From: Veeduber
Date: Wed, Dec 25 2002 11:41 am
Groups: rec.aviation.homebuilt

To All:

Christmas sometimes brings a call from a homebuilder who has read one of my articles or seen an ad in an old magazine and is convinced I'm the best person to build an engine for their Dream Machine. For the last twenty years I've always told them ‘no.'

I used to build engines for sale; had an ad in ‘Sport Aviation,' went to all the air shows. Waste of time, pretty much. I put the prop on the wrong end and do a lot of modifications others say aren't needed. Plus, my engines were never as powerful as the ones built by the other guys. But they seemed to hold up rather well.

This year the call came on Monday, 23 December 2002. The fellow wanted a simple engine, a plain vanilla sixty horsepower power plant based on VW components. He wanted direct drive; in fact, he'd already bought the propeller. To keep down the cost and make it easy to overhaul, he wanted it to use the standard 69mm crankshaft and 85.5mm jugs. It was for a Texas Parasol and there are several flying with exactly that engine, which has a displacement of 1600cc.

The call represented a major decision on his part. Months of thought and careful savings had culminated in this Christmas Present to himself. I could hear the disappointment in his voice when I told him I'm too busy right now. I suggested he contact someone else. But he was insistent, willing to wait until I wasn't too busy. His disappointment became tinged with anger when he realized I simply didn't want to build him an engine. I've a hunch he thought I was trying to jack up the price; you could feel the tension mount as the silence grew. Finally, I told him I don't know how to build a sixty horsepower 1600cc engine. Perhaps someone else could but I can't get that much power out of 96 cubic inches when there's a prop on the crankshaft. His anger vanished, replaced by confusion. How much power COULD I get?

"Maybe thirty-five, forty... somewhere in there."

Now he sounded amazed. Clearly, there was no secret to getting lots of power from a VW engine. He started to rattle off horsepower figures from several other engine builders until I stopped him.

"I guess I'm just not as good a mechanic as those other guys," I said. He thought about that for a moment then wished me a merry Christmas and rang off.

In a way he was right. There's no secret to getting lots of power from an internal combustion engine. Sir Harry Ricardo literally wrote the book on it shortly after World War I. Since then the only things that are truly new are thermal barrier coatings and some improvements in metallurgy, the basic principles - and the equations defining them - remain unchanged. Using those

principles I've built VW-based engines that pulled over 200hp on the dyno, good enough to see low twelves on the drag strip.

The problem I have here is that you've got to spin a 1600cc engine nearly five thousand rpm to see an output of sixty horsepower. And you can only do that for about a minute before the CHT runs into the red and you have to let it cool down for half an hour or so before you do another pull. Fitted with a blower, tightly shrouded, and installed in a car, you can get away with calling it a sixty horsepower engine. But a car engine isn't an airplane engine.

The reality of airplane engines is conversion of torque into thrust. You may insert horsepower into that equation if you wish but it serves no practical purpose. When the task is generating thrust using a fan bolted directly to the crankshaft, torque is the critical factor.

For an internal combustion engine, particularly a carburetted Otto-cycle engine, maximum torque occurs at the point of maximum volumetric efficiency. You can fiddle with the cam and induction system ‘til the cows come home trying to improve the VE but with a displacement of only 96 cubic inches, normal aspiration and a compression ratio you can live with, lighting the fire is going to give you a certain quanta of heat and that's going to raise the pressure in the combustion chamber to a certain level and it's that pressure - you may call it BMEP if you wish - that turns the crankshaft. For a 1600cc engine and that particular set of conditions, you're never going to see more than about 80 lb-ft of torque. And at a fairly low rpm too, which isn’t all that bad because props are more efficient at lower speeds. (When the object is to produce thrust, if you're honest the bottom line has to include the propeller's efficiency factor.)

Eighty ft-lbs of torque at prop speed is closer to 40 horsepower than sixty. But even that level of output will quickly exceed the thermal limitations of the Volkswagen's heads, assuming a standard atmosphere and a cooling-air pressure differential equal to six inches of water, about all you manage in a tumbleweed like the Texas Parasol. Exceeding the thermal limits doesn't mean the thing will explode but it does mean your MTBO takes a header into the porcelain fixture, forcing you to top the valves every fifty or one hundred hours. Not my idea of a durable engine.

The situation is even worse if the caller wants me to build him one of those 100hp VW engines he's heard about. Sorry, Charlie. I simply don't know how, unless you want to compare apples to oranges or dune buggies to airplanes.

Remember the Continental A40? (Even flown a Piper E-2? :-) The A40's displacement is 112 cubic inches, about the same as an 1834cc VW conversion. The A40 produced about 90 lb-ft of torque at about 2000 rpm for a TBO of 200 hours. (I'm pulling this out of the memory bank so you'll have to work with me here.)

A standard equation for computing horsepower is to multiply the torque in ft-lbs times the RPM and divide the result by 5252, which is sometimes called the ‘winding constant,' as if the torque were acting through a lever a foot long for a full minute. 90 times 2000, divided by 5252 equals

34.3 horsepower. Which sez I've mis-remembered something because the A40 was rated at 37hp. But you get the idea.

Ditto for the A65. Max torque was something like 145 lb-ft at 2400 rpm. from a displacement of 171 cubic inches. (I'll let you do the math :-)

See that 2180cc VW hanging on the test stand out behind the shop? That's my Hangar Queen. Since 1968 or thereabouts she's racked up better than fifteen hundred noisy hours testing everything you've ever heard of and a lot that you haven't. (I've torn-down the poor thing so many times I've lost track.) See that box of wiggle sticks over there in the corner? Dig around, you'll find stock VW cams along with several from Engle, Web and Schneider, both solids and juicers, even a couple of special grinds I worked up myself, all chuggers designed to give maximum torque across an RPM practical for a propeller. Forty years of VW engine building experience, nearly two thousand hours of testing - enough gasoline to float a boat - and the best I can do is about 115 lb-ft of torque out of that thing. That's about 55hp. At prop speeds. Not 80 or 100 like all those other guys.

Of course, those hours of testing are comparing apples to apples. Or rather, torque to torque. And at speeds suitable for slinging a prop efficiently. On that basis I think it's fair to say I've managed to do about as well as Continental or Lycoming when it comes to the power output of a small air-cooled engine. The 2180, which is about 133cid, produces about 115 lb-ft of torque. The A65's 171 cubic inches cranked out about 145, the A40's 112 cubes managed about 90. And I've gotten as much as 80 ft-lbs out of a sorta-stock 1600 turning about 2600 rpm. But I've obviously got a long way to go to catch up to those other VW engine builders. Based on their published figures volumetric efficiencies regularly exceed 100%, specific fuel consumption on the order of three tenths of a pound per horsepower-hour is not uncommon and pulling nearly one horsepower per cubic inch for a TBO of 1500 hours is old hat. Truly incredible engines.

No one in their right mind would buy a forty horse engine when they can buy a sixty horse that weighs and costs the same, which is why I no longer build engines for sale.

Given the nature of this Newsgroup I'm sure some will detect a hint of sour grapes in the message above (and they may be right. :-). But in doing so they will miss the point entirely. The key to powered flight is the power plant. Ready availability of an inexpensive, reliable engine could play a vital role in arresting the decline of General Aviation in America, whereas fallacious claims of power or performance do exactly the opposite.

Such an engine has been available for more than a quarter of a century and a number of airframes have been designed around it. Designs based on the engine's actual output and durability have proven successful, those based on its fallacies have not.

- R.S.Hoover