working on his Ph.D. in physics in Germany when he conceived his version of a turbojet. His concept was patented in 1935. Shown here is the He-178, the world's first jet aircraft.

of an aircraft engine that weighed less, cost less to manufacture, and could use almost any sort of fuel.

Power Jets was given a contract to deliver a flight-worthy engine, and on Feb. 3, 1940, Gloster Aircraft Co. was given a contract for two prototype jets. The aircraft were designated the E.28/39.

Meanwhile, Back in Germany ...

Hans-Joachim Pabst von Ohain grew up in an atmosphere of noble affluence. His father, Wolf Pabst von Ohain, was a military officer who married twice into the same wealthy family. His first wife died, and after a suitable interval he married her sister Katherina Louise, who gave birth to Hans in 1911.

Hans von Ohain's childhood was idyllic, with plenty of vacations and no lack of funds. In 1930, he entered the Georg August University at Göttingen, a prestigious technical school. There he studied aerodynamics and thermodynamics under world famous instructors.

Von Ohain experimented briefly with gliding but stopped when participation required him to be a Nazi. His interest in aircraft propulsion was kindled in 1931, when he took a flight in a Junkers Ju-52 and found that the noise and vibration ruined the beauty of flight.

He decided to make flying as beautiful as gliding was to him—and to do it as simply as possible. In 1933, he began pondering jet propulsion. His first concepts involved no moving parts whatsoever, but he soon shifted to the idea of using a compressor and a turbine.

Von Ohain continued working on his ideas, even as he completed seven years of doctoral work in four years. He received a patent for his jet engine concept on Nov. 10, 1935—nine days after receiving his doctorate in physics.

He also had the good fortune to work with Max Hahn, a mechanic with a knack for building things of metal. He took von Ohain's drawings, analyzed them, and agreed to build a model of the device.

While the test model ran only with assistance from an electric motor, its compressor did pump, its combustor burned, and the turbine rotated. This indicated that von Ohain was on the right track.

Building the engine was beyond his resources, so von Ohain sought out financing and backing. One of his mentors wrote a letter of introduction for him to Ernst Heinkel, who immediately agreed to meet in March 1936.

Heinkel was an important manufacturer, supplying a wide range of aircraft to the Luftwaffe. He wanted to manufacture engines, but knew his company would not be allowed the time or resources to develop piston engines, as his arch rival Junkers had done. Thus the idea of a revolutionary new engine was attractive.

Heinkel already had Walter and Siegfried Günter working for him on a rocket plane, the He-176. Heinkel knew that the Günters would be able to design an experimental airframe to test von Ohain's jet engine.

Von Ohain's position was now better than Whittle's had ever been. Hahn was hired with him, and a special workshop was set aside for his use.

In addition he had access to Heinkel's equipment, engineering team, and finances. Von Ohain and Hahn began their work at Heinkel in April 1936, unaware that Frank Whittle was immersed in building his first test engine.

The Germans sidestepped the enormous problems Whittle was encountering with combustion by designing their test engine to run on hydrogen gas. It was placed in a test rig in March 1937 and ran successfully. A few months later, design work began on the airframe, the Heinkel He-178.

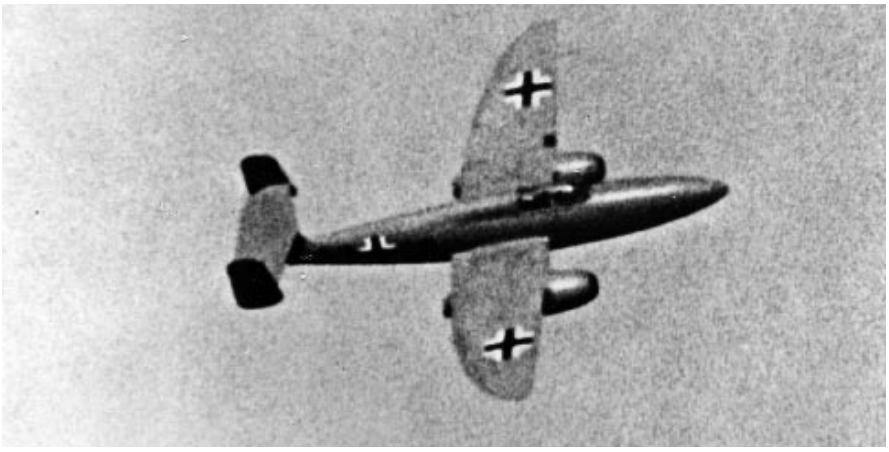
Heinkel was pleased by von Ohain's success and demanded a flight-worthy engine as soon as possible. Much needed to be done to make a jet engine that would function on conventional fuel. Two prototype engines were built.

The first prototype, the HeS 3A, was capable of producing 992 pounds of static thrust by March 1939. This was tested in the air, slung beneath the fuselage of a Heinkel He-118.

The second prototype engine, the HeS 3B, was modified by the flight-

Photo/Eddie Creek collection

Whittle's Gloster E.28/39 was configured much like the He-178. The Gloster shown here on takeoff from Britain's Farnborough Testing and Evaluation Center is model # W4041/G. The G indicated that the aircraft was to be kept under armed guard at all times.



Von Ohain kept working for Heinkel after the success of the He-178. His next engine design, the HeS 8A, was installed in the world's first twin-engine jet fighter, the Heinkel He-280 (pictured here).

test experience and was available for installation in the brand-new He-178 in August 1939.

In an eerie forecast of a future hazard to jet aircraft, flight testing of the He-178 was delayed when a bird was sucked into the air intake during taxi tests. The engine was cleaned and repaired, and on the morning of Aug. 27, 1939, Flugkapitän Erich Warsitz made history with the He-178.

It was the first turbojet aircraft ever to fly.

This was a remarkable run for von Ohain, who had gone from a vague concept to a successful flight in about three years. Unfortunately for von Ohain, in the future, things would not go quite so well for his engine.

Back in Great Britain ...

Squadron Leader Frank Whittle continued at his same furious pace. He was in a constant series of disagreements with the Air Ministry, which was determined to take his work and turn it over to other companies for development.

Whittle had developed a functioning jet engine on a ludicrously small budget—less than $60,000—but lacked the confidence of the Air Ministry.

Whittle worked closely with Gloster in creating the E.28/39, which (except for its tricycle landing gear) happened to have the same low-wing monoplane configuration used by the He-178. After preliminary taxi tests, Gloster's chief test pilot, P.E.G. Sayer, made the first flight on May 15, 1941.

The combination of stress, overwork, and lack of appreciation continued to sap Whittle's health. It did not help that he smoked and drank too much.

Once the British government realized how important his work was, it elected to provide information on the jet engine to Rover, Rolls Royce, Metropolitan-Vickers, and de Havilland, literally putting them in business on the back of Frank Whittle.

The information also was shared with the United States, where General Electric was tasked with developing the engine. Whittle gladly came over to help.

There followed a long series of business events that saw Power Jets nationalized—at great economic and personal cost to Whittle.

Promoted to air commodore, Whittle soldiered on. He received a grant of £100,000 from the Royal Commission on Awards for Inventors in May 1948, a pittance in light of the billion dollar industry that developed from his invention.

In July 1948, he was knighted. Sir Frank became sick on a lecture tour in the United States and retired from the RAF on the basis of ill health in August 1948.

Whittle continued to consult and lecture as his health permitted and eventually immigrated to the United States in 1976, where he became a research professor at the US Naval Academy in Annapolis, Md. Honors were heaped on him over the years until his death on Aug. 9, 1996.

Operation Paper Clip

Von Ohain continued his developmental work for Heinkel, and his new engine, the HeS 8A, powered the world's first jet fighter, the Heinkel He-280. There were difficulties with this engine—its thrust was low and its diameter was too large. The He-280 program was canceled in favor of the new Messerschmitt Me-262 that also used a Junkers engine.

The war ended before another engine designed by von Ohain became operational.

In terms of monetary reward, von Ohain had received moderate pay increases, and about three months after the war ended he received a check for several hundred thousand now-worthless Reichsmarks from the Heinkel Co.

In 1947, the United States swept von Ohain up along with hundreds of other German scientists in Operation Paper Clip. He went to work as a research scientist at Wright-Patterson AFB, Ohio. Von Ohain continued to distinguish himself, becoming chief scientist of the Aero Propulsion Laboratory in 1975. He continued publishing and patenting until retiring in 1979.

In his retirement years, von Ohain remained active as a consultant and was selected as the Charles Lindbergh Professor at the National Air and Space Museum in 1985. Like Whittle, von Ohain received many honors recognizing his work. He died on March 13, 1998.

Whittle and von Ohain met many times in the United States, often when they were jointly receiving some prestigious honor, such as the 1991 Charles Stark Draper Prize. When they were together, von Ohain deferred graciously to Sir Frank.

Of all their meetings, the most significant took place at Wright-Patterson in May 1978. Col. Philippe O. Bouchard, commander of the Aero Propulsion Laboratory, hosted a two-day session where Whittle and von Ohain spoke freely of their experiences and answered a barrage of questions from the captivated audience.

The two men clearly enjoyed themselves, for this was recognition by people who understood the immensity of their challenge and the talent that it took to meet it.

Perhaps more important, it was perfectly obvious to Whittle and von Ohain that, at last, each man truly recognized and applauded the achievements of the other. ■

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