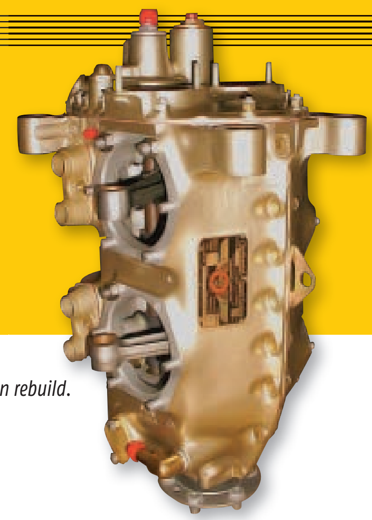

C90 in rebuild.

The Small Continentals

Reviewing the A40 through C90

BY OSCAR ZUNIGA

POSSIBLY THE MOST POPULAR aircraft engines of postwar times, four-cylinder Continentals have powered certified and experimental aircraft of many types and have gained a renewed interest as Teledyne Continental Motors (TCM) has begun providing updated and modernized versions for the light-sport market. This article describes the older family of engines and the conversion routes between models from the A40 to the C90.

In 1931, just 30 years after the Wright brothers first flew at Kitty Hawk, Continental released an air-cooled flat-four engine for the emerging private aircraft market. The engine, designated the A40, had a displacement of 115 cubic inches and was rated 37 hp at 2550 rpm. It was said to be the simplest four-stroke internal combustion engine ever built, and it was also credited with keeping private aviation alive during the Depression. From that early and successful design have sprung some of the most popular and reliable aircraft engines in modern aviation history, and from it also evolved the succession of refinements that came from pushing the engine to produce more power with the same or better reliability. As for simplicity, there would be no returning to the days of the A40.

The landmark Continental A50 was released in 1938. It was a more robust and better-developed engine than the A40 in many respects, and it was designed conservatively in keeping with the austere times. Its basic characteristics of a modest 5.4-to-1 compression ratio and 171-cubic-inch displacement (nearly square 3-7/8-inch bore and 3-5/8-inch stroke), along with its rugged design and generous tolerances, would be so mild as to allow it to eventually produce more than twice its original rated horsepower. In the ensuing 70 years it has powered aircraft in war and in peace and has operated in states of tune from "sedate" to "race" and beyond. In its ultimate incarnation as the O-200, the engine has powered some of the most popular and useful aircraft of all time, accumulated untold numbers of hours, powered record-setting race aircraft of many descriptions, and seen service in more aircraft designs than its creators ever envisioned. Because of its popularity and ubiquity, experimenters in the 21st century continue to use the engine and exploit its strengths and variations. Indeed, a water-cooled variant of the O-200 powered the Voyager in 1986 on Dick Rutan and Jeana Yeager's non-stop, around the world flight of an airplane without refueling. That pusher engine and its companion O-240 on the nose of the Voyager vaulted experimental aviation into the spotlight and further solidified the image of the four-cylinder Continental as a reliable aircraft powerplant.

As is commonly the case with engines that are produced in large numbers, many of their users explore the limits of the engines' power and flexibility. In the case of the A50, the increasing growth of aviation activity (and, before long, World War II) pressed the Continental engineers to extract more power from it, and they found that not much effort was needed for that. Testing quickly proved that the engine could be fitted with a propeller that allowed it to turn 2300 rpm rather than its rated 1900, and along with pistons that provided an increased compression ratio of 6.3-to-1 and minor changes in jetting for the carburetor, the engine would reliably and continuously produce 65 hp. This combination was placarded as the Continental A65, an aviation milestone and the benchmark against which many engines are compared and measured even today for operating reliability, simplicity, durability, and configuration.

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CONVERTING AN A50 TO AN A65

The A50, like the other A-series engines that were to follow, was type certificated in many different configurations. There were single-ignition, up-exhaust, dry-sump, fuel-injected, and starter versions. None of the dry-sump versions are candidates for upgrading. The increase in power from 50 to 65 hp results from increasing the compression ratio from 5.4-to-1 to 6.3-to-1 and operating the engine at 2300 rpm instead of 1900 rpm. The compression ratio change is achieved by using different pistons, pins, rings, and rods. If an early A50 engine is converted, other changes (including crankshaft) may be required. Other minor changes such as timing and carburetor jetting are needed when converting the A50 to an A65, but most other parts such as magnetos, ignition harnesses, carburetors, propeller flanges, and fittings are interchangeable between the engines, as are all hardware items and external fittings such as intake manifolds, exhausts, gaskets, oil sumps, and engine mounts. In many respects, the A65 is the parent to its predecessor and its later descendants, since it was produced in greater numbers and is more familiar to pilots and mechanics than the other A-series engines.

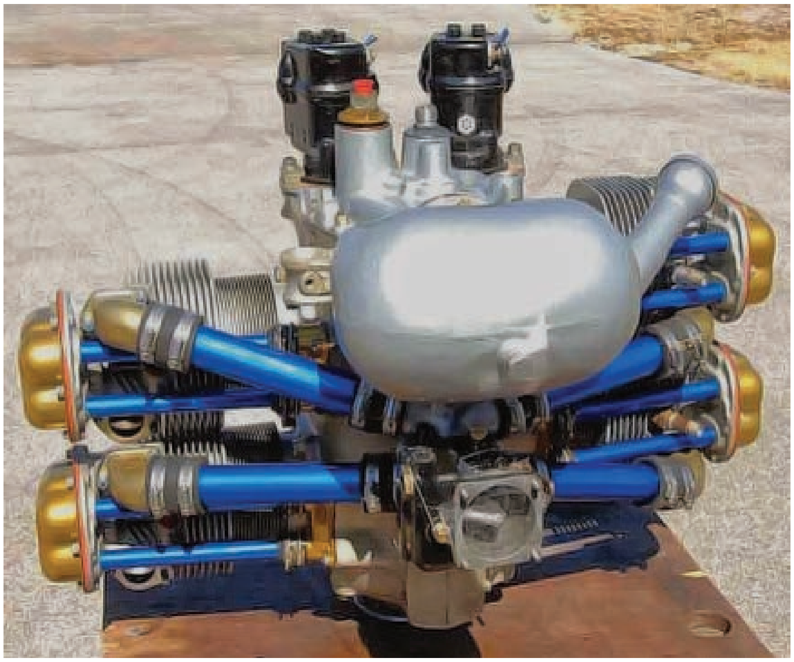
THE NEXT STEP: A65 TO A75

In order to obtain 10 additional horsepower by turning the A65 at 2600 rpm rather than at 2300, Continental changed several things related to cooling and lubrication. The cap ends of the rods were drilled with 1/16-inch holes to provide additional squirt lubrication for the cylinder walls, the exhaust valves were changed to Stellite-faced (a cobalt-chromium alloy with increased hardness and a high melting point), and the undersides of the pistons were made with a waffle pattern for additional cooling. The wrist pins were also changed to a smaller diameter, although it is possible to create a pseudo-A75 from an A65 by simply changing the valves and drilling the connecting rods to allow the engine to operate at the higher rpm without changing pistons, rods, or wrist pins, but engine life and cooling may suffer. Once again, minor changes to ignition timing and carburetion differentiate the higher-horsepower engine from its predecessor. The external appearance is unchanged, and other than by examining the engine data plate, it is not possible to distinguish one engine from the other. While many A65s have been made to operate at the higher engine speed by simply changing propellers to obtain A75 performance, one must understand that the Continental engineers had reasons for implementing the various changes to the engine to achieve certification at the higher horsepower. Countless hours of operation in all sorts of aircraft and configurations brought to light the weaknesses that led to the changes in later engines.

END OF THE A-LINE: A75 TO A80

The conversion from A75 to A80 involves installing taller pistons than on the preceding versions to obtain a compression ratio of 7.55-to-1. The taller pistons have five rings rather than four as on the earlier versions; two beveled compression rings in the first two grooves, one plain compression ring in the next groove, and two oil rings in the two lower grooves. The rated 80 hp is achieved with this piston/ring change and by operating the engine at 2700 rpm. This power comes at the expense of higher piston drag, however, due to the taller piston with its five rings, supplemental lubrication to the rotating components, supplemental cooling of the valves, and with diminishing returns due to the 1940s components and technology.

At this time in the evolution of the engine, operators began clamoring for electric starters, vacuum pumps, generators, and other accessories that the original engine castings and components could not readily be modified to deliver. The tried-and-true combination of engine, prop, ignition, and carburetion proven on the earlier A-series engines could be called upon to provide power sufficient for many of the newer airframes being developed by Piper, Cessna, Luscombe, and others, but those objectives were becoming more difficult to achieve without major design changes. Increases in



Underside of a recently overhauled A80. Differences between A-series models are not generally distinguishable by cursory examination. Kidney-shaped oil sump identifies the series.

carburetor jetting and venturi diameter satisfied the need for air and fuel, advances in magneto technology provided retarded spark for easier starting, shielded ignition harnesses responded to more widespread use of avionics and communications equipment, and starters and generators provided power to initiate and sustain operation of the aircraft's systems as sophistication increased. However, the engine had reached (and, some would say, exceeded) the apex of its development. The A80 marked the practical limit of the original A50 engine and its sub-systems, but the same basic engine design would soldier on in its C-series reincarnation as the TCM engineers brought the engine from the 1930s into the postwar era.

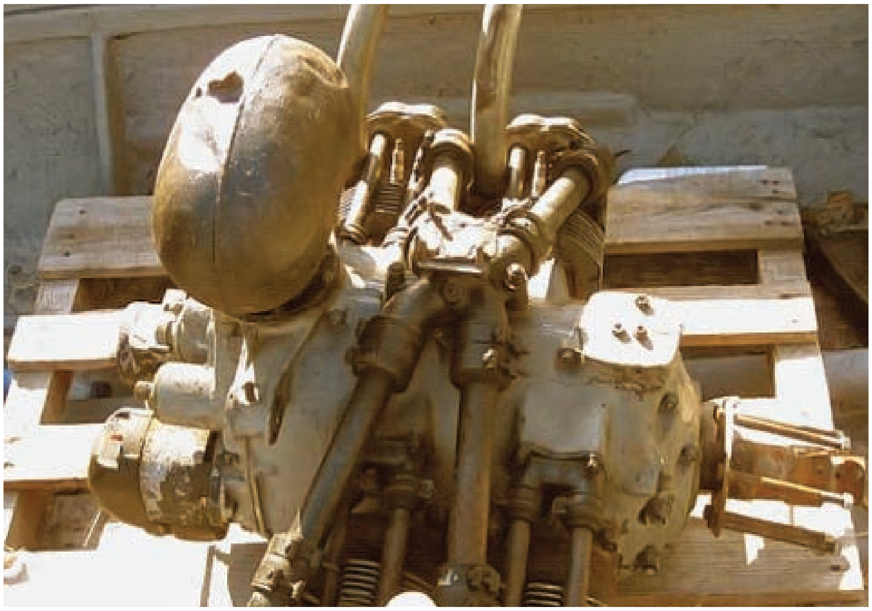
NEXT GENERATION: THE C-SERIES

Several variants of the A-series engine were fitted with accessory cases that included generators, starters, and vacuum pumps to drive instruments, but those accessories consumed power, so not many were thus fitted. With the C-series engines, the use of instruments and avionics had become commonplace in aircraft, and generators and vacuum pumps were required in the vast majority of certificated aircraft. In addition, electric starters were expected to be fitted to new aircraft just as they were on all automobiles. When engine compression increased in later years, starters would become essential for safe operation of aircraft, and nearly all new engines would be fitted with them.

The C75 and C85 introduced cylinders and pistons with a new bore diameter of 4-1/16 inch to the series, increasing displacement to 188 cubic inches and thus the O-190 designation. With the increased bore and displacement, the C75 could achieve rated power at an A65-like engine speed of 2275 rpm. The jump from the C75 to the C85 was easily achieved by simply changing the venturi and main jet in the Stromberg carb (or by using an approved model of Marvel-Schebler carb similar to those that would later be used in the C90 and O-200 engines) and operating the engine at 2575 rpm.

THE BRIDGE ENGINE: THE C90

The C90 has been held by many to be a standout in the C-series engines and an excellent match for many light-sport aircraft. It is somewhat of a bridge between the C-series engines and the O-200 in that it shares the same bore, stroke, compression ratio, and displacement as the O-200 but does not have the same crankcase castings, crankshaft, and many other components. The bore is the same as the C75 and C85, but the crankshaft is stroked to 3-7/8 inch to provide the 201-cubic-inch displacement that defines the O-200 class. Compression ratio is increased to 7.0-to-1, which is up from the 6.3-to-1 of the earlier C-series engines. Rated power is 90 hp at 2475 rpm, although takeoff power of 95 hp is available at 2625 rpm for a limited time (typically five minutes). C75 and C85 engines can be



A typical core engine as found in barns, shops, hangars, warehouses, and hanging on abandoned aircraft. This one is an A65 and was sold in "as is–where is" condition from an abandoned freight liquidator for $250. Dented oil sump is very common but can be corrected by pressurizing the sump with compressed air and gently heating the dented area with a torch until the dent is blown out.

converted to C90s, but the cost can be dear: The crankshaft, connecting rods, cam, lifters, pistons, rings, carb, and valve springs must be changed along with many other hardware items and operating adjustments. Starters and generators are typically fitted to the engines, making the C90 a strong, versatile powerplant for many light aircraft.

O-200: ENGINE FOR THE FLYING PUBLIC

There is one more page to the story, a page that closes one chapter in the proud history of the four-cylinder Continental engine and begins yet another: the O-200. With the burgeoning demand for large numbers of lightweight, affordable, reliable aircraft engines in the 1960s and following, Continental refined its classic engine into another standout in aviation history...the O-200. Together with the Cessna 150, the O-200 would go on to become one of the most-produced flying machines of all time, deserving a story of its own.

Oscar Zuniga, EAA 237232, is a builder, experimenter, and lover of engines of all types. This article was excerpted, with permission, from *CONTACT!* magazine, issue No. 102, *www.ContactMagazine.com*.

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