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EXPERIMENTAL AIRCRAFT AND POWERPLANT NEWSFORUM FOR DESIGNERS AND BUILDERS

Chevy Powered Wheeler Express

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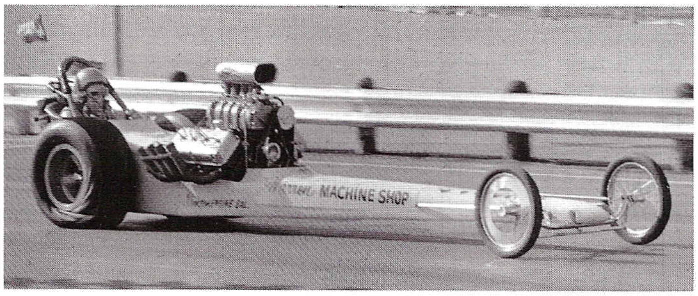
All photos courtesy of Bud Warren, unless otherwise noted.

Bud Warren built his first motor at age thirteen and since then has amassed an enviable record in the automobile racing community. His passion for speed was expressed by building and racing funny cars, race boats and most anything else with wheels. His successful Warren Machine Shop business supported these fun activities that grew with time. Airplanes appeared as a means of keeping his hands on the business while increasing his racing presence on the West Coast. But there is much more to Bud's credit: safety inspector for SEMA (Specialty Equipment Market Association); machine work on the NASA Gemini program; Commemorative Air Force aircraft restorer and pilot; licensed A&P mechanic. Bud began flight lessons in 1980. He has owned three Mooneys over time but around 1990, concerns over potential engine failures brought him to consider an automotive conversion. His Chevy powered Wheeler Express features his unique design of a gear-driven prop speed reduction unit (PSRU) which he refers to as a "transmission".

~Mick Myal



HOW IT ALL STARTED

In 1992, a friend approached Bud about the possibility of using a small block Chevrolet in his all composite four place "Wheeler Express" experimental aircraft. Bud was fascinated, saw a challenge, and set out to design and assemble an engine and redrive combination that would be safe, dependable, and affordable. As a certified A&P mechanic and former National Hot Rod Association (NHRA) top fuel dragster builder and driver, he was intrigued with the idea that an automobile engine could be successfully installed and used in experimental aircraft.

As time drew near to install the engine in the airframe, Bud found that existing redrive solutions were disappointing to him. His previous experience with chain and belt driven racecar components did not leave him with a lot of confidence, so the idea of using a chain or belt driven PSRU did not satisfy him. It was obvious to Bud that the weak link in automotive conversions was within the redrive unit itself; the technology needed to efficiently and safely transfer torque to the propeller. This concept set him to the task of developing a redrive "transmission" that would allow his Chevy engine to function in an aircraft in exactly the same way it was built to function in a car and at the same time reduce RPM to the propeller to achieve the best rate for efficient flight. This work culminated in the invention of his gear-driven, fully automatic centrifugal clutch, which is the basis for success with his geared redrive. After several years, Bud accumulated a following of local homebuilders who had been watching his progress and they began to encourage him to share this redrive with others. Bud eventually agreed to the commitment and began to offer his redrive to the experimental aircraft world. The original test bed aircraft, a Wheeler Express now owned by Bud (seen on the cover of this issue and in the photos throughout this article), can be seen at most airshows, still powered by his original Chevrolet engine and prototype Geared Drive™ unit.

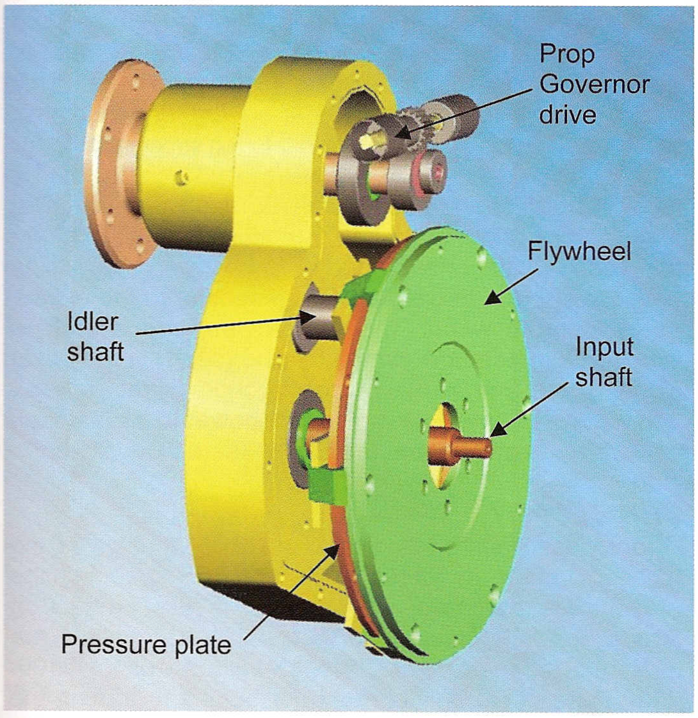
PHILOSOPHY

Operating an aircraft engine at an RPM that gives the highest amount of torque while not over-speeding the propeller is preferred. Horsepower is the product of torque and RPM and since conventional propellers are designed for maximum efficiency in the area of 2100-2500 RPM, there is little need nor benefit to turning the propeller any faster even if it does produce more power. Bud built his 383 cubic inch Chevrolet to produce the

Bud's plane on the flight line at AirVenture '06

most torque in the 2500-4000 RPM range, and his choice for gear reduction ratio is 1.562:1. This allows the propeller to turn at optimal RPM for efficient propulsion at a given speed, and runs the engine at an RPM that will allow it to also function efficiently, extending engine life.

There are many who are currently using automotive engines in their experimentals, directly driving the propeller off the crankshaft, and some of those folks swear by their design. Bud had reservations about this type of engine setup and mentions that almost anything will work for a while. It is true that direct drive works on certified engines. However, many may not realize that unlike aircraft engines, automobile engines have crankshafts with narrow main bearings and were not designed to bear the side and thrust loads that a propeller would apply. Certified engines have crankshafts that are shorter, stronger, and their main bearings are many times wider, simply put, designed to bear the load of the prop. On auto engines, the snout end of the crankshaft was designed and engineered to drive accessories only. Long-term success for auto engines in airplanes is determined ultimately by the ability to utilize the engine in exactly the way it was designed to be used in an automobile. Bud's redrive achieves this goal by driving the propeller off a short sturdy prop shaft through spur gears, and ultimately to the crankshaft by means of an input shaft, exactly the way an engine works with an automotive transmission.



CAD rendering of the PSRU assembly as seen from the engine side.

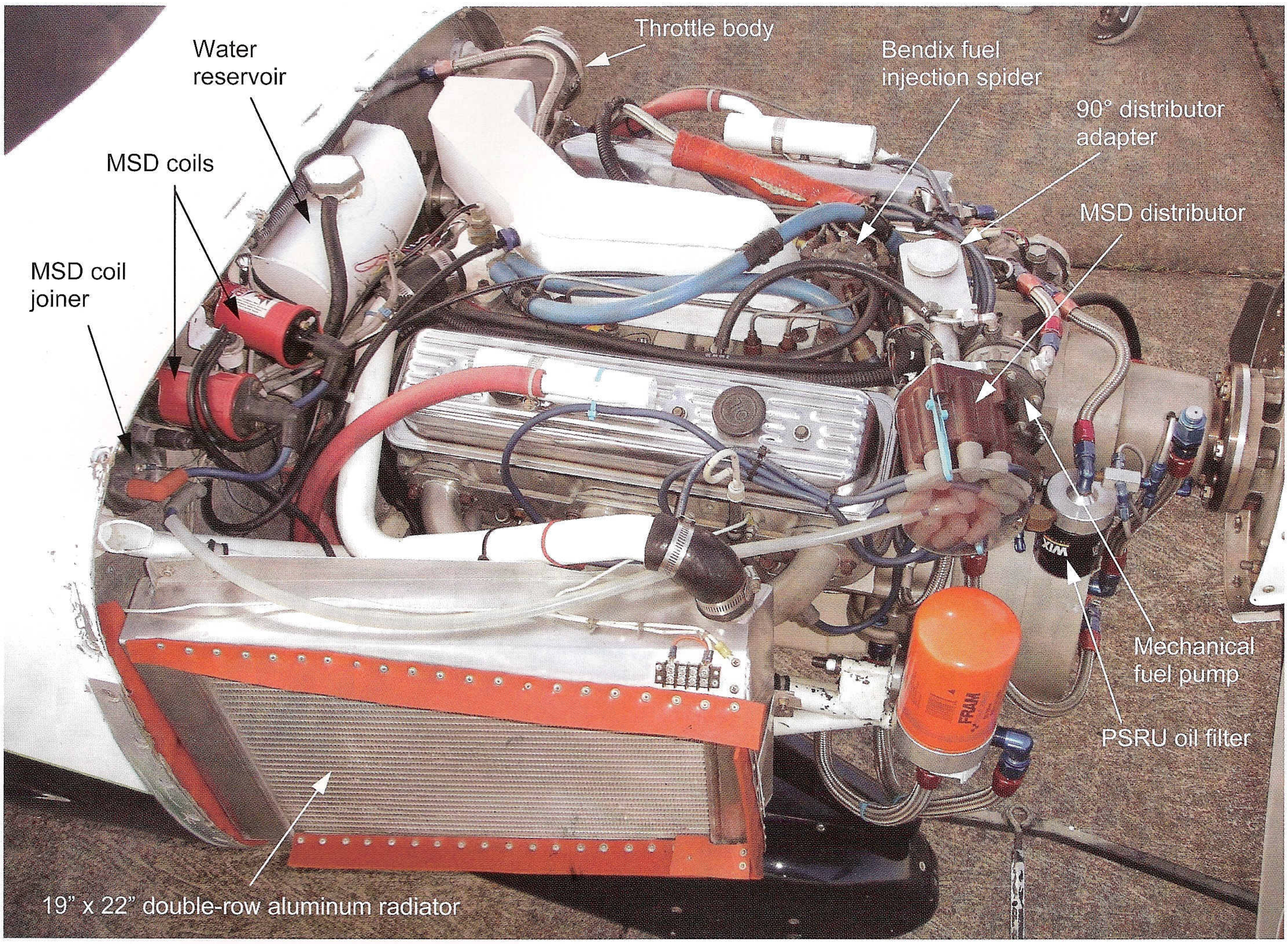
Bud believes that one should never exceed what the engine is happy with, in other words, what it was built and designed to do. He never pushes his engine past a very conservative combination of engine RPM and manifold pressure (3,900 @ 30" T/O and 3,300 @ 25" cruise) and sees great performance combined with low fuel burn.

BUILDING THE ENGINE

Bud chose Chevrolet for his engine platform because their engines are already performance proven and easily produce good torque and horsepower at moderate RPM. Because Chevrolet is an everyday household name, some people don't seriously consider it as an engine for an airplane, even though Chevrolet has won more awards and auto racing titles than any other make. No big secret; plenty of information is available to build a Chevrolet powerplant for an airplane. The old, time-honored way to bring one of these engines together is by custom-building your own engine using separate Chevrolet components. However, Bud has some simple guidelines for the avid homebuilder: stay away from racing builds. A visit to a racing shop can end up being a disaster if lacking some basic engine build jargon. These fellows are professionals and experts at producing maximum power at 8,000 RPM or more. Rarely will you find shops that build engines suitable for powering aircraft. Having said that, you might find a shop that understands your specific power requirements. Bud recommends the build of a "tractor" engine, another racing term for a conservative build.

Bud's recipe for a successful outcome are high compression heads with a ratio not exceeding 10:1 and choosing the smallest volume (combustion chamber) heads you can buy, having small intake ports, small valves and small combustion chambers. Your choice of camshaft should be very conservative with low lift and duration, and maximum torque achieved in the 2500 - 4000 RPM range. This camshaft keeps timing duration and lift short, producing high velocity flow and higher torque at lower RPM. Coincidentally, this combination is the least expensive to build.

The popularity of Chevy small-block engines is a result of its support by aftermarket parts vendors and their customer base. As a result, Chevy parts are generally less expensive and easier to come by than those offered to Ford enthusiasts. Because Bud did not choose Ford as his original engine platform is not an indication that he does not believe in Ford. Many are flying Ford engines currently with much success and Bud has already adapted his Geared Drive for 302 Ford V8s. In fact, Bud recommends Ford's V6 for those applications requiring 150-180 HP since it is both lightweight and compact. Throughout the automotive world, there are a wide variety of different makes of engines that can be adapted for successful use in an experimental aircraft.



Building an engine yourself or finding a shop that will build what you need can sometimes pose more challenges than it's worth and, thankfully, there is an alternative to "do it yourself" (DIY), which could be more attractive to the typical experimenter. A tip for the DIY'er, salvage yards are a good source for modern engines. Look for fresh wrecks, low mileage and all uncut engine wiring. But if you are really going for the biggest bang for your buck and time investment, you don't have to scour the salvage yards or try to build your own engine. You could go the easy and reasonably inexpensive route with a new Chevrolet crate engine. One choice could be a 400 horsepower V8 Chevrolet for less than $5,000. An outstanding buy, and all brand-new right out of the box, professionally built and usually with a warranty. An LS6 Corvette crate engine, which also produces around 400 HP, can be purchased for around $5,500. Additional money will, however, be needed to buy the electronics and engine wiring harness that do not come with most crate engines but are available on the aftermarket.

ENGINE SETUP

Bud's Chevy engine has been flying in his Wheeler for a little over three years to date. He admits his setup is old technology, as it is an early style 350 engine with a stroker kit, producing 383 cu in. Bud knows these earlier model engines inside out, and prefers them because he says they are just a little bit lighter weight than later model engines. His 383, complete with all accessories, (less propeller and radiator), weighs in at 454 lbs. and is actually lighter than a twin-turbo'd IO-540 that produces 100 HP less than the 383. Two MSD ignition modules reside inside the cabin with two MSD ignition coils (mounted on the engine side of the firewall) and an MSD distributor. The latter was modified to reduce cowling clearance by a custom 90-degree rework of the distributor shaft and its seals. This modification hides the distributor body between the engine valve covers. Later model EFI engines do not have distributors, which allow a neater installation and engine compartment.

Only one set of plugs in this engine. Attempts by others to add a second set of plugs to a set of Chevrolet heads have resulted in cracked combustion chambers and other problems. Sparkplug redundancy is an area that Bud is not concerned about, as his experience is most modern automotive engines in good repair just don't have problems with fouling spark plugs. Even so, Bud says, foul one or two plugs with a V8 engine and you can still fly to safety with six or seven cylinders still firing. The engine might run rough, but it will run. To date, with 660 hours on the engine, Bud has had no spark plug fouling issues or any other issue related to using a single plug wire per cylinder and a single distributor.

Left: Radiator intake. Middle: Front view of cowl showing radiator inlet and fresh-air scoop. Right: Fresh-air intake.

COOLING SYSTEM

Bud runs a 19 x 22 inch, two-row radiator that he purchased from a sprint car racing parts supplier and has no problem with cooling. He used an old racing trick that he says increases the radiator's cooling capacity by splitting the water tank on the radiator, blocking it off to allow the water to make one more pass through the cooling tubes; he says he gets one third more cooling capacity than he would have otherwise. Originally, Bud tried taking in air through the stock Wheeler intake openings. These were rounded and quite close to the heads, which apparently kept any air from entering the cowling. After much scratching of head and wiping of brow, Bud blocked off these round openings and installed a small side scoop on the cowling to route air over the radiator coils. This did the job. The actual opening of this side scoop is smaller than what is used on some of the LSA types using a lot less power. A coolant header tank, mounted as high in the engine compartment as possible, is used to purge air in the cooling system. Both temperature and pressure gauges monitor this. A drop in water pressure will show on the gauge and give a pilot enough time to descend and land safely before any damage is caused by any potential leaks. Bud does not use a thermostat in order to avoid boil over problems from a sticky thermostat, which would be hard to deal with while flying. He simply removes the thermostat center and uses the outer ring for gap sealing and to slow the water flow a bit through the system. 40° OAT renders 175° water temp

Another little trick that Bud uses is to route two water lines off the thermostat housing, drill and tap two holes in the opposite end of the intake manifold water jacket and install fittings, thereby attaching two hoses to the fittings. This helps with engine cooling as it allows cool water to circulate more uniformly in the engine.

CARBS vs. EFI

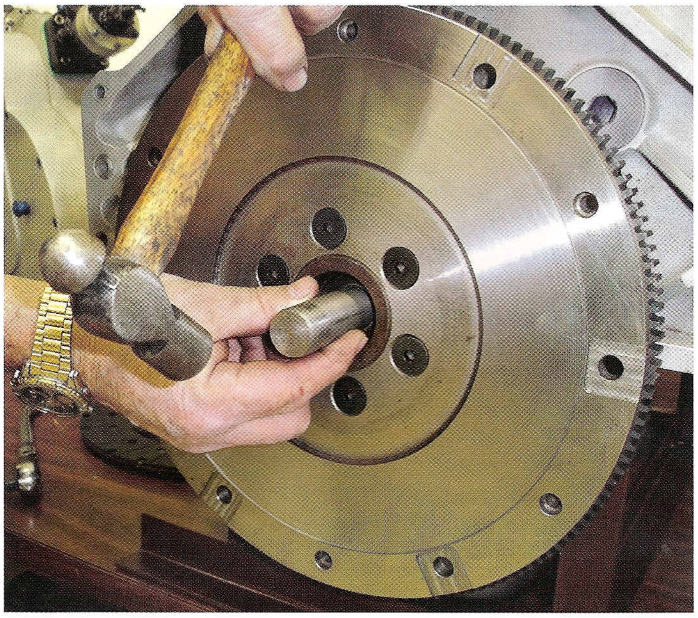
Bud has no strong opinions either way regarding fueling methods. Carburetors are simple devices and require little attention if properly maintained, however carburetor icing can be a factor to consider. Standard aircraft fuel injection systems are indeed old technology, but are dependable and eliminate electronics. Bud chose to use a Bendix aircraft system in his Wheeler when he originally built the engine because this technology was familiar to him and he knew it would be trouble free. Stock EFI would be a good choice and has the added benefit of automatically adjusting for altitude. Any system you chose can work just fine, just be sure to know your system, its drawbacks and how to use it safely and properly.

TURBO vs. BLOWER

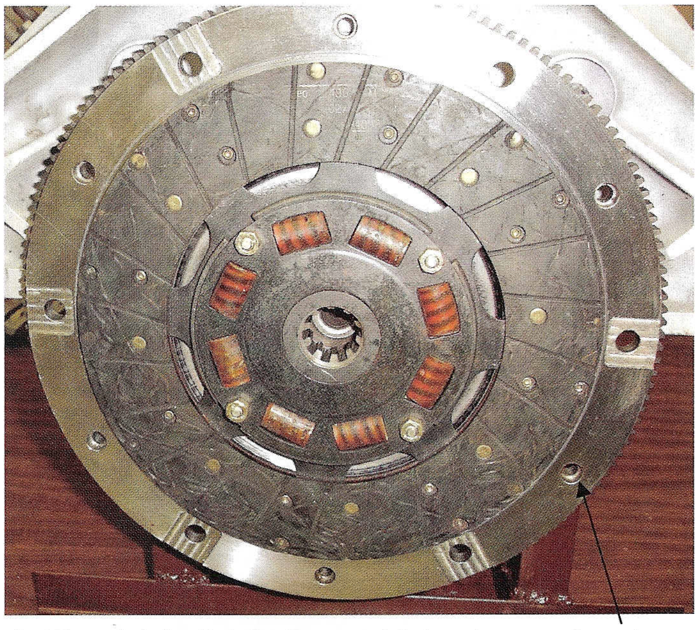
Bud has some strong reservations about turbochargers installed in experimental aircraft. His personal and rather strong opinion is that it is not safe to have a "white hot flaming ball of fire" under the cowling. His strong opinion arose from hands-on experience as a certified mechanic. Turbos are expensive to install and maintain and, by their very nature, can shorten engine life. Bud is, however, an advocate for blowers (belt-driven superchargers) and says that if they are properly setup they should not have a negative effect on engine life. Superchargers were standard equipment during his racing days; he has plenty of good experiences from which he draws confidence, and as such he's an advocate of their use. According to Bud, you can supercharge a Chevrolet race engine for $3,000 compared to the cost of turbocharging that can reach as high as $20K (for a twin turbo, intercooled system) mainly due to the necessity of a rather expensive and exotic exhaust system required for use with a turbocharger.

REDRIVE SOLUTION

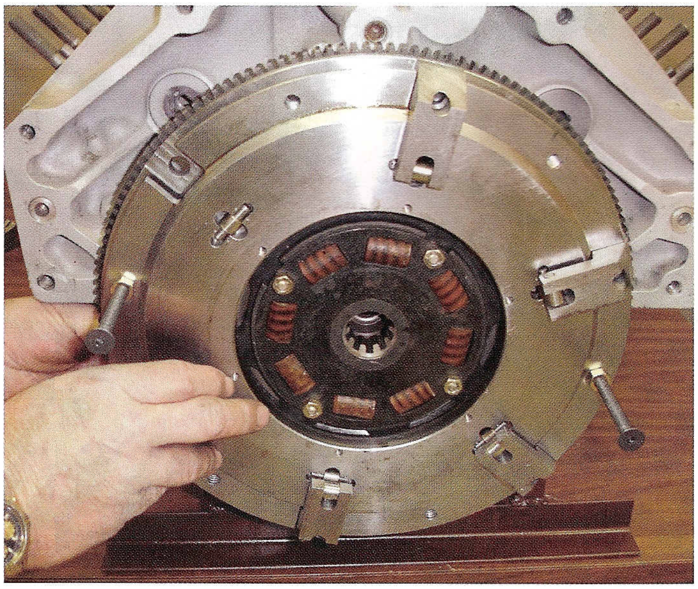
Bud set out to design and build a redrive that he could be confident in flying behind, but this proved to be a huge challenge. Bud's original geared redrive design was not very successful. A marvel of design in billet aluminum, it looked great from a machinist's point-of-view. However the case was made up of five pieces and consequently it leaked oil, even after many attempts to keep it from leaking. Despite these leaks, the redrive was tested on the engine to see how the design would perform. It proved successful and functioned exactly as intended but the gearbox and engine combination produced tremendous issues with starters. Starter life expectancy was bleak as it was obvious that the starter would not be able to hold up against the inertial resistance of the constant-speed propeller and the geared redrive.



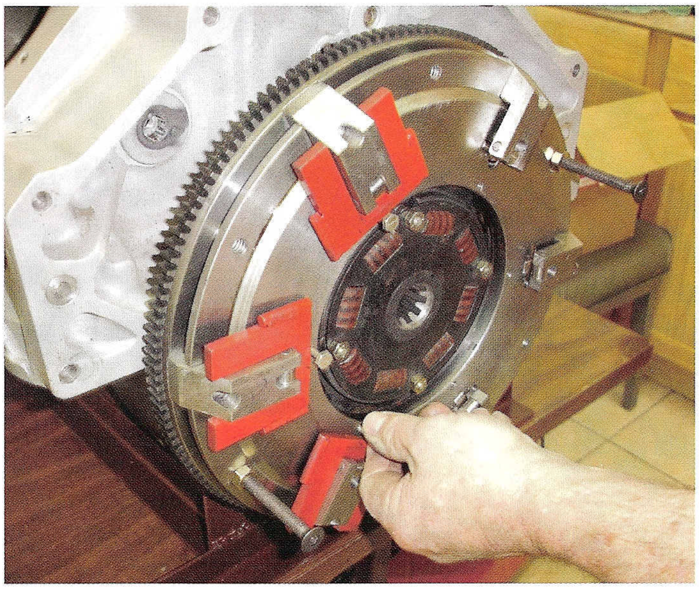
1. After torquing the flywheel in place the pilot shaft bushing is tapped into place.



2. The clutch disk is then set into place and springs (not shown) are installed into perimeter holes .



3. The pressure plate is then installed and secured by L-shaped brackets that will later act as a fulcrum.



4. Counterweights are attached to the L-brackets, completing the centrifugal clutch installation .

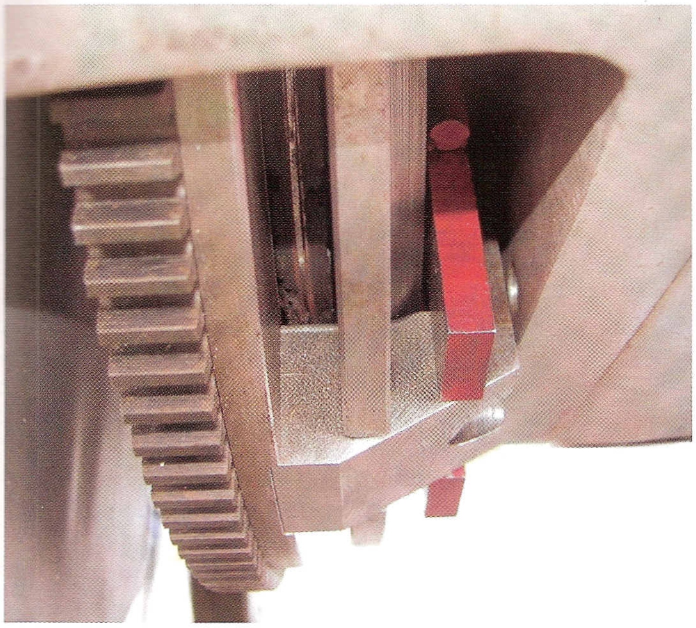
This problem was unacceptable and required a cure. Eventually, a solution based on heavy-duty engine clutch experience in Bud's top-fuel race cars came to mind. These cars utilized a flywheel and several heavy-duty clutch discs, the latter being effective but not adaptable to the aircraft redrive solution. What would solve the dependably problems (in a rather crafty manner) was an automatic clutch that would replace the slipping, sliding, friction action of the racing clutch. Bud came up with an elegant design that connects the engine and flywheel to the redrive, gently and quietly engaging the propeller at low RPM once the engine is already running. The automatic clutch is tuned to remain disengaged at dead idle and become engaged with an increase in power. Engagement under all flight conditions is positive. Bud comments that people were astounded by the operation of the redrive. One of the most common questions asked was whether the clutch would disengage during flight, and the answer is that it will not. Upon startup, the propeller engages once the engine RPM reaches around 1000, in a fluid and smooth action that is virtually imperceptible. The counterweights engage due to centrifugal force, and remain engaged while in flight, after landing, and all the way to the hanger; they will not disengage until the engine stops spinning. The automatic clutch simply will not disengage until the aircraft is on the ground and the engine is not running.

Consider this: you are flying along at altitude, you run one tank dry and the engine quits firing. Of course, no one has ever done that but in this case, it is a non-event. Just switch to another tank and your engine restarts instantly because the propeller and engine are still turning, just as they do with any direct-drive, certified air-cooled engine. The cylinders are not loaded up or flooded, and the engine will start again.

The redrive, less flywheel, weighs in at 63 pounds and requires the use of the flywheel to dampen engine impulses. Bud does not offer any "extras" to purchase with his redrive, as his design is simple, effective and complete. It also doesn't require any engine modifications for use. The unit is merely a bolt-on to the engine and is easy to install. Bud publishes his installation manual on his website for all to see.

HARMONIC ISSUES RESOLVED

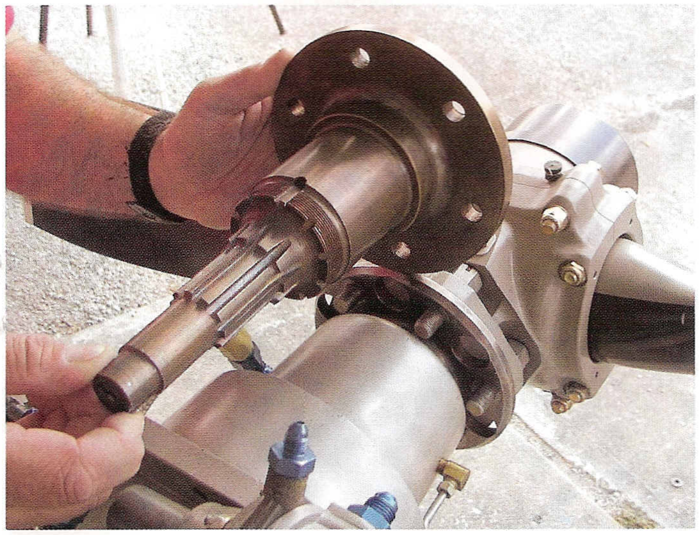
One of the big problems in any auto engine conversion is the matter of harmonic vibration which is a natural result of reciprocating engines. Simply put, the crankshaft is subject to firing pulses. These vibrations are moderated by a harmonic damper, custom-built to match specific inertial forces installed at the opposite end of either a manual clutch plate, or by the fluid coupling of the automatic transmission. Removing the transmission prior to installing the engine into an aircraft leaves one with the resulting issue of how to dampen these harmonic vibrations; half the tuned system is gone. To solve these issues in an experimental aircraft, solutions such as flex plates, elastomer donuts, driveline couplings, sprag clutches and other devices have been used; some of these dampening techniques were tried out in Bud's earlier redrives but most offered unsatisfactory results.



A view from the underside of the redrive exposes the assembled centrifugal clutch mechanism, consisting of a counterweight attached to an L-bracket fulcrum. Rotation over 750 RPM causes the six counterweights to apply a uniform load to the pressure plate sandwiching a traditional-style clutch disk between the pressure plate and the flywheel.

His redesigned and refined prototype has been proven in 660 flight hours to date and over 1,000 takeoffs and landings in his Wheeler Express. Bud flies to the air shows to demonstrate the performance and operation of his engine and redrive to other homebuilders. He thinks it makes sense to show others that he believes in his redrive by actually flying one in his own airplane. His opinion is that he personally would never purchase any aircraft components from any designer or builder unless they stood behind them enough to put their reputation (life?) on the line by flying their own products on their own airplanes. Don't be fooled though; he doesn't just go to the events to show-off his airplane and his redrive. He simply loves to fly this airplane and loves to demonstrate its performance to others, sales notwithstanding.

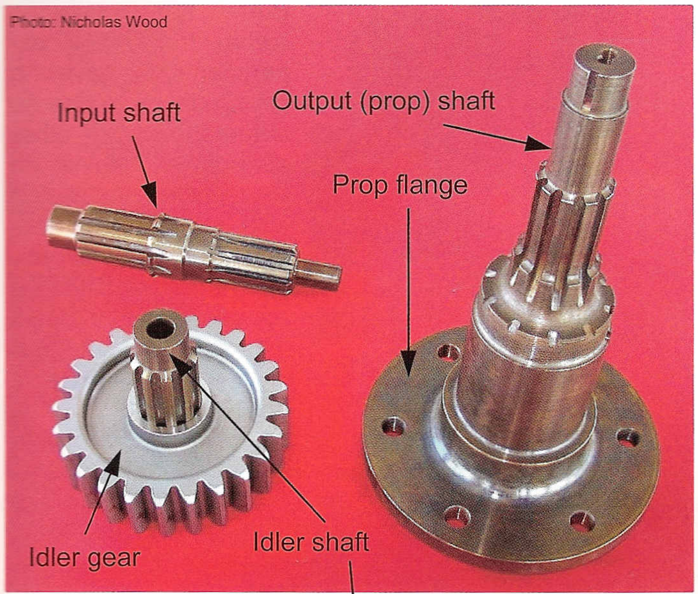
TBO of this redrive is expected to be extensive. Since the automatic centrifugal clutch operates in an off/on mode, Bud believes this component should last the lifetime equivalent to that of a new engine. This redrive multiplies torque to the propeller and does not impart any side loads, thrust loads, or end loads from the prop back to the engine crankshaft. After exhaustive research and days spent in the Rice University patent library, no similar device was found to have been issued a patent, so it would appear likely that a patent would be issued for the redrive and its unique features.

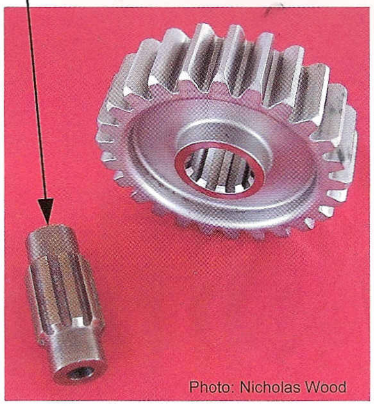


REDRIVE COMPONENTS

The three-gear layout places the prop 7-11/16 inches above the crankshaft centerline which increases prop clearance and fits most airplane cowlings originally produced for Lycoming or Continental air cooled installations. The standard prop rotation is maintained. The aluminum redrive case is assembled in two pieces. The parting line has an embedded O-ring, which prevents any oil leakage. All bolt attachments are reinforced with Helicoils, eliminating the chance for pulled threads. Eighteen bolts secure the front redrive cover, more than sufficient to resist prop thrust loads.

The redrive utilizes three premium (and expensive) spur cut gears: drive, idler and final drive, all built to Bud's specifications. Gear profiles have a smooth finish, kind of a frosted look prior to being used in the redrive. This combination has several advantages: spur gear profiles are stronger than helical gear profiles; there are no added issues with bearing end thrust loads; each gear has its standard tooth profile modified by a machined crown shape that optimizes tooth dynamic loads; and spur gear noise is not an issue with end users in the airplane environment. Proper backlash is critical and is set when the redrive is assembled by use of eccentrics on the idler gear shaft. In the event that a customer changes his mind about his gear ratio, it may be changed by shipping the redrive back to Bud for the cost of actual labor, materials and shipping.

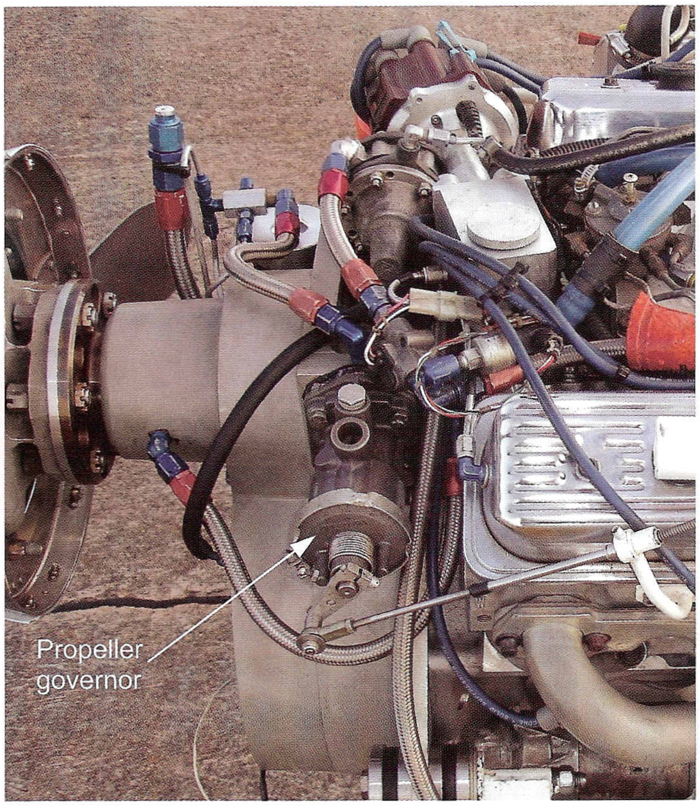




The main shafts (both input and prop) are made from premium stainless steel (17-4 PH) and heat-treated at 900° F, producing a tinsel strength of 195,000 PSI. This all but ensures an infinite fatigue life with no potential for cracking. The heat-treating process turns the stainless steel to a warm bronze color and causes it to resist rust and corrosion.

The redrive has a separate lubrication system with its own independent oil supply and oil pump, which forces oil through a filter before circulating the lube at 60 PSI through all of the bearing surfaces, shafts and gears with every turn of the prop. Lubrication is achieved with success as long as transmission grade 75W 90 oil is used in the redrive unit. Bud's opinion is that the kiss of death for an airplane engine and redrive is for the two to share engine oil. He insists that engines do not like gear lube, and gears do not like engine oil. Other than the typical visual inspection of lines and fittings, etc. maintenance of the redrive consists of changing the oil filter and checking the lube level every 100 hours. Standard 30W HD auto engine oil is Bud's choice for engine lube.

Bud tried five different types of synthetic transmission oils in the testing phase of his redrive. Each synthetic lubricant tested caused overheating and all were found to be inferior for use in this application. In fact, Bud will not honor the warranty that he offers on his redrive unless the non-synthetic, 75W 90 or 80W 90 gear oil is used. This is the same type of lube used in automotive differentials across the world and works perfectly in this redrive. This gear lube has been proven to produce minimal noise and heat. For example, with 75W 90 in the redrive, Bud flew his Wheeler in the Homebuilt Parade at Oshkosh AirVenture 2006, in 100+ degree F weather. The temperature gauge for the redrive oil temperature climbed to 150°, then at cruise around the patch, leveled out to 140°



The PSRU comes ready to install the prop governor of choice. This Woodward unit is installed inverted.

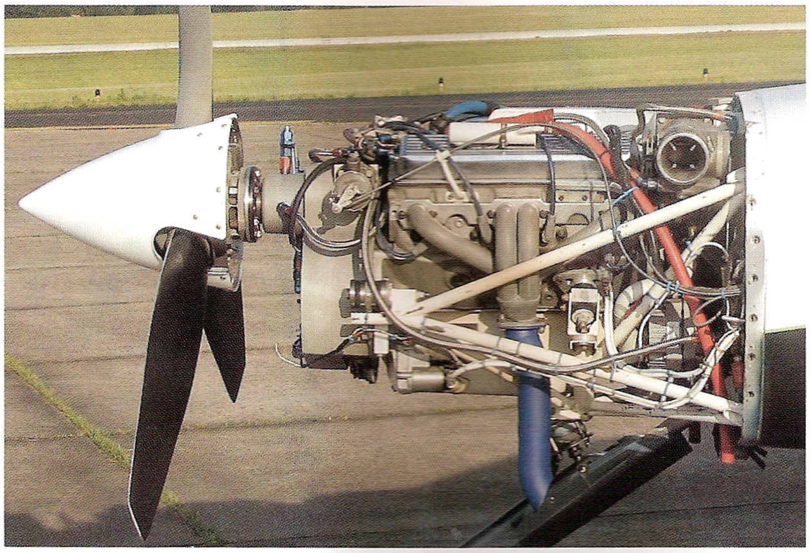
The redrive has a geared boss on the side of the case which allows a standard aircraft governor to be mounted in the normal location off the prop shaft. The governor mounts upside down, which does not affect function at all. Many certified aircraft mount their prop governors in this attitude so it does not pose any problems. Since prop governors are standardized and share the same mounting pad, the redrive will accommodate all brands of governors.

No blast tubes are required, no oil coolers, or anything beyond reasonable air circulation under the cowling has proven to be necessary to keep the redrive running cool. The operation of Bud's PSRU is smooth, quiet, and doesn't produce heat, indicating an efficient design.

PROPELLERS

The propeller of choice on Bud's Wheeler is a three blade 80" prop cut to 78" for just a bit more clearance. "I personally like a three blade prop with a high horsepower engine because it gives you a little bit more climb. If the engine horsepower is not real high, I go for a two blade."

As far as propeller manufacturers are concerned, Bud says you can put just about any propeller you want on his transmission. "I prefer to install a Hartzell on my plane, but there are many companies that make good propellers. However, I think you get more bang for your buck with a constant speed prop than you do a fixed pitch, although my redrive will work with either equally well. I just believe in constant speed propellers because you can get better efficiency out of it; you can climb a little faster and cruise with better economy."



Side view of the subject engine, showing the location of the prop governor and a good overall view of the engine mount.

The PSRU will also work well with beta-mode capable and self-feathering props. Feathering is achieved because of the constant oil supply to the redrive, which means that an oil accumulator is not required. In the event of an engine failure, the prop will still turn and positive oil pressure still exists. In theory, one could install a prop capable of beta-mode and put it in reverse to back up if so desired.

The PSRU lubrication system including oil filter and high-volume oil pump.

Bud's "transmission", as he likes to call it, will work with Hartzell, McCauley, MT Propellers, or virtually any other propeller that is chosen for use. Since these redrives are built and assembled with the individual aircraft and application in mind, propeller shaft flanges can be drilled and/or lugged to accommodate any bolt pattern in addition to SAE-1 and 2.

PERFORMANCE

Bud is completely satisfied with the performance of his 383 Chevrolet. Initial climb out is 4000 FPM plus. Since Bud's home airport is close to sea level, manifold pressure on run up indicates 30 inches. At 11,000 feet altitude, the engine still is pulling 19 inches manifold pressure. In keeping with Bud's philosophy of not working the engine hard, his engine and redrive combination produces 3,900 RPM on take off, with cruise around 3,200 engine RPM. Consequently, the prop turns an ideal 2,500 RPM on take off. At cruise speed with engine RPM of 3,200 RPM, the prop turns around 2,100 RPM. Fuel burn for Bud's Express is typically at 15 GPH or less (cruise), and clocks about 180 MPH.

ENGINE MOUNTS

Bud has become aware that many experimenters have a strong desire to use an automobile or other alternative engine in their experimental aircraft, but find that considering such an endeavor (especially if it's not supported by the kit manufacturer or designer), can create a boat-load of challenges. Many do not have the knowledge or ability to personally build an engine mount for their engine/airframe combination, nor do they have access to anyone else who does. Necessity being the mother of invention, Bud offers custom engine mounts for individual experimenters and is currently designing engine mounts for many of the popular kits. This ability comes from his racing days and experience in building racecar chassis for high performance racecars, so building engine mounts is second nature.

Bud is a master machinist and certified aircraft welder with many years of design and troubleshooting experience to his credit, both in the aviation and in the automotive world. At his home FBO, Bud is known as the "go-to" person when it comes to fabricating anything that has to do with an airplane. Locals know him as the person who can repair anything from certified engines to automotive engines, to airframe and lots in between. In fact, Bud totally restored a Consolidated-Vultee BT-13A Valiant, sponsored and flew it in air shows for three years. This airplane still exists within the organization that we know of today as the "Commemorative Air Force"* and has been customized to look like a Japanese Val bomber. At the time, this airplane was considered the fastest airplane in its class within the organization. This Val still carries the words "Lovingly built by Bud Warren, master craftsman".

**The Commemorative Air Force (CAF), formerly known as the Confederate Air Force, is a Texas-based non-profit organization dedicated to preserving and showing historical aircraft at airshows primarily throughout the U.S. and Canada.*

With form following function, the cockpit of N901RC is fully appointed as a traditional IFR machine with everything right where it should be, in addition to being comfortable and as attractive as the exterior would suggest.

TEST-BED AIRCRAFT

The proof-of-concept airplane is a four place, fixed gear, composite airplane called a Wheeler Express. This airplane weighs in at 2100 lbs (empty) and has a gross weight of 3200 lbs. It was originally purchased as a Wheeler C/T kit; however, prior to the airplane being completed there was a deadly crash of a Wheeler C/T which stopped other kit owners in their tracks. Wheeler owners apparently got together and consulted an engineering firm which determined that the tail surfaces for the C/T were simply not large enough for proper control and safe flight. Prior to completion of Bud's Wheeler, the more substantial tail-section for the newer model Express was purchased and took the place of the smaller C/T tail section. The resulting conversion makes the plane handle and fly well, and does not have any control weight issues with full capacity.

Bud's handiwork: A restored Vultee BT-13A, modified to resemble a WWII era Japanese Val bomber, now a part of the Commemorative Air Force.

"This is a working airplane," Bud says. He spends so much time with his customers and their projects that he doesn't have a lot of time left to work on his own plane. Performance and safety being the main concerns, his efforts go into the continued development of the design and function of the automotive conversion, which he loves to share with others. Bud is a humble man and is happy to share his experience with others. He says, "I'm glad to tell anybody all the information they need to know. I keep a telephone in my ear all the time and if people call me to pick my brain that is fine; I am happy to share information".

"I help people who are not even my customers. I just believe in trying to help people get these airplanes flying with auto conversions because I know that they are going to be a lot happier. I just like to get there fast, not spend a lot of money, and get back safely. I think a lot of other people want to do that too."

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