HIGHER FLYER

FliteCraft's Turbo-Flite system adds speed and capability to the Bonanza.

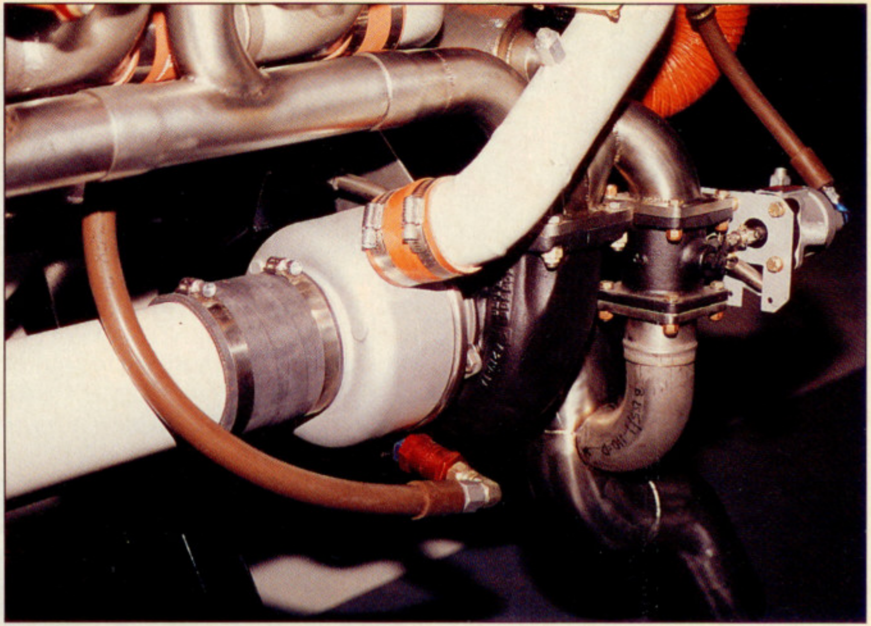
BY MARC E. COOK

For the right person, on the right mission, turbocharging is the great provider. It offers sustained climb performance, high-altitude capability, and all but eliminates worries about high-density-altitude takeoffs. Given the advantages, it's no surprise that factory turbocharging has been around in quantity for nearly three decades. Through the late 1970s, Cessna, to examine just one manufacturer, applied turbocharging liberally throughout the line, all the way down

PHOTOGRAPHY BY MIKE FIZER

to the fixed-gear 182 Skylane. In time, all the major airplane makers offered turbocharged singles; in many cases, these models outsold the normally aspirated versions by a hefty margin.

In the minds of most pilots, factory turbocharged aircraft—those with their turbo engines designed by Lycoming or Continental and installed by the airframe maker—live on a higher plane than those with aftermarket turbo systems. (Within that subset, those systems actually put together by the engine maker are more highly regarded than those tacked on at the airframe factory, à la the Cessna Turbo Skylanes and the early Aerostars.) A number of add-on affairs came to market in the 1960s, mostly based on the small and generally unloved Rotomaster/ Rajay turbocharger. These engines were turbo-normalized, in that the maximum boost remained at sea-level pressure, about 30 inches of mercury. Most factory arrangements, working with lower engine compression ratios, were boosted to as much as 41 inches of manifold pressure at takeoff. Aftermarket systems were not known to be overly reliable, often suffering from exhaust-system maladies and packaging problems in airplanes never designed to carry a turbo.



The Garrett turbocharger and wastegate reside the under pilot's side bank of cylinders.

FliteCraft Turbo, an arm of the Pagosa Springs, Colorado, fixed-base operation FliteCraft, went into the aftermarket turbo business understanding all the previous shortcomings of an add-on system. The company, run by the husband and wife team of Van and Mary K. Carpenter, has taken great pains to see that its systems work well, fit properly, and are serviceable in the long run. The Carpenters knew that an add-on turbonormalizer system would face some buyer resistance based upon history, but they figured that a conservatively designed and well-constructed system could be made durable. Besides, there is a large fleet of Bonanzas and Debonairs whose owners want greater altitude performance.

Currently, the Turbo-Flite kit is available for virtually all IO-520- and IO-550-powered Beech Bonanzas, including models 33, 35, and 36; a conversion to the 300-horsepower IO-550, under the Beryl D'Shannon supplemental type certificate (STC), can also be accomplished at the time of turbo installation. Overall, the turbo system adds about 30 pounds to the airplane. Modifications to some earlier Bonanzas can be performed after a D'Shannon upgrade from the IO-470 Continental to the IO-520 or IO-550. The company also has a kit for the Cessna Cardinal RG, and a kit is in the works for several Baron models.

All of these kits, installed under STC approval, are turbo-normalizers, limited via an automatic wastegate to a maximum of 30 inches manifold pressure, which maintains the original engine's horsepower. No internal changes are made to the powerplants, which means, in the case of the big-bore Continentals, they retain the standard 8.5:1 compression ratio. Most factory turbo systems use compression ratios of around 7.5:1 as a margin for detonation and achieve power through increased maximum manifold pressure. Turbo-Flite's system safeguards against damaging detonation in two ways. One, the fuel system is modified to provide great gobs of fuel into the engine during high-power operations, on the order of 35 gallons per hour at takeoff. Two, the induction air is intercooled, which helps widen detonation margins.

Using a Cessna T210–style turbo controller, the Turbo-Flite system behaves much the same at altitude.

At the Turbo-Flite's system heart is a Garrett AiResearch T06 turbocharger, a well-known and durable unit used in many aviation applications. This turbo is mated to an automatic wastegate. The absolute-pressure controller is similar to one used in the Cessna T210. Though not the most sophisticated type of wastegate controller, the absolute-pressure model works well in the Turbo-Flite installation.

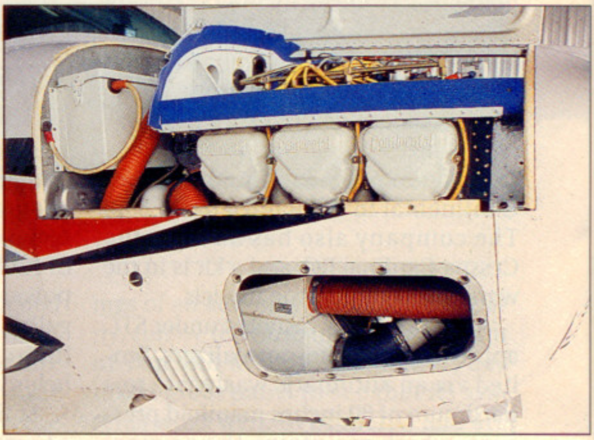
In the controller, a sealed diaphragm compares the turbocharger's output to a known setting—in this case, about 36 inches of mercury. If the upper-deck pressure, or the manifold pressure between the turbocharger and the throttle plate, should fall below this setting, the controller will command the wastegate, located upstream of the turbo, to close. This action sends a greater volume of exhaust gases to the turbo's compressor side and will cause the turbine wheels to spin up. In turn, this increases the compression of ambient air into the intake system. Once the set point has been reached, the wastegate modulates the turbo's supply of exhaust gases to maintain this upper-deck setting. Although the controller's set point is 36 inches manifold absolute pressure, intake system losses and pressure-drop through the intercooler mean that the manifold pressure arriving at the throttle body is limited to 30 inches. This is a straightforward system, with only one simple controller to do the work. A pop-off valve ensures that a failure of the controller or wastegate will not result in a catastrophic overboost of the engine.

The main drawback of the absolute-pressure controller scheme is that the turbo is being asked to produce boost even when the throttle has been pulled back to a much lower value, say far enough to provide 20 inches of manifold pressure, as would be the case on descent. Turbo-Flite has mitigated some of these shortcomings through intercooling, which reduces the intake-air temperature. Also, at the modest manifold-pressure levels of the system, the turbo isn't working as hard as it would be in a highly boosted application.

Easily as important as the quality of the hardware being used is the construction and packaging of an aftermarket turbo system. In the Bonanzas, Turbo-Flite has done an excellent job of keeping the hot parts away from the delicate bits forward of the firewall. Mounted low beneath the pilot's side bank of cylinders, the Garrett occupies a cavernous space compared to most turbo setups. (Take a gander under the cowl of a turbo Mooney or Piper Aerostar to see an example of tight, difficult packaging.) The exhaust system in most versions of the Turbo-Flite kit is high-quality 321 stainless steel with a wall thickness of 0.065-inch, thicker and better material than the vast majority of factory turbo systems employ. A large heater muff covers a cross-over pipe behind and below the engine; the exterior of the muff is covered with insulating material to both improve heat transfer—a necessity when it's 30 below at altitude—and to further protect the engine's accessory case.

On the induction side, the Garrett receives air through the original opening beneath the spinner and ducts it to the turbocharger's compressor section; except on the IO-550 conversions, which receive cooling louvers on the lower cowling, there are no additional intake ducts. The turbo's output is then routed to a folded-flow air-to-air intercooler located low in the copilot's side of the cowling. It receives cold air from the airbox plenum and releases it just above the right-hand cowl flap. Boosted induction air from the intercooler is piped to the stock Continental fuel-injection throttle body, still in its usual aft-center location. The remainder of the intake-air side of the system is stock.

Though Turbo-Flite doesn't make internal engine modifications, it does tweak the fuel system. Injector nozzles from the non-turbo engine are pitched in favor of nozzles with an upper-deck air reference—they are replaced with off-the-shelf TCM nozzles intended for turbo use. FliteCraft tests the nozzles to make sure they meet the specified fuel flows. Depending upon the engine being converted—the 285-hp IO-520 or the 300-hp IO-550—fuel pump modifications are made. On the 520s, the standard engine-driven fuel pump is replaced with one intended for turbo installations (it has an upper-deck pressure-sensing aneroid to control fuel flow). In addition, the 550s (which already have the altitude-compensating aneroid) get a special fuel-control rod in the pump that FliteCraft had designed for it by Continental. It is not a regular TCM part, and it contributes to better

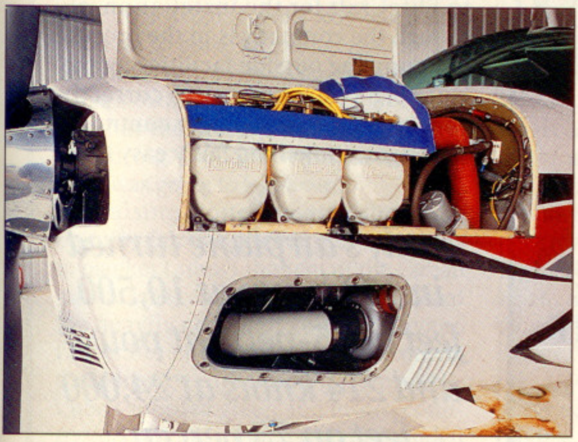


The intercooler can be seen behind the lower inspection panel.

Retaining before-turbo compression ratio, the Turbo-Flite system manages good fuel efficiency.

matching of fuel flow and manifold pressure in the 550-series installations. Finally, revised electric boost pumps come aboard—a pair of them for 12-volt airplanes and a single pump with two windings for 24-volt models.

Another part of the turbo upgrade is a revised cooling-air baffle arrangement. The usual Beech hanging upper baffles are replaced by what FliteCraft calls a closed bridge baffling system. Essentially, aluminum baffles are positioned between the cylinders' rocker boxes and the cowling to redirect cooling air more efficiently through the cylinder fins. In all cases, the standard cowl flaps are retained. The cooling-baffle mods can be purchased separately for nonturbo Bonanzas.



Installed in a V35 Bonanza, the Turbo-Flite system is barely visible.

Specifications are one thing, but performance is what sells, and the Turbo-Flite system performs well. We had the opportunity to spend most of a day at the controls of a FliteCraft-kitted V35, owned by George Braly of Ada, Oklahoma. He has what you might call the ultimate version of FliteCraft's various kits. To the 1967 airframe, Braly fitted the popular IO-550 upgrade and the McCauley Black Mac -409 three-blade propeller. Within a few hundred hours of installing the factory-remanufactured 550, Braly took the V-tail to Pagosa Springs and had the top-line Turbo-Flite 550 system installed.

We flew Braly's airplane from the recent AOPA Expo in Orlando, Florida, to his home base in southern Oklahoma. Our route took us from Kissimmee, Florida, to Auburn-Opelika, Alabama, for a fuel stop and then finally to Ada. Headwinds or no, we tried altitudes from 3,500 feet msl to Flight Level 240 and cruise power settings from 75 percent to 55 percent. In all phases of flight, the FliteCraft system worked smoothly and predictably. Temperatures were well controlled, with the cylinder heads remaining at or below 425 degrees Fahrenheit in the climb and typically running between 375°F and 400°F at high-altitude cruise; Continental specifies a maximum cylinder head temperature of 460 degrees.

As you might suspect, the Turbo-Flite's operating characteristics are much like a Cessna Turbo Centurion's. Throttle response is reasonably smooth, and there's little tendency for the pilot to overshoot desired power settings. At high altitude, the throttle response becomes a bit balky, and leaning the mixture creates large variations in manifold pressure. You must take your time managing the power up high, which is, frankly, true of any turbo system. Certification requirements called for OPEC-satisfying fuel flows at takeoff, but it has been Braly's experience that leaning to about 30 gph for takeoff will result in slightly better performance and no increase in cylinder temperatures compared to running full rich.

Additional high-altitude power over the non-turbo V35 does predictable things for performance. We averaged better than 713 feet per minute in a 120-knot climb to FL200 from near sea level. At low altitudes, the climb will easily exceed 1,000 fpm. Braly was still working out a climb-speed schedule for high-altitude work when we flew with him; in later flights, he reported that reducing indicated climb speed to 105 knots nearing FL240 improves the rate of climb to better than 800 fpm. We were able to maintain climb power (28 inches manifold pressure at 2,500 rpm) all the way to FL240.

FliteCraft predicts that a turbo-kitted IO-550 Bonanza will begin to overtake its normally aspirated sibling in 75-percent-power cruise by 6,000 feet, where typical speeds will rise from 176 knots to 179. By 12,000 feet, the turbo bird will true 187 knots; 16,000 feet will show 195 knots true; and 20,000 feet will return 205 knots or better. In Braly's airplane, we noted 174 knots at 10,500 feet on a slightly warmer than standard day, using 65-percent power, leaned to the peak exhaust gas temperature on the first cylinder to peak, and burning 13 gph. Our best speed occurred at FL240 on a 6° Celsius warmer than standard day: 75-percent power (17.7 gph, 50°F rich of peak) resulted in a true airspeed of 214 knots.

What's more, this Continental ran smoothly at peak EGT and 25°F lean of peak on 65-percent power or less. For greater power settings, we used a mixture setting of 50°F rich of peak. Typical fuel flows are: 25 gph in the climb; 17 gph at 75 percent, leaned to 50° rich of peak; 13 gph at 65 percent and leaned to peak; and 10.9 gph at 55 percent, leaned to peak. Operating slightly lean of peak will shave 1 to 2 gph from the overall flow.

These fuel specifics are very close to those of the normally aspirated IO-550, something quite unusual in turbo applications. This is largely the result of good mixture distribution within the turbo-kitted IO-550 and the retention of the standard compression ratio. Another often unsung advantage of turbocharging is the ability to run a lower engine speed for a given power setting, which greatly reduces cabin noise and vibration.

Such impressive and useful performance does not, however, come cheap. Including installation at Pagosa Springs, the turbo kits run from $25,600 to $33,900, depending upon how many of the various options you choose and which engine it will be applied to. At press time, you must go to FliteCraft for the installation, although the company is in the process of approving outside facilities for the work. The Carpenters are correctly concerned that the quality control be kept tight, something fairly easy to do within the walls of one's own hangar.

Braly's airplane turned in 174 knots at 10,500 feet at 65-percent power and 214 knots at 24,000 feet on 75 percent.

FliteCraft maintains an enviable concern for quality and supportability. Many of the earlier add-on turbos today are unsupported, with special parts, notably the exhaust system, in need of replacement and no one to make spares. Relatively few specialized parts are to be found in the Turbo-Flite system—the turbo, pop-off valve, controller, and wastegate are off-the-shelf items. This system even has the tacit approval of Continental; the warranty on factory-remanufactured engines remains intact. Indeed, many of FliteCraft's customers have brought in nearly new airplanes, many having just a few hundred hours on them. But the core buyer is the individual with a late-model V35, F33A, or A36 Bonanza who has decided the need for high-altitude performance is worth shelling out about $30,000. Just ask George Braly or the other 300 Bonanza owners flying behind the FliteCraft Turbo-Flite system. □

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