AIRCRAFT DESIGN TURBO BULLET

Turning the 201 into a higher flier

BY MARC E. COOK

Coldly efficient performance isn't every pilot's preference. Sure, airplanes like the Mooney 201 can provide outstanding speed and capability on a modest amount of horsepower; here the speed emerges from a small, slippery airframe rather than a large stable of horses at the other end of the throttle. Efficiency mavins point to the 201's ability to run in the mid- to high 160-knot range on about 11 gallons per hour, pat themselves on the back, and go about their business.

But some pilots like speed and climb performance in excess, and Mooney has over the

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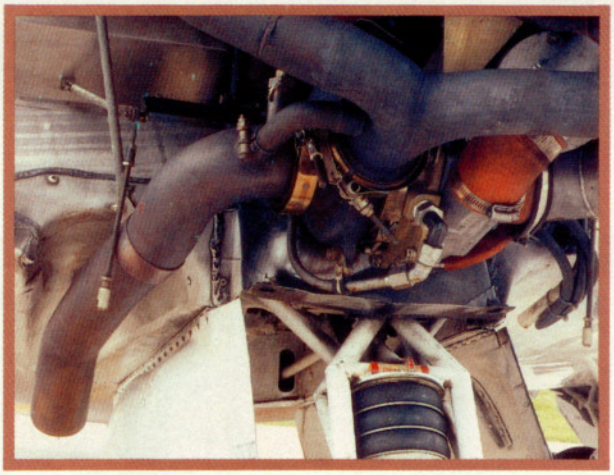
years catered to this desire with the turbocharged 231 and 252; though bringing only modest horsepower increases (to 210 hp), these turbocharged airplanes offer outstanding high-altitude speed and climb capability. (Only recently has Mooney stuffed hairy-chested power into the M20 airframe, in the form of the turbocharged 270-hp TLS.) High-altitude performance enables airplanes to top bad weather and terrain and makes for impressive true airspeed numbers at altitude; when Mooney introduced the 231 in 1978, it handily outsold the then two-year-old 201.



Typically, moving up to turbocharged performance means swapping airplanes, which can be a bitter pill if you already own a well-equipped airplane and are loathe to trade it in on a used model that could be chock-full of someone else's problems. Which is precisely the predicament in which Casey Silverberg of Marshfield, Massachusetts, found himself. He had logged about 250 hours in his 1988 Mooney 201SE when the urge for more speed gripped him like a vise.

"People buy Mooneys for speed, and I wanted more of it," he says.

Silverburg decided to take a demonstration flight in a TLS but decided that the big Mooney's performance edge was seriously blunted by sticker shock.

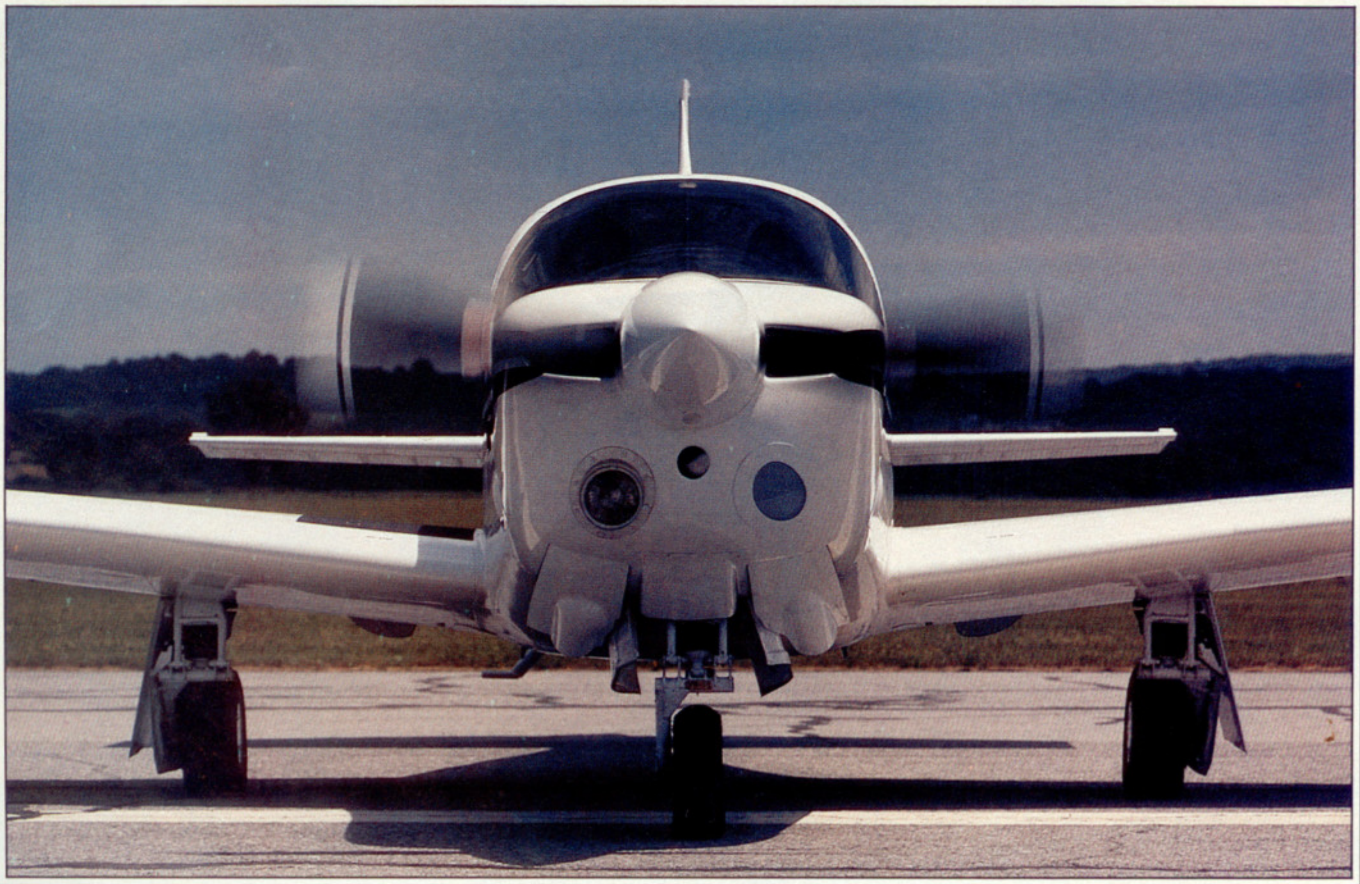
"Besides," he says, "I really liked my 201."

Silverberg then turned to Aircraft Design, Incorporated, of Spokane, Washington. Founded by two men formerly with Machen, Incorporated (notably purveyors of turbo system modifications, intercoolers, and engine swaps for Aerostar twins), ADI provides a bolt-on turbo system for Mooney 201s and earlier M20s. The modification carries supplemental type certificate approval for installation of a turbo system on the 201's four-cylinder Lycoming IO-360. (The turbocharged 231 and 252 Mooneys use the six-cylinder Teledyne Continental IO-360, while the TLS employs a Lycoming TIO-540.) This comprehensive package mates a Rajay turbocharger and associated hardware to the 201's engine, allowing it to make 200 hp all the way to 19,000 feet.

Benefits brought to the 201 by the turbo system are predictable—and just what Silverberg had in mind.

At low altitude, the modified Mooney performs much like its normally aspirated brethren. Up to about 8,000 feet, the turbo 201's climb rate and cruise speeds closely match the standard airplane's. Two tip-offs to the new hardware under the cowl are substantially greater than stock full-power fuel flow (because the turbo modification relies on fuel for cooling) and a lower noise level than the typical 201's (because engine redline has been reduced from the 201's 2,700 rpm to 2,575 rpm).

Continue the climb to high altitude, and the turbo 201 begins to strut its stuff. Full power is available to 19,000 feet, so the climb rate remains more con-



stant through the teens than would a 201's, which would begin to lose stamina rapidly at high altitude.

On our flight in the Turbo Bullet, climb rate tapered from 1,300 feet per minute to about 750 fpm at 18,000 feet. The day we flew with Silverberg was hot (about 15 degrees Fahrenheit above standard), but N928KC performed remarkably. Despite using a high, 120-knot climb speed (best rate for the 201 is 96 knots), the airplane managed better than 750 fpm to 17,500 feet.

Silverberg uses such a gentle climb rate largely for traffic avoidance and says that greater climb rates are available without cooking the engine. The system's maker, ADI, agrees: Maximum-performance climbs can be made at full power without running the oil and cylinder head temperatures into the red. This requires use of a low-boost pump in addition to the engine-driven pump to push more fuel through the motor for cooling.

According to an on-board fuel-flow computer, we were pumping 20 gph through the engine in climb; using the boost pump would add about 4 gph to that figure. (Silverberg's Mooney carries long-range fuel tanks, with 94 gallons usable, to help offset the turbo's thirst.)

Cruise speed at 12,000 feet takes a large jump over a stock 201's. At 33 inches of manifold pressure and 2,350 rpm—ADI's recommended setting for 80-percent power—Silverberg's airplane indicated 155 knots for a true of 189 knots, burning 13.8 gph; this fuel flow is very close to the maker's claims and the speed about 6 knots better. (ADI says that its performance testing took place on an earlier M20 and that late-model 201s are noticeably faster.)

A stock 201 at this altitude would be limited to 64-percent power and only with the engine spinning at its 2,700-rpm redline. True airspeed would be 161 knots on 11.2 gph, according to the pilot's operating handbook. A 252, by comparison, would be burning 12.7 gph for a 176-knot cruise at 78.6-percent power at 12,000 feet.

Using the same power setting at 17,500 feet, Silverberg's Mooney turned in a dazzling 206-knot reading in warmer than standard conditions. The stock 201's power charts stop at 14,000 feet, and there, with throttle and propeller fire-walled, it would slog along at 156 knots true on 11 gph. A 252's true airspeed should clock in at 185 knots on 12.7 gph at this altitude.

One caveat to go with the Bullet's heady speed: Though ADI claims the Turbo Bullet's engine carries the same 1,800-hour time between overhaul period as does the stock 201 powerplant, don't bet the farm on it. In most factory turbo installations, TBO goes down compared to similar powerplants without turbos, and historically, turbo engines are less likely to make their TBOs in the first place. Remember, you're asking the engine to make a higher percentage of its maximum power output more of the time than is true in a normally aspirated configuration.

We didn't take Silverberg's 201 into the flight levels, but because his airplane meets or beats ADI's performance claims at lower altitude, we see no reason to argue with the firm's other predictions. According to the company, the Turbo Bullet should run at 205 knots true at 24,000 feet, very close to the 252's showing of 202 knots at 28,000 feet.

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Every high-altitude flight ends with a long descent, and this is where the Turbo Bullet runs up against a typical turbocharging bugaboo. ADI recommends reducing power very gradually, on the order of 2 inches of manifold pressure each minute. In the Mooney, you would have to plan well ahead for the descent; the 201 is loathe to decelerate and descend simultaneously. Add in the needs of a turbocharged engine, whose life can be shortened by long, power-off descents, and you can see the necessity of advance planning. Silverberg's airplane enjoys Precise Flight speed brakes, and they are the saving grace here. Without them, expedient descents would be nigh well impossible without shock cooling the engine. Potential customers of this turbo kit should consider the speed brakes a mandatory addition to the package.

Part of the ADI kit is a manually controlled oil-cooler door. Opening the door admits substantial cooling air, and it seems to work. In climb, Silverberg occasionally had to close the door to keep the oil temperature in the middle of the green arc; the door should be closed for descent to help keep the oil warm. Even with this door closed, though, the Turbo Bullet's engine temperatures plummet during descent, despite keeping the power up.

Many subtle cowling changes have been made to accommodate the turbo system, the lion's share of which are to increase cooling airflow. Louvers on the cowling cheeks and alterations to the cowl flaps help pump more air to the engine and its accessories. A port adjacent to the landing light on the nose feeds cold air to the intercooler. What was once the ram-air door (a small port below the prop spinner) becomes a source of accessory-cooling air in the turbo modification. From the outside, these alterations provide the only clues that something other than a stock 201 powerplant resides inside the cowling.

Remove that cowling, though, and ADI's handiwork is plain to see. The turbo itself nestles under the engine against the fire wall; this location helps provide for short intake and exhaust tracts, which improve throttle response and the efficiency of the turbo. Pressurized air from the compressor side of the turbo runs forward to the nose-mounted intercooler and then around to mate with the fuel-injection throttle body at the lower front side of the engine. This view of the installation suggests that ADI took great pains to reduce the hardware count and to construct an elegant installation. (By contrast, the accessory case at the rear of the engine fairly bristles with oil lines, making oil-filter removal impossible without loosening one of these lines; chalk that up to the Mooney's pinchpenny-tight engine compartment.)

The ADI system goes further than bolting a turbocharger into place, though. With the kit comes low-compression pistons (reducing the compression ratio from 8.5:1 to 7.5:1), oiling system modifications, an overboost protection system (a pop-off valve), and an additional fuel boost pump. There is also a myriad of fuel system and fuel injector changes to trick the stock 201 setup into providing greater than stock fuel flows. Low-compression pistons help increase the detonation margin, says ADI. This approach is different from that usually taken with aftermarket turbo kits. Generally, these kits turbo-normalize the engine; in short, the turbo exists to help provide sea-level pressure to the intake manifold, which improves high-altitude power production. This type of installation often leaves too thin a margin for detonation (especially when the host engine contains high-compression pistons). The fact that turbos heat the intake air as they compress it also whittles away at the detonation margin and can make for a hot-running installation.

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In the Turbo Bullet, the combination of low-compression pistons and intercooler allow full power to be made on 38.5 inches of manifold pressure at 2,575 rpm. The 231's (and Turbo Arrow's) installation makes full power at 40 inches and 2,700 rpm. Such a reduction in takeoff rpm (from 2,700 in the 201) helps quiet the cabin considerably and reduces work load slightly in that the prop control can be left alone until reaching cruising altitude.

Other facets of pilot work load have increased with the turbo installation, though. Throttle management takes a smooth hand because the Turbo Bullet uses a fixed wastegate. A more sophisticated wastegate system—which would maintain a selected manifold pressure regardless of outside air temperature and density, engine rpm, and airspeed—would be too costly for a bolt-on kit. In the Turbo Bullet, the pilot must advance the throttle slowly on takeoff to not exceed the 38.5-inch limitation, and then advance the throttle during the climb to maintain a given power setting. With 200 hours on the modification, Silverberg showed that practice can make the process look easy; his power management was more accurate and smooth than was ours.

Handling of the three fuel pumps in the Turbo Bullet also requires some effort on the pilot's part. The stock engine-driven pump runs all the time, and the standard low-boost pump is used for takeoffs, approaches, landings, and some climbs, depending on OAT. So far, this is just like a 201. But when it's hot outside, the high-boost fuel pump must be called into play to keep enough fuel running through the engine for adequate cooling. How do you know when to use the pumps? Engine temperatures are the primary indicators, and so is fuel flow. Again, experience helps with this installation. Silverberg says he's never had to use the high-boost pump and that the low-boost pump comes off at the first power reduction.

Installation time is estimated at about 60 man-hours, less if an engine overhaul is accomplished at the same time; Silverberg's airplane was out for a week. This could add $2,000 to the basic kit price of $19,500, according to ADI; the firm will perform installations at its Spokane facility for about $2,500. Also, the company says the turbo installation should not affect the Lycoming's 1,800-hour TBO; obviously, keen operation of the engine will be the key here, with rapid, low-power letdowns to be strenuously avoided. Is the promise of high-altitude performance and great speed worth $20,000 and increased pilot work load? Silverberg thinks so: "I would do it again. Absolutely." Your decision might also come down to how important coldly efficient travel is to you. If other things, like going fast and climbing high, are more to your liking, the ADI Turbo Bullet modification might be for you. □

For more information, contact: Aircraft Design, Incorporated, East 5629 Ruttner Avenue, Post Office Box 11955, Spokane, Washington 99211; telephone 800/727-9173.