The story of how I ended up building the engine after the airplane, and my experience and tips on ECI Kit engine building

Louis Beaulieu, May 2011
KIT ENGINE BUILDING - Agenda

- How I ended up building my engine
- Step 0 – Ordering the kit – The options
- Step 0.1 – Documentation
- Step 0.2 – Tooling/Consumables
- Cylinder Assembly
- Connecting Rod Assembly
- Crankcase Mating
- Gearbox and Cylinders Assembly
- Documentation
How I ended up building my engine

- I have been building a Vans RV-9 since 2001
- I had decided to use a 160hp Lycoming
- Budget constraints had guided me to consider a used engine:
  - I looked for months for a good condition, right configuration, working condition engine
  - Useable for 500 hours before repair
  - To save some $$
How I ended up building my engine

- Some options for the Lycoming O-320 engine:
  - Engine Mount: Conical, Dynafocal I or II
  - Intake: Updraft, Front or Rear Inlet
  - Accessory case: For 2 mags or for one dual mag
  - Oil Filter: with cartridge adapter or with screen
  - Orphan Configuration: H2AD, Aerobatic, Helicopter
  - Fuel Injection or Carburetor
  - Variable Pitch or Fixed Pitch, hollow or full crank
  - Prop Flange: bolt diameter
  - Compression ratio: 7:1 or 8.5:1
  - See Lycoming SSP-204 for configuration definition
How I ended up building my engine

- After years of searching, I found a pearl ???
- The used engine I had found:
  - Crank flange misalignment, but within limit
  - Camshaft gear had been inspected OK
  - It seemed to be a good choice, but a detailed inspection revealed:
    - Front cylinders had severe carbon deposits
    - Front cylinder intake cam was worn out, (found once installed on my RV)
    - Internal crankshaft pitting found after removing fixed pitch plug (ref. SB505 & SB530)
How I ended up building my engine

- The first engine before the kit:
  - Out of a 1963 Cherokee 160
  - 5000 TT, 1500 since OH, Prop strike (flange within limits)
How I ended up building my engine

- Camshaft inspection: worn cam lobe
How I ended up building my engine

- Camshaft lobe damage:
How I ended up building my engine

- Repairs estimation
  - Repair cost for a new camshaft and possibly a new crankshaft (due to internal pitting) were up to $9000 + unknowns
  - Cylinders would have required an addition $500 each (repair required special tooling to remove carbon deposits)
  - Opening the engine may have revealed additional issues

- Was not a good economical solution and too risky.
How I ended up building my engine

- LESSONS LEARNED
  - Good compression is not the only factor
  - A less than perfect flange alignment is not acceptable if you are going to use a prop spacer because it magnifies the misalignment
  - For a used engine look for:
    - Currently in use
    - Has time left before overhaul, and
    - Comes with accessories (expensive)
    - Pay no more than % of remaining life + core
    - Already in the appropriate configuration
Final Engine Choice

- There are several kit engine suppliers:
  - Superior
  - Lycoming
  - ECI
  - And others that manufacture some parts.

- Most suppliers promote an assembled experimental engine, cost starts in the lower $20K for a Lycoming or clone but increases quickly when adding options.

- However, they also sell them as kits.
Final Engine Choice

- My final engine choice: ECI® Titan Kit Engine

- Selection based on price and reputation
Kit Engine Cost

- Lycoming or clone Engine Kits:
  - If you buy the unassembled core without accessories it will be less expensive
  - Get accessories from a retired engine, new accessories are expensive
  - Weight carefully expensive options like:
    - Electronic ignition: + $1000 + per side
    - Variable pitch prop: + $5000 with prop
    - Fuel Injection: + $3000 with DC pump
  - Performance modifications will increase the cost significantly
Building VS Overhauling

- If you are planning to overhaul your engine, you need to plan for:
  - Much more tools and shop equipment are needed for cleaning, measuring, and inspecting
  - Some of the work will have to be done by an approved shop
  - Many parts will still need to be replaced
  - Read the OH manual, it’s all in there
Building VS Overhauling

- Used Accessories:
  - Consider using the time left on salvaged accessories but keep track of total time in service since OH
  - Consider having critical components overhauled by an approved shop:
    - Propeller Governor (because a prop overspeed may be fatal)
    - Fuel Injector / Carburetor
My engine choice

- My ECI engine designation is OX-320-B1A1N (ECI designation is different)
- Accessories were salvaged from the previous engine:
  - Carburetor (overhauled myself)
  - 1 Magneto (replaced breakers)
  - Fuel pump (new, replaced salvaged one)
  - Starter (salvaged was almost new)
- I added one Lightspeed electronic ignition (still not sure of the added value)
Paperwork – To Get

- ECI DOES NOT PROVIDE ASSEMBLY INSTRUCTIONS
- ECI provides an Assy Hardware Manual
- Lycoming Service Manuals:
  - Overhaul (OH) Manual
  - Parts Manual
  - Service Bulletin (SB), Service Letter (SL), Service Instruction (SI), Airworthiness Directives (AD)
- Your Engine Log
Kit Builder Homework:
- Read through all the applicable assembly section of the Lycoming OH manual, List all required tools and consumables
- Read through all applicable SB, SL, and SI. They contain additional useful information for the build and for the break-in period
- Take some notes: Consumables, Tools, Run-in instructions, etc.
- Fill-out the Engine Log as you are building
- Record the P/N & S/N of major components
Shop Setup & Tools

- You will need some special tools for your engine.
- I had to get the following specific tools:
  - Torque Wrench, preferably new or verify calibration.
  - Valve compression tool.
  - Piston ring compression tool.
  - Painting booth and equipment if you are painting your engine.
Shop Tools - $10 Engine Stand
Consumables

- You will have several choices for consumables
- Specific consumables (per OH manual):
  - STP
  - Lubriplate 105
  - Loctite 515 (for crankcase half joint)
  - Valve lapping compound
  - Storage oil
  - Graphite Spray
  - Mineral engine oil, engine paint, etc.
Engine Painting

- Took much longer than expected
- Required a lot of complex masking
- I used Randolph Engine Enamel 303 black (Spruce does not stock gray), but gray paint would require lighter coat
- The enamel must be baked in an oven
- At a minimum, the steel barrel section of the cylinder must be painted
- If I were to do it again, I would not paint cylinder heads for better cooling
Cylinder Assembly

- Most of the cylinder assembly work had already been done by ECI because it requires shop tools:
  - Valve guides are installed
  - Rocker bushings are installed
  - Studs and Helicoils are installed
- You will lap and install the valves
- Verify ring gap
- Install piston rings and piston in cylinder
Cylinder Assembly
Cylinder Assembly
Connecting Rod Assembly

- Connecting rods come with the piston pin bushing installed.
- The crank pin bearing are installed with Lubriplate 105 and bolted to the crankshaft.
- Nut orientation is critical.
- Torque is also critical, there is no lockwire.
- The connecting rod part number at the crankpin should look down at the sump.
Connecting Rod Assembly
Connecting Rod Assembly

- If you end up with something that looks like this you have **not** followed the instructions correctly.
- Your engine is supposed to fire every 180 degrees and it won’t happen like this.
Connecting Rod Assembly

- It should look like that
- Confirm with the OH manual, there is no fool proofing
- Otherwise the pistons won’t be where the camshaft expects them to be
Crankcase Mating

- There are 2 ways to seal the crankcase parting joint:
  - The traditional silk and form-a-gasket
  - Locktite 515 per SI 1125 (my choice)
- The camshaft needs preparation by applying graphite to the cam lobes
- The lifters need to be installed in place
- There are Orings on the crankase thru bolts
Crankcase Mating
Crankcase Mating
Crankcase Mating
Crankcase Mating

- Ready for mating
- Lifters installed
- Thru-bolt oring
- Front bearings
Crankcase Mating

- Loctite 515 application
- See SI 1125
Crankcase Mating

- Thru bolts are interference fit
- Be prepared to use persuasive force
- Follow OH manual instruction
Camshaft Idler Gear

- That part is fool proof
- The other idler gear can be put in any position
Accessory Section Gears
Accessory Section Cover

- Contains the oil pump
- Don’t forget the fuel pump pushrod
Accessory Section Cover

- Cover installed with accessory gears
Accessory Section Cover

- Side note on Pipe Threads: Spiral Leakage Path
- Thread sealant must be used

See EAA Sport Aviation Aug 2010 (above)
Cylinder installation

- All valve clearances were within limits without having to swap pushrods
Ready for installation
Ready for installation
Installed on the RV-9
Engine Hanging on an RV

- Engine Hanging Information
  - http://www.vansairforce.net/articles/IllustratedGuideToEngineHanging/enginehanging.htm
Prop Seal Installation

- There is a special tool available, see SI1324
- The wrench trick worked but it may have damaged the seal… I would not try that next time.
Firewall Forward Installation

- Manufacturing & installing baffles
- Installing the oil cooler
- Installing fuel system
- Installing the ignition system
- Installing the electrical system & sensors
- Installing induction system
- Installing the cowling and air inlets
Engine Break-In

- ECI recommends doing a run-in to verify the engine operation, and thereafter the break-in period starts.
- Initial break-in requires 20 to 30 minutes operation at 75% engine power.
- Thereafter and for the next 50 flight hours the engine should be operated between 65% and 75% power when in cruise.
- See ECI publication ‘Break-In Instructions’, or Lycoming SI427.