The Race for the

In World War I, Germany's high-flying zeppelins gave the Allies a shock. They posed a new bomb-ing threat and generated the need to be able to fly and fight at great altitudes. The giant airships would glide to their targets at 20,000 feet, a level at which few airplanes—and even fewer pilots—could operate well. By war's end, it became only too clear that military aviators would have to go far higher than anyone had ever expected.

In the postwar race to high altitude, the US at first set the pace. Its pilots and aircraft produced world records almost at will, with little serious foreign competition. The path was blazed by the likes of Army Maj. Rudolph Schroeder, who reached 33,113 feet in 1920, and Army Lt. John A. Macready, who soared to 34,449 feet in 1921. *[See "Pioneers at High Altitude," April 1991, p. 88.]* The US capped a decade of success when, in 1930, Navy Lt. Apollo Soucek set a new world mark of 43,166 feet.

However, that would prove to be the last US record for some time. Shortly after Soucek's accomplishment, the US abandoned its high-altitude work. The Great Depression brought harsh austerity, and aeronautic experimentation withered. Except for the landmark work of Wiley Post [see box, p. 85], the decade-long race for the stratosphere was a European show.

Actually, the future had been presaged in 1929. Germany's Willi Neuenhofen set a short-lived world altitude record in a single-engined Junkers W 34, though Soucek soon shattered that mark.

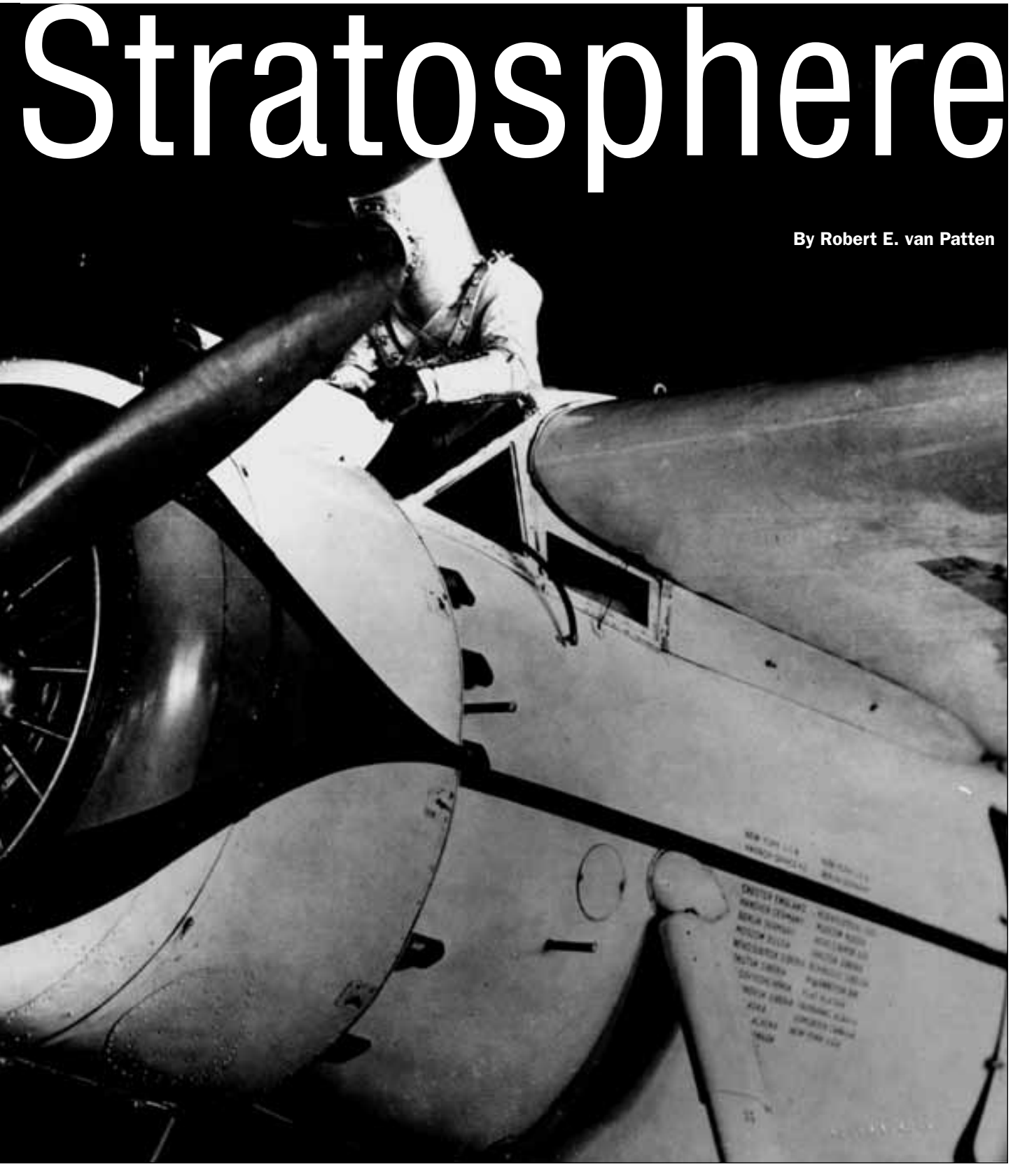
World War I underscored the need to fly higher, leading Maj. Rudolph Schroeder and Lt. John Macready to altitudes in a LePere biplane (above) that set new records. Reaching for even higher altitudes soon spurred development of pressure suits, such as the one Wiley Post (above, right) helped develop in the 1930s.

Europe's Assault Begins

By spring 1932, the European surge was about to begin. Rumors swirled about a secret Royal Air Force assault

Stratosphere

By Robert E. van Patten



Between the wars, airmen ran enormous risks to take piston-powered airplanes above 50,000 feet.

on Soucek's record. Cyril F. Uwins, Bristol Aircraft's chief test pilot, already had made several unsuccessful attempts to better Soucek's mark, all of them flown in an open-cockpit Vickers Vespa VII biplane. And on Sept. 16, 1932, he finally succeeded. Flying from Filton in England, Uwins notched up the altitude record to 43,976 feet.

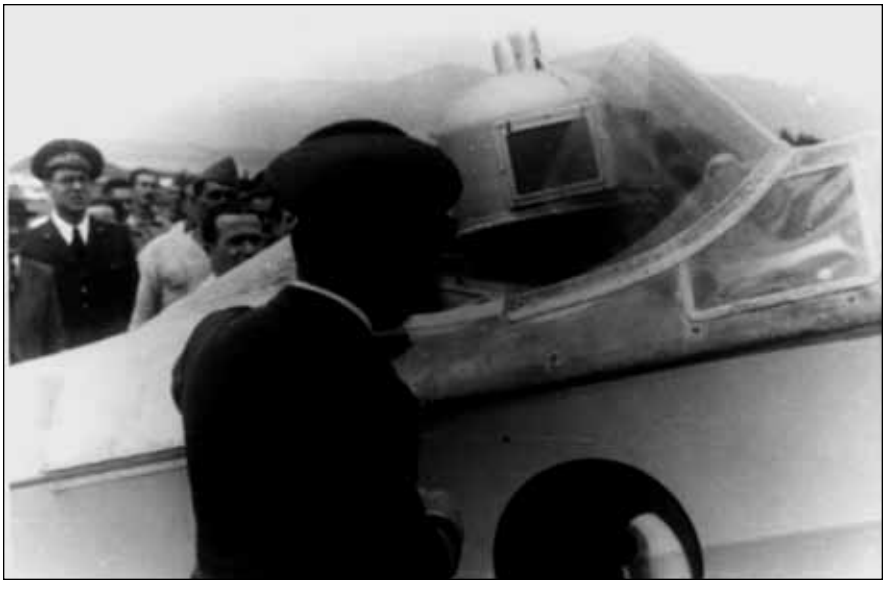
The British aviator used a continuous-flow oxygen system modified to provide 100 percent oxygen at rates selected by the pilot. Because the flow of oxygen was continuous, however, half was wasted, thus limiting use of this kind of system to short duration flights.

Uwins' hold on the record didn't last long. Another European, Frenchman Gustave Lemoine, surpassed it the next year. Lemoine, flying in a modified Potez 50 aircraft, got within range of the Uwins record in 1932, but success did not come until the following year. Lemoine's record flight came on Sept. 28, 1933, when he flew up to an altitude of 44,808 feet.

Lemoine's Potez 50 was derived from a military design that was widely known for its speed records. For the 1933 flight, the aircraft underwent extensive modifications—for example, the upper wing was extended seven feet. Power came from a modified Gnome Rhone engine with a three-bladed propeller optimized for high altitude. Single-stage supercharging enabled the engine to develop 800 hp at 13,120 feet.

In his personal account of the flight, Lemoine emphasized that his cockpit was not pressurized; he was protected from the cold only by his windshield and by an electrically heated flying suit. His face was shielded by two items: a chamois balaclava worn under his fleece-lined leather flying helmet and his oro-nasal oxygen mask.

Lemoine started using oxygen at 10,000 feet and, at 33,000 feet, he started using a high flow of oxygen. To survive for more than a short time at his peak altitude, he must have been using some form of positive-pressure breathing system. Lemoine, in fact, had conducted a great deal of experimentation in an altitude chamber in order to develop and refine his oxygen equipment.



The Europeans set several altitude records in the 1930s, two of them in a Caproni 161 flown by Lt. Col. Mario Pezzi, who reached more than 50,000 feet. In both photos, Pezzi wears an aluminum pressure helmet with electrically heated glass ports.

The First Pressure Suit

The idea for a pressure suit was outlined in 1920 by the renowned British physiologist John Scott Haldane.

Haldane noted that flight above 40,000 feet would require enclosing the pilot in an airtight suit, one which would be able to maintain a proper pressure no matter what the ambient atmospheric pressure.

Haldane's idea came to the attention of an American balloonist, Mark Ridge, who corresponded with its author on the construction of such a suit.

Haldane passed the letter to Robert Davis at the firm Siebe Gorman, which adapted one of its self-contained sea diving suits for the purpose. It was tested at a pressure altitude of 90,000 feet, and it performed perfectly.

No detailed records exist, but this test almost certainly was carried out without a human subject in the suit.

Wiley Post Sets a Standard

In the 1930s, famous American aviator Wiley Post convinced the Army Air Corps and B.F. Goodrich Co. to lend support to his effort to develop a full pressure suit.

Post wanted to use the altitude chambers at Aeromedical Laboratory at Wright Field, Ohio, to develop a rubber suit that would enable him to operate in an atmosphere of about 12 pounds per square inch absolute. This is equivalent to between 5,000 and 6,000 feet.

Post went on to state that he anticipated flying at altitudes at which the ambient pressure would be as low as five pounds per square inch absolute—equivalent to nearly 30,000 feet.

On Sept. 5, 1934, Post flew his aircraft comfortably at an altitude of 40,000 feet. During this flight, his full pressure suit maintained his suited environment at a pressure altitude of 5,500 feet.

On Dec. 7, 1934, everything was finally ready for Post to attempt to set a new world altitude record. The existing mark—47,352 feet—had been set eight months earlier by Renato Donati.

Post apparently reached an altitude of more than 50,000 feet. Unfortunately, however, he was denied the record because the two mechanical barographs (pressure/altitude recording devices) installed in the aircraft did not agree within the narrow margin prescribed for validation of an altitude claim.

In any case Post's use of liquid oxygen and a fully mobile pressure suit set a benchmark for all subsequent pressure suits, including space suits.

Soon afterward, he died in an aircraft crash with a famous passenger, humorist Will Rogers.

It is clear that Lemoine well understood the hazards of flight above 40,000 feet. As an aid to pilot survival, the Potez 50 had a safety system incorporated in the joystick; it required the pilot to maintain a grip on the stick. If he lost consciousness, the system would put the aircraft in a controlled descent automatically and increase oxygen flow. Lemoine's flight produced the conviction in the French aeromedical community that sustained operations at altitudes above 36,000 feet would require either pressure suits or pressurized cabins, or both.

Italy Steps Up

Before long, Italian military aviation entered the high-altitude competition. The Regia Aeronautica (the pre–World War II Royal Italian Air Force) had produced many fine aircraft and pilots, but it had never seriously pushed for records.

That all changed April 11, 1934. On that day, Italy claimed a new world altitude record of 47,352 feet. Cmdr. Renato Donati established the new mark while flying his specially modified Caproni 113 AQ biplane. This was an aircraft with very-high-aspect ratio wings, using a large four-bladed propeller and a supercharged British Bristol Pegasus engine.

Donati, suffering from hypoxia and frostbite, had to be helped from the open cockpit of the Caproni after his landing at Montecelio, Italy, airport. The media, in the wake of Donati's ordeal, noted the necessity for improved high-altitude life support equipment, especially pressure suits.

Meanwhile, in Soviet Russia, significant advances in high-altitude flying flowed from the exploits of the Polikarpov TsKB-3 version of the I-15 biplane. On Nov. 22, 1935, pilot Vladimir K. Kokkinaki flew the Polikarpov prototype to a record of 47,806 feet. However, the Soviet Union did not belong to the Fédération Aéronautique Internationale, the official keeper and arbiter of world aviation records, and the FAI never recognized this claim.

Contemporary reports of the flight make it clear that Kokkinaki's aircraft was an unpressurized, open-cockpit machine and that he had an oxygen appartus specifically designed for high altitude, featuring a special oxygen mask. Nevertheless, Kokkinaki is quoted as having said, "Though my oxygen apparatus worked perfectly, it is not enough for the stratosphere. A single breath makes one realize this. Every movement requires great effort."

To lighten his aircraft, Kokkinaki took off with his fuel tanks only half-full. With full tanks, he might have attained an even higher record altitude. However, the pilot's head-to-foot fur flying suit could not have protected him from the biting cold at higher altitudes. That, coupled with the lack of positive-pressure breathing, probably would have been lethal.

In 1935, Junkers engineers developed yet another high-altitude research aircraft, designated Ju-EF 61. The designation EF probably was a special one used for purposes of secrecy. It is probable that the initials EF stand for the German phrase Entwurf Flugzeug (experimental aircraft).

The EF 61 was powered by two 950 hp Daimler–Benz 600 engines. An unusual feature was the two-place, full transparency cockpit forming the nose of the plane. The cockpit was in the shape of a cylinder which transitioned into a gently rounded bullet-nosed shape. This cockpit module was fastened to the remainder of the airframe by spherical rod

end ball-joints, which isolated any airframe stresses from the pressurized structure.

Two of these aircraft were built, one of which was destroyed in flight in September 1937. No data survives from testing on the other, which crashed in December 1937.

Flight of Georges Détré

On Aug. 14, 1936, the world witnessed the last record high-altitude flight in which the pilot didn't wear a pressurized suit. The flier was Georges Détré, who flew the same Potez 50 used by Lemoine in his earlier record flight.

The aircraft, redesignated the Potez 506, was further modified by Détré. It had a different propeller and the absolute minimum of landing gear. At the outset Détré considered the use of a pressure suit, but he found that the one supplied for him was unbearably hot and therefore unusable.

Preparations were filled with difficulties. For example, the new propeller, nearly 10 feet in diameter, caused dangerous vibrations at certain airspeeds and altitudes. Only by chance did Détré discover the cause of the problem: In extreme cold, one of the blades began rotating in its hub, altering the pitch of that blade and causing unbalanced thrust.

A real threat to any attempt to fly the Potez 506 was its near-uncontrollability at low altitudes and normal temperatures. This flaw stemmed from slack in the wire cables operating the control surfaces. The cables needed slack to be able to withstand thermal contraction caused by the bitter cold of high altitudes. The built-in time lag in aircraft control nearly resulted in several crashes.

Détré made his record attempt on Aug. 14, 1936. Wearing only the high-altitude clothing of that period and using the same dual-regulator oxygen system used by Lemoine, he reached a height of 48,698 feet.

Détré was lucky to have survived his unpressurized exposure at this altitude. He lost consciousness repeatedly, found himself overwhelmed with euphoria, and suffered a splitting headache of almost disabling intensity. After 20 minutes of deep gasping and zero gain in altitude, he descended with the new record.

He held it less than two months.

Earlier in 1936, RAF Squadron Leader S.R.D. Swain had presided over an escalation of high-altitude technology. Swain was given a full pressure suit and flew a closed-cockpit, low-wing Bristol monoplane with dual-intercooled superchargers, the second of which cut in at an altitude of about 30,000 feet. The lack of pressure independent joints made this suit very rigid; it was tailored to fit the pilot only in a sitting position. The suit's rigidity nearly cost Swain his life.

On the morning of Sept. 28, 1936, Swain took off from Farnborough, UK, in his big experimental Bristol 138A aircraft, a low-wing monoplane made entirely of wood and powered by a special version of the erstwhile Pegasus engine. Swain wore a full pressure suit which featured a closed circuit rebreather designed by the Instrument Department at the Royal Aircraft Establishment at Farnborough.

Swain's suit had two major parts which enclosed the head, trunk, arms, and legs; they were sealed together with an airtight joint at the waist. The breathing gas was oxygen, conveyed

Last Word in Propeller-Driven Records?

On March 31, 1995, Einar K. Enevoldson, a former NASA test pilot, flew the Burkhart Grob Strato 2C research aircraft to an unofficial world record for manned, piston-engine aircraft.

The altitude was 60,867 feet. Enevoldson's flight bettered Pezzi's 1938 record by some 4,000 feet.

The development of the 2C was underwritten by the German Federal Ministry of Research and Technology. Grob is well-known for building high-technology, high-performance sailplanes, and the 2C reflects that background. In layout, it is a monoplane of very-high-aspect ratio, resembling that of a U-2.

The XC-35

In 1935, the US Army Air Corps suddenly mandated a crash program to develop an aircraft with a pressurized cabin. This new turn of events may have stemmed from concern about the pace of activities abroad.

The result was a Lockheed twin-engine, low-wing monoplane, a variant of the Electra transport, called the XC-35, which had a pressurized cabin. Pressurization was accomplished mainly by reducing all windows to slits and plastering every crack and crevice with soft, sticky neoprene rubber tape.

The XC-35 aircraft was delivered to Wright Field, Ohio, in spring 1937, and, despite the slapdash approach to construction, it proved to be capable of maintaining cabin pressure at the level of 12,000 feet.

to the helmet by hose. The exhalation was then sent through a scrubber and put back into the suit atmosphere. Contemporary reports of this flight indicate that the closed cockpit was not pressurized.

Swain was struck by the awesome visibility from his high-altitude vantage point. At 45,000 feet and about 10 miles north of Brighton, he could see the entire coastline of England from Margate (on the Thames River estuary) southwestward to Land's End at the tip of Cornwall.

When Swain decided to descend, he throttled back into a glide. Sometime later in the flight, Swain experienced air-hunger and, assuming that he was running out of oxygen, slashed an opening in the double-layer Celastoid faceplate of his helmet with an emergency knife kept in cockpit. He didn't begin to feel normal until he had desceneded to 14,000 feet.

Swain was airborne for 3 hours and 20 minutes. When it was over, he had set a new altitude record of 49,944 feet.

The mark stood up for only a bit more than seven months.

On May 8, 1937, Lt. Col. Mario Pezzi of the Regia flew a Caproni 161, a variant of the type 113 used by Donati, to a new record of 51,361 feet. This aircraft, like its predecessor, was a very-high-aspect ratio biplane built mostly of wood. On this flight the big Caproni was equipped with the more powerful Piaggio XI R.C. 72 engine, an air-cooled double row radial with 14 cylinders, developing about 1800 hp at sea level. This engine swung a massive fixed-pitch four-bladed propeller.

At the time of his flight, Pezzi was commandant of the Italian High Altitude School, one of a number of special schools operated by the Regia Aeronautica. Also at that time, the students at this school were routinely flying daily at altitudes above 40,000 feet.

Like the English aviators, the Italians were fully aware that high-altitude flying had entered an arena in which some form of pressurization, either suit or cabin, had become a necessity. Pezzi wore a special airtight, electrically heated pressure suit made of rubber and fabric reinforced with an alloy metal cuirass. The suit incorporated a very large aluminum pressure helmet which had electrically heated glass ports. Oxygen tubes fastened to the helmet provided breathing gas and pressurization. Contemporary accounts state that this pressure suit was sufficiently flexible to permit Pezzi to use his parachute in an emergency.

Pezzi's record survived for just under two months.

On June 30, 1937, Pezzi lost the title to RAF Lt. M.J. Adam, who hit a new record altitude of 53,937 feet. The Bristol 138A monoplane again was pressed into service. Adam also used the same pressure suit used by Swain.

According to an authoritative account, Adam received a severe jolt at maximum altitude. The top of the cockpit canopy split open with a bang loud enough to be heard above the engine noise and through the pressure helmet. This explosion was attributed to the high-pressure differential between the cabin and the ambient pressure at nearly 54,000 feet.

USAF Maj. Robert White (center) brought altitude records into the jet age 37 years ago this month, reaching 314,750 feet—marking the first spaceflight in a manned aircraft.

Shortly after his record-setting flight, Adam died in a crash near Cove. Apparently the RAF high-altitude program died with him, because the world's altitude record for piston-engine airplanes passed, once and for all (more or less), to the Italians in 1938.

Pezzi was a man not easily discouraged by setbacks. He returned to the high-altitude arena almost immediately after the shattering of his record by Adam. This time the Caproni 161 was superseded by the higher performance Caproni 161bis, also a biplane. On Oct. 22, 1938, Pezzi once again claimed the high-altitude laurels, setting a new record at 56,046 feet.

The jet age brought new altitude records. On July 17, 1962, Air Force Maj. Robert M. White, in a North American X-15 launched from a carrier aircraft, reached 314,750 feet, the first spaceflight in a manned aircraft. However, Pezzi's record for manned, piston-engine aircraft has stood for more than 60 years. In 1995, Einar K. Enevoldson flew a Grob Strato 2C to an unofficial record of 60,867 feet.

By the outbreak of World War II on Sept. 1, 1939, the world's aviation technology could support air combat at altitudes above 40,000 feet. Both the Allies and the Axis made good use of their capabilities, establishing the fact that, in war, the high ground definitely was the place to be. ▪

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